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Priority Treatment for High Occupancy Vehicles in the United States: a Review of Recent and Forthcoming Projects

Final Report
August 1978

Service and Methods Demonstration Program

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16. Abstract

This report describes recent high occupancy vehicle (HOV) preferential projects in the United States, summarizes the results of many projects and draws implications, and outlines projects which are to be implemented over the next few years. The report describes each of the following approaches to preferential treatment: non-separated concurrent-flow freeway HOV lanes, contra-flow freeway lanes, metered ramp bypass lanes and exclusive ramps, physically separated priority lanes, express bus service and park-and-ride lots, lanes on arterials and CBD streets reserved for buses, bus priority signal systems on arterials and CBD streets, transit malls, and auto restricted zones.

During the late 1960's and early 1970's a variety of priority treatments were attempted. Both capital intensive projects and non-capital intensive projects were implemented during this period. By the middle of the 1970's, thinking within the transportation planning community had moved away from the costly capital intensive priority treatments that require extensive new construction to the more operationally oriented traffic management schemes that use existing facilities in a more efficient manner. Except for the non-separated concurrent flow projects, other non-capital intensive priority treatments on freeways have fared well.

Nearly every HOV priority treatment on freeways has involved the use of new or expanded express bus service and the opening of new park-and-ride lots. Arterial and CBD street bus lanes have been implemented in many cities and transit malls have grown in popularity. Four auto restricted zones are to be built during the next few years.

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PREFACE

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METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
in	inches	2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
	AREA			
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
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oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
	VOLUME			
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
	TEMPERATURE (exact)			
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
	AREA			
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
	MASS (weight)			
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
	VOLUME			
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l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
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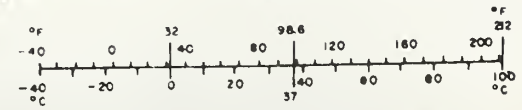

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1. INTRODUCTION

The purposes of this report are threefold: to describe recent high occupancy vehicle (HOV) preferential projects in the United States; to summarize the results of these projects and draw implications; and to outline projects which are to be implemented over the next few years. The report describes each of the following approaches to preferential treatment: non-separated concurrent-flow freeway HOV lanes, contra-flow freeway lanes, metered-ramp bypass lanes and exclusive ramps, physically separated priority lanes, express bus service and park-and-ride lots, lanes on arterials and central business district (CBD) streets reserved for buses, bus priority signal systems on arterials and CBD streets, transit malls, and auto restricted zones.

Table 1 lists most of the HOV preferential projects that have been implemented or are being planned. Projects in all areas are well represented, but during the past decade the thrust of the preferential program has undergone several fundamental changes.

During the late 1960's and early 1970's a variety of priority treatments were attempted. Both capital intensive projects (such as the Shirley Highway reversible bus and carpool lanes and the El Monte Busway) and non-capital intensive projects (such as the contra-flow lanes on I-495 in New York and metered ramp bypass lanes on Los Angeles freeways) were implemented during this period.

By the middle of the 1970's, thinking within the transportation planning community had moved away from the costly capital intensive priority treatments that require extensive new construction to the more operationally oriented traffic management schemes that use existing facilities in a more efficient manner. As an example, the implementation of a concurrent-flow lane utilizing an already existing freeway lane can be accomplished literally overnight compared to the time it takes to construct a new lane or a completely new facility. Boston spent a total of $53,000 and very little time for signing, drilling holes, and purchasing plastic inserts to implement the eight mile (12.8 km) Southeast Expressway concurrent-flow reserved lane, while the eleven mile (17.6 km) Shirley Highway with reversible lane cost $43 million to implement over a period of six years.

However, as is pointed out in Section 2, the concurrent-flow "take-a-lane-away" projects on the Southeast Expressway and Los Angeles' Santa Monica Freeway have been terminated. While the other non-separated concurrent-flow freeway projects are still operating, they are experiencing high violation rates. In summary, non-separated concurrent-flow freeway HOV lanes have proven to be difficult to

TABLE 1. APPLICATIONS OF PRIORITY TREATMENTS FOR HIGH OCCUPANCY VEHICLES IN THE UNITED STATES

Technique	Before 1970	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	After 1980
Non-Separated Concurrent-Flow Freeway Reserved Lanes	San Francisco, Oakland Bay Bridge					Boston, I-93 at I-95 Junction Honolulu, Moanalua Freeway San Francisco (Marin County), US 101 San Diego, Route 163 (bus only)	Portland, Banfield Freeway San Francisco, I-280	Los Angeles, Santa Monica Freeway Miami, I-95 New York, Gowanus Expressway New Jersey I-95	Boston, Southeast Expressway		San Francisco (Marin County), US 101 (Extension)	New York, Gowanus (Extension)	
Contra-Flow Freeway Reserved Lanes		New York (New Jersey), I-495	New York, Long Island Expressway Boston, Southeast Expressway	San Francisco (Marin County), US 101						Houston, IH45 North Freeway			
Metered-Ramp Bypass Lanes (number)					Los Angeles, I-405 (1)	Minneapolis, I-35W (8) Los Angeles, I-405 (1) I-5 (GS) (1) I-10 (4)	Minneapolis, I-35W (1) Milwaukee, E-W Freeway (1) Los Angeles, I-5 (GS) (2) I-10 (5) Dallas, N.C. Expressway(1)	Los Angeles, I-10 (1) I-11 (5) San Francisco, I-280 (1)	Los Angeles, I-5 (GS)(10) I-10 (1) US 101 (1) I-605 (2) I-5 (SA, (5)	Los Angeles, I-405 (2) I-605 (12) Planned (47)	Los Angeles, (11) Dallas, I-30 (1)	Los Angeles (21) San Diego, Route 94 (4)	Los Angeles (22) (1983)
Exclusive Access Ramp		Seattle, I-5	Pittsburg, Braddock Ave./ Parkway East			San Diego, Route 163	Chicago, O'Hare		Miami, I-95			Seattle, I-5 (Extension)	
Separated Rights-of-Way	Washington DC, Shirley Highway (1969-1975)				Los Angeles, San Bernardino Freeway El Monte Busway				Pittsburgh, S. PATway San Francisco, Route I-580			San Francisco, I-580 (Extension)	New York, Long Island Expressway Pittsburgh, E. PATway I-91 (1981) Washington DC, I-66 (Virginia) (1981) Boston, Southeast Expressway (1982) Los Angeles (possible 40-100 miles) Portland, I-205/Banfield (1983)

TABLE 1 (continued). APPLICATIONS OF PRIORITY TREATMENTS FOR HIGH OCCUPANCY VEHICLES IN THE UNITED STATES

Technique	Before 1970	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	After 1980
Reserved Bus Lanes Arterials w=with-flow c=contra-flow r=reversible m=median	Baltimore (w) Buffalo (w) Indianapolis (c) New Orleans (m) Washington (w) Seattle (w)	Madison (c)	Honolulu (c) Philadelphia (w) San Juan (c)		Honolulu (c)	Miami, NW 7th Ave. (w) Miami, US 1 (w + c) Seattle, SR-522 (w) Arlington (w)	Miami, NW 7th Ave. (r)			Portland (r)			
Reserved Bus Lanes on CBD Streets w=with-flow c=contra-flow m=median	Baltimore (w) Birmingham (w) Buffalo (w) Chicago (w,c,m) Dallas (w) Harrisburg (c) Nashville (w) New York (w) Newark (w) Philadelphia (w) Pittsburgh (w,c,m) Providence (w) Rochester (w) Washington (w)	Seattle (c)	Houston (w)			Minneapolis (c) Denver (w) Los Angeles (c)	San Francisco (w)	St. Louis (w) Washington, DC (w)	NJ Lincoln Tunnel Approach (w)	Chicago (c) Portland (w)	Los Angeles (c) Boston (w + c)		
Bus Priority Signal Systems on Arterials and CBD Streets pre=preemption pro=progression				Louisville (pre) Washington DC, (pre)		Miami, NW 7th Ave. (pre) Miami, US 1 (pro)	Miami, NW 7th Ave. (pro)	Sacramento (pre)	Santa Cruz (pre) Concord (pre)	Dallas (pre) Houston (pre) Memphis (pre) Santa Clara (pre) Portland (pre)	Minneapolis (pre) Philadelphia (pre)	Boston (pre)	Boston (pre)
Transit Malls	Minneapolis, Nicollet Mall (1967)							Philadelphia, Chestnut St.		Portland, 5th & 6th Avenues Madison, State Street Detroit, Woodward Avenue and Washington Boulevard Chicago, State Street Mall Minneapolis, Nicollet (Extension) Los Angeles, Broadway		St. Louis, Locust St. Buffalo, Main Street Denver, 16th Street Brooklyn, Fulton Street	Cleveland, Euclid Avenue
Auto Restricted Zones										Memphis Boston	Providence	New York, Broadway Plaza	

enforce, subject to accidents, and, when an already existing lane is re-dedicated for HOV's, unacceptable to the public.

By contrast, the Shirley Highway (which was opened to four or more person carpools in 1973) and the El Monte Busway (which was opened to three or more person carpools in 1975) have been highly successful in attracting bus riders and carpoolers, while experiencing none of the enforcement and safety problems encountered by the non-separated treatments. Several activities indicate a resurgence of interest in physically separated priority lanes: planners in both Boston and Los Angeles are investigating designs similar to Shirley and El Monte for their troubled corridors; new physically separated facilities were opened during 1977 in San Francisco and Pittsburg, and both are scheduled to be expanded; and a Virginia freeway (I-66) reserved for buses and four or more person HOV's during peak periods is scheduled to open in the early 1980's.

Fortunately, except for the non-separated concurrent flow projects, other non-capital intensive priority treatments on freeways have fared well. Metered ramps have proven to be an effective device for reducing freeway congestion and increasing vehicle speed. However, some of the time saving is lost waiting in the queue at the metered ramp. As a result, bypass lanes for HOV's have been installed in several locations and have proven to be an effective, safe, relatively inexpensive, and publicly acceptable way to provide HOV priority treatment on freeways. However, California has recently been experiencing an increasing and potentially serious problem with enforcement. The only major installations of bypass lanes have been in Minneapolis (nine bypasses) and in Los Angeles (53 bypasses as of March 1978, with an additional 211 scheduled to go into operation by the end of 1979). San Francisco opened one in 1976 and plans to have a total of seven in operation by the end of 1980.

Several very successful contra-flow bus lanes have been in operation for many years, and a new one will open in Houston in late 1978 or early 1979. Contra-flow lanes have probably not been more prevalent since they require a major directional flow imbalance. They are typically only used (for safety reasons) by buses and other large, specially licensed vehicles, and there is a significant daily cost to insert and remove the lane separators.

Nearly every HOV priority treatment on freeways has involved the use of new or expanded express bus service and the opening of new park-and-ride lots. Express bus service has proven to be popular but costly to provide due to extensive deadheading. The expansion of the express bus coverage, and not the priority treatment itself, seems to have been the primary reason for increases in ridership. The performance of park-and-ride lots has been mixed, being

dependent on the placement and design of the facility and the quality of the bus service provided. For example, the success of Miami's Golden Glades park-and-ride lot was due, in part, to the placement of a large, guarded and well lit lot eleven miles (17.6 km) from the CBD at the confluence of several major highways. Buses travelled to four central city destinations, and headways were short.

At least 27 cities had implemented reserved bus lanes on arterials and/or CBD streets by the beginning 1971. Since then several additional cities have begun similar treatments, while many of those with existing concurrent-flow, contra-flow, reversible, or median lanes have expanded their systems. Bus priority signal systems (preemption and progression) are operating in several cities, and four new preemption systems will become operational in 1978 and 1979. All of these treatments have led to decreases in bus travel time and increases in schedule reliability.

Transit malls have become a popular method for improving transit reliability and revitalizing CBD shopping areas. A successful transit mall was opened in Philadelphia in 1976 and several new transit malls will be completed in 1978. Finally, four auto restricted zones, which will result in an increase in pedestrian amenities and a broad reorganization of traffic in the downtown areas, are to be built during the next few years in Boston, Providence, Memphis, and New York.

2. NON-SEPARATED CONCURRENT-FLOW FREEWAY HOV LANES

Four major non-separated concurrent-flow reserved lane on freeway projects were initiated during the past several years: on the Santa Monica Freeway in Los Angeles, I-95 in Miami, the Southeast Expressway in Boston, and the Banfield Freeway in Portland, Oregon (see Table 2 for a description of these projects). These projects have met with differing degrees of success and failure. The two projects that involved the taking away of an existing lane from general traffic and re-dedicating it to HOV's ended amid much controversy and public dispute. The voluntary reserved lane on the Southeast Expressway survived for six months only to be cancelled suddenly two and a-half weeks after the lane restrictions became mandatory. A Federal judge shut down the Santa Monica project after 21 weeks of operation because an appropriate environmental impact report had not been filed. The other two projects, which involved the creation of a new lane for HOV use, are still in operation, but the restrictions have been modified. In Miami, the underutilization of the HOV lane, a high violation rate, the lack of police commitment to the project and difficulty of enforcement led to a lowering of the lane qualification to two or more persons per car and a decrease in the hours of operation. In Portland, the hours of lane operation were

TABLE 2. COMPARISON OF FOUR NON-SEPARATED CONCURRENT-FLOW PREFERENTIAL LANE PROJECTS

PROJECT	FACILITY	LENGTH (miles)	OPERATING DATES	LANE RESTRICTIONS	LANE ORIGIN	HOURS OF OPERATION	SPECIAL FACILITIES
Boston: Southeast Expressway	Freeway, 3 or 4 lanes each direction, including use of shoulder in peak direction during peak period	8	5/04/77-11/02/77	Buses and carpools (3 or more occupants)	1 existing lane reserved (inbound)	6:30-9:30 a.m. inbound only	Plastic inserts space 20-40 feet, freeway "metering" for 3 months
Miami: I-95	Freeway, 4 or 5 lanes each direction	7.5	3/15/76-present	Buses and carpools (3 or more occupants, changed to 2 or more)	2 lanes built in median area	6-10 a.m. (changed to 7-9 a.m.) inbound; 3-7 p.m. (changed to 4-6 p.m.) outbound	Flyover connecting major park and ride lot to I-95 after one year
Los Angeles: Santa Monica Freeway	Freeway, 4 or 5 lanes each direction	12.9	3/15/76-8/09/76	Buses and carpools (3 or more occupants)	2 existing lanes reserved	6-10 a.m. (changed to 6:30-9:30 a.m.) 3-7 p.m. inbound and outbound	Ramp metering, some with preferential bypass
Portland Oregon: Banfield Freeway	Freeway, 3 or 4 lanes each direction	3.3	12/15/75 present	Buses and carpools (3 or more occupants) and taxis as of June 1978)	resurfaced, removed shoulder, narrowed lanes	24 hours/day changed to 6:30-9:30 a.m. inbound and 3:30-6:30 p.m. outbound	

TABLE 2 (continued). COMPARISON OF FOUR NON-SEPARATED CONCURRENT-FLOW PREFERENTIAL LANE PROJECTS

PROJECT	ACCESS/EGRESS	ENFORCEMENT	TRANSIT	EXPRESS BUS AVERAGE FARE(one-way)
Boston: Southeast Expressway	Only at beginning and end	Voluntary for first 5 months, enforced last 2-1/2 weeks; increase in police surveillance	Minor changes to existing express and feeder bus, rapid rail, commuter rail, and commuter boat; new park and ride route	$1.25
Miami: I-95	Unlimited	Little enforcement; no increase in police surveillance	Park and ride and feeder/express bus service increased from 18 to 52 trips per day; new large park and ride lot	.60
Los Angeles: Santa Monica Freeway	Unlimited	Fifty percent increase in police, reduced to normal by 12th week	Four existing feeder/express bus routes increased to 9; 3 new park and ride routes and lots	.61
Portland Oregon: Banfield Freeway	Unlimited	High level of enforcement	Ten express buses added	

reduced from 24 hours per day to three hours in-bound in the morning and three hours out-bound in the evening.

Several smaller non-separated concurrent-flow projects were instituted during the past several years. A lane reserved for buses and carpools of three or more occupants began operating on I-280 in San Francisco in late 1975. The lane, which is two miles (3.2 km) long, operates southbound only, 24 hours per day.

In October 1976, a reserved lane for buses and taxis with passengers was opened on New York's Gowanus (Brooklyn-Queens) Expressway for a distance of 1.2 miles (1.9 km). The purpose of the facility is to give buses and taxis a travel time advantage at a major merge area. The lane operates from 7:00 a.m. to 10:00 a.m. on weekdays, and the restrictions are currently not being enforced.

Also in 1976, the right hand shoulder of the I-95 approach to the George Washington Bridge on the New Jersey side was physically separated by plastic inserts for a quarter of a mile (.4 km) during the morning peak period to expedite the movement of buses to the toll plaza. Some existing automobile traffic was also permitted use of the lane; however, current plans call for a reduction in non-HOV traffic and the inclusion of carpools.

The following summarizes the results of the Los Angeles, Boston, and Miami projects:

- Auto occupancy rates increased (in Los Angeles, from 1.22 to 1.31; in Boston, from 1.31 to 1.38; in Miami, from 1.23 to 1.28).
- Carpooling increased by about 70 percent at the three sites.
- Travel time for users of the reserved lanes decreased.
- Projects provided a focal point for transit marketing.
- Projects created a perceived, as well as real, time advantage in the minds of bus passengers.
- Violation rates were high (15 percent in Los Angeles where enforcement was strict; 80 percent in Boston during the voluntary period; 75 percent in Miami during the three person carpool phase).
- Restrictions were difficult to enforce without a median shoulder in Boston and Miami.

- In Boston, plastic inserts separating the reserved lane did not prevent illegal weaving.

- Accidents increased by 150 percent in Los Angeles; Boston unclear; no statistical change in accidents in Miami.

Several general statements can be made about this concept:

- Re-dedication of an existing lane for concurrent flow priority use is not recommended. The two major projects (Boston, Los Angeles) which implemented this approach were terminated due to a strong negative reaction from the media and the public and lack of political consensus.

- Concurrent-flow lanes should be separated from normal lanes by closely spaced plastic inserts to prevent weaving and by a concrete barrier or a safety lane to minimize problems of accidents and violations (see Section 5).

- A left shoulder is desirable for vehicles in distress and necessary for enforcement.

In Los Angeles, the controversy over the Santa Monica reserved lane was so intense that no additional "take-away" lanes are planned, and a newly constructed lane on another Los Angeles freeway that was originally planned to be dedicated for exclusive HOV use was opened to general traffic. In Boston, the current plan is to re-build the Southeast Expressway in a 3-2-3 configuration with the center two lanes being reversible, separated from the rest of the roadway and reserved for HOV's.

In Florida, non-separated concurrent-flow reserved lanes are still being considered for other locations, but not without a median area. Some members of the Florida Department of Transportation would like to see Miami's I-95 re-striped with narrower lanes so that a median area can be created for use as an area for enforcement and distressed motorists. The Oregon Department of Transportation is currently studying three options for the Banfield Freeway: extension of the reserved lane, construction of a separated busway, and construction of a light rail vehicle right-of-way.

A feasibility study is underway to extend New York's Gowanus concurrent-flow bus and taxi lane as far as the Brooklyn Battery Tunnel. The project would involve offsetting the concrete median barrier and using the former median breakdown lane for the preferential lane. If approved, implementation would be in 1980. The California Department of Transportation is planning to extend the

concurrent-flow bus and carpool lane on U.S. 101 north of San Francisco in 1979.

3. CONTRA-FLOW FREEWAY LANES

Several successful contra-flow freeway lanes reserved for buses have been operating for many years in the United States: U.S. 101 in Marin County, California; I-495 approaching New York City's Lincoln Tunnel; and the Long Island Expressway approaching New York City's Queens-Midtown Tunnel. Taxis with passengers were first permitted to use the Long Island Expressway facility in September 1977.

While there have been no new contra-flow freeway projects during the past several years, one will be implemented in Houston in the fall of 1978. Construction began in early 1978 to develop an exclusive contra-flow lane for about ten miles (16 km) on the IH45 North Freeway between the CBD and the Houston city limits. Initially, the lane will carry only buses, airport limousines and registered commuter vans. Most of the buses will run between the CBD and a 750 space park-and-ride lot at the northern terminus of the contra-flow lane.

4. METERED-RAMP BYPASS LANES AND EXCLUSIVE RAMPS

In 1973, the first metered freeway ramp in Los Angeles was equipped with bypasses for buses and carpools with two or more occupants. The number of ramps with bypasses in the Los Angeles area grew to seven by the end of 1975. As of March 1978, 53 bypasses were in operation. Early California installations proved to be effective, safe, easily enforceable, relatively inexpensive, and publicly acceptable. However, recently there has been an increasing and potentially serious problem with violations.

Forty-seven additional bypasses are scheduled to go into operation by the end of 1978 if sufficient California Highway Patrol manpower are provided for enforcement purposes. The total number of bypasses is expected to reach 264 by the end of 1979 and 350 by the end of 1983. Los Angeles officials would like to increase the number of bypasses at this rate but they have not as yet received a commitment from the State for an adequate number of police to enforce a greatly expanded system.

The only other city that currently has a major commitment to ramp meter bypass lanes is Minneapolis. A bypass ramp was opened to carpools of three or more occupants at the Grant Street entrance to I-35W in November 1975, bringing the number of bypasses on that freeway to nine.

A bus-only ramp was implemented in Milwaukee in late 1975. This project allows buses to bypass a metered ramp which other vehicles use to access the westbound "East-West Freeway" from the downtown CBD of Milwaukee. An exclusive lane allows buses to go around the metered ramp. While using this exclusive lane, a red-signal is triggered at the metered ramp thereby allowing the bus safe access to the Freeway.

A preferential bypass lane was implemented in Dallas in late 1975 on the North Central Expressway, and one will be implemented on I-30 in 1979. A bypass lane on I-280 in San Francisco was opened in 1976, and plans call for six bypasses on U.S. 101 by 1980 and several more on I-280 after 1982.

During the next five years metering will be installed on eight ramps on Route 94 in San Diego. Four of these ramps will have HOV bypass lanes.

Ramps for the exclusive use of HOV's have been built in several locations, typically to avoid bottlenecks or to provide more direct access from a major traffic generator. A bus-only ramp was opened at Chicago's O'Hare International Airport in September 1975. The ramp saves .9 miles (1.4 km) and five minutes running time for the express buses. A flyover connecting carpools and buses at a major parking lot to the Miami I-95 reserved lanes was opened in 1977, reducing travel time by several minutes.

An on-ramp and an off-ramp reserved for buses and carpools are planned for the north terminus of I-5 in Seattle's CBD. Implementation is scheduled for 1980. These will complement the two ramps at the southern terminus which were implemented in 1968.

5. PHYSICALLY SEPARATED PRIORITY LANES

Physically separated priority lanes result in savings in travel time as well as improvements in travel time reliability compared to regular lanes. There have been two new physically separated priority lane projects opened during the past two years. In 1977, a four mile (6.4 km) reserved lane for buses and three or more occupant carpools was opened on Route 580 east of San Francisco in Livermore. The road configuration is similar to the El Monte Busway and consists of two regular lanes, a buffer lane, and the preferential lane. Plastic inserts are used to separate the reserved lane from the regular lanes.

In December 1977, a 4.5 mile (7.2 km) busway (the South PATway) was opened to connect the southwestern suburbs of Pittsburg to the CBD. The two auto-free lanes reduce travel time from 15 to 30 minutes by permitting buses to bypass

critical points of traffic congestion. The South PATway is the first busway built entirely on its own right-of-way and not in connection with or part of a highway project. (Busways functioning or being developed elsewhere occupy a reserved lane or the median strip of an existing expressway.) Plans are to extend the South PATway another mile and to connect it to a light rail transit right-of-way. In addition, a new 6.8 mile East PATway will open in 1981.

Several other new projects are under construction or planned for the early 1980's. The entire width in the peak direction of a portion of I-66 from Virginia to Washington will be reserved for buses and carpools during the morning and evening peak hours. The only exception will be traffic to and from the Dulles Airport via the Dulles access road (which intersects I-66 and provides services only to the airport). The exclusive roadway is ten miles (16 km) long and extends from the Capital Beltway to the Potomac River. The road is scheduled to be completed in 1981.

Portland, Oregon is building a 28 foot wide, seven mile (11.2 km) long busway in a right-of-way parallel to I-205, a circumferential freeway currently under construction. At present, only the roadbed of the busway is being built; paving will be subject to the type of HOV treatment decided on for the Banfield Freeway, which connects I-205 to the Portland CBD. The Banfield currently operates a non-separated concurrent-flow lane (see Section 2) over half of its distance. The options being considered for the Banfield include extending the present HOV lane the full length of the roadway, building a separated busway or constructing a light rail vehicle right-of-way in the center of the Freeway. Work on both the Banfield modifications and the I-205 busway is expected to be completed by 1983.

The State of Massachusetts is considering rebuilding Boston's Southeast Expressway as a 3-2-3 configuration. Similar to the Shirley Highway, the center two lanes will be reserved for buses and carpools of two or more occupants. The project is in the preliminary design phase and, if approved, will be built within the next five years.

During the next three years the California Department of Transportation is planning to build a five mile (8 km) extension to the I-580 busway in San Francisco. A study to assess the feasibility of constructing 40 to 100 miles (64-160 km) of new busways is underway in Los Angeles (see Section 12).

6. EXPRESS BUS SERVICE AND PARK-AND-RIDE LOTS

Nearly every HOV priority treatment on freeways has involved the use of new or expanded express bus service and the opening of new park-and-ride lots. In many cases, brand

new buses with greater than average passenger amenities have been used for this high quality service. Two German Neoplan double-deck buses have been providing feeder/express and park-and-ride/express service on the El Monte busway in Los Angeles since 1976, and 20 more double-deck vehicles will be added to the fleet in 1979. Major impacts of express bus service are as follows:

- Long haul suburban to CBD transit service for commuters is very expensive; such service typically gets only one scheduled revenue trip per peak period, and deadhead mileage is high
- Fare increases for high quality priority transit service have not had a significant negative impact on transit patronage; many of these services are underpriced considering how much they cost to provide
- Increased transit patronage is highly correlated with increased transit level-of-service in the form of expanded coverage and reduced headways as well as to the reduced travel time of a priority facility
- Priority treatment techniques increase vehicle productivities and reduce resources required to move people in major urban corridors.

The success or failure of park-and-ride lots is highly dependent on their location, the amenities they offer, and the type of bus service provided. Guidelines for park-and-ride lots are that:

- Lots should be distant enough from the CBD to make transferring modes worthwhile
- Lots should be located so as not to require any backtracking
- Lots should have good transit and highway access
- Lots should be adjacent to the freeway offering the priority treatment
- Lots should be large enough to support low headway service to several major destinations
- Lots should be guarded, well lit, highly visible to the motorists and contain amenities such as sheltered waiting areas and telephones.

7. LANES ON ARTERIALS AND CBD STREETS RESERVED FOR BUSES

Concurrent-flow, contra-flow, reversible and median bus lanes on both major arterials and CBD streets may be found in at least thirty American cities. Table 1 contains a list of these cities and the date the first lanes were implemented. Since then, many of these cities have expanded and will continue to expand their reserved lane networks. The reduction in travel time has been found to depend on the length and the number of stops along the restricted portion of the route and the level of enforcement. Thus, express buses running on contra-flow arterial lanes realize greater time savings than local buses operating on concurrent-flow curb lanes within the CBD. Section 8 discusses the use of bus priority signal systems which can be used by buses travelling in reserved lanes to further decrease travel time. All of these options lead to improved scheduling adherence and reliability. The remainder of this section discusses important recent and upcoming preferential street projects.

San Francisco began a transit preferential street program in 1974. In 1975, exclusive transit lanes were installed on 1.02 miles (1.63 km) of Sutter Street and 0.74 miles (1.18 km) of Post Street. In 1976, both all-day and peak-hour bus lanes were instituted on 0.65 miles (1.04 km) of Mission Street. In 1977, reserved transit lanes were installed on 0.68 miles (1.09 km) of Geary Street and 0.41 miles (.66 km) of O'Farrell Street. The extension of the already existing lanes and the implementation of reserved lanes (both with-flow and contra-flow) and transit-only streets on other streets is contemplated for 1978 and 1979. In an attempt to make the lanes self-enforcing, the use of thermo-plastic striping (which is more permanent than paint), better signing (including overhead signs) and plastic lane buttons is planned for 1978. The City plans to establish an office with responsibility for the coordination, refinement, standardization and expansion of the transit preferential streets program.

In 1976, Washington, DC began implementing a system of reserved lanes. Reserved curb lanes are provided for both local and express buses running on nine different arterial streets from outside the CBD to the CBD during peak morning and in the opposite direction for evening periods. In the off-peak these lanes are used mostly for parking. Future plans call for providing reserved lanes at certain "key" areas within the CBD by the end of 1978.

Reserved bus lanes on Olive and Lindall Streets were implemented in St. Louis in 1976. A curb lane is reserved for both express and local buses running between Kingshighway Boulevard and the downtown CBD. The restrictions are in effect eastbound between 7:00 a.m. and 9:00 a.m. and westbound between 4:00 p.m. and 6:00 p.m. In

addition, a curb lane is reserved for buses on Locust Street between 4th and 12th Streets in the downtown area from 6:00 a.m. to 6:00 p.m.

In Portland, Oregon a reversible bus lane has been constructed in the center of Barbur Boulevard by removing the parking on both sides and narrowing the existing lanes. The project, which includes bus preemption, began operating in the spring of 1978. Express buses travel between a park-and-ride lot and the downtown core area, a distance of approximately six miles (9.6 km), during the morning and evening peak hours. During the off-peak this lane is used by other vehicles for left turns only.

In the fall of 1978, Chicago will implement contra-flow bus lanes on four consecutive east-west streets. The project cost is $300,000. Bus time savings are expected to be from five to seven minutes on the .8 mile (1.3 km) length of each street. The average number of buses per street during the peak period is 74. These four streets cross the State Street Transit Mall, which is scheduled for completion in December 1978. Los Angeles is planning a .7 mile (1.12 km) contra-flow express bus lane on Glendale Boulevard. The two contra-flow lanes in Minneapolis, which were installed in 1974, are to be made permanent in the near future with the installation of a mountable concrete barrier.

The Massachusetts Bay Transportation Authority has begun a feasibility study of reserved bus lanes in Boston and the neighboring towns. With-flow, contra-flow, and reserved median treatments are being considered. Implementation is expected to begin in 1979.

8. BUS PRIORITY SIGNAL SYSTEMS ON ARTERIALS AND CBD STREETS

Bus priority signal systems may be either progression (fixed signal cycles where the green phase is sequenced at adjacent signalized intersections) or preemption (signal cycle controlled by the presence of a bus). Preemption may be active (an optical or radio emitter on the bus and a detector at the intersection; a transponder on the bus and a loop detector embedded in the roadway) or passive (a detector embedded in the roadway that recognizes the "signature" of a bus; a sensing device on a trolley wire). In general, the presence of the bus is noted at a single signalized intersection. However, it is possible to enter the position of the bus into a computerized traffic control system that can be programmed to give the bus a "green window" through a portion of the system.

The first preemption system (optical emitter) was installed at 12 intersections in Louisville, Kentucky in 1972 and is still in operation. In 1972, Washington, DC

added a preemption capability to its computerized traffic control system, but this has been discontinued due to high information transmission costs, competing calls from the large number of buses and insufficient time savings. Miami installed an optical emitter system for express buses on NW 7th Avenue in 1974 on an experimental basis. In the same experiment, progression was also tested. Since then, the buses have been rerouted to a parallel freeway (see Section 2) and the preemption system has been removed.

Optical preemption systems have been implemented in California in Sacramento (three intersections), Santa Cruz (ten intersections), Santa Clara (twelve intersections), and Concord (twelve intersections). A bus preemption system has been installed on a reversible center lane on Barbur Boulevard in Portland, Oregon (see Section 7.). Detectors embedded in the pavement automatically trigger the traffic signals when a bus is approaching.

Impacts due to signal priority treatments are difficult to summarize since they are a function of many system parameters such as bus headways, whether buses are express or local, physical spacing of the intersections and detection distance, preemption strategy employed, sophistication of the signal controller, amount of cross traffic, presence of a reserved lane and constraints by the operating authority. The following general statements should, therefore, be treated in this context:

- Simulation studies and actual street tests show about a ten percent reduction in bus travel time in CBD grids with preemption. These savings can be very cost effective when considering bus operating costs and travel time savings for all bus passengers.

- Local buses or buses in non-reserved lanes have to stop frequently for passenger service or because of traffic congestion and, therefore, signal priority techniques, whether preemption or progression, are not as effective as in the case of express buses or buses in a reserved lane.

- The most effective application is for express buses travelling in a reserved lane. Travel time reductions of 30 percent have been observed.

- For express bus operation on reserved arterial lanes, signal progression appears to be nearly as effective as preemption at a significantly lower cost since many cities already have interconnected traffic signals.

Several new projects are planned. Dallas has installed a signal preemption system at 61 intersections on the

service roads and major arterials paralleling the North Central Expressway. These will become operational in the fall of 1978 and will be used by buses travelling to and from the CBD.

The City of Houston is planning to implement a bus priority signal system at 24 intersections on a major transit arterial in November 1978. Twenty local and express buses will be equipped with control devices.

A study to design an express bus preemption system on the Poplar Avenue corridor in Memphis will be completed in May 1978. Approximately 22 intersections outside the CBD (a length of nine miles) will be included in the preemption system. About 20 express buses (ten in-bound and ten out-bound) use this corridor during each peak period. Implementation is scheduled for late 1978.

Minneapolis plans to install a bus priority system on their two contra-flow bus streets and on the Nicollet Mall in 1979. Bus priority will be in effect for 25 blocks on each street and for eight blocks on the Mall. Loop vehicle detectors will be used to detect the bus "signature" and extend the amount of green time. In addition, buses will be able to preempt traffic signals at 21 other intersections.

St. Louis is studying signal timing changes to improve the performance of buses within the CBD. Philadelphia is considering installing signal pre-emption detectors on trolley wires on four lines in West Philadelphia in 1979.

Boston is developing priority signal systems along the surface sections of two light rail lines. Full implementation is expected in 1980. Boston is also considering a bus priority control of traffic signals to be implemented after 1980.

9. TRANSIT MALLS

A transit mall is a street on which standard transit vehicles are given exclusive or near-exclusive use, sidewalks are widened, and amenities are added for pedestrians and waiting transit patrons. As a compromise between preferential treatment for transit vehicles and a full pedestrian mall, transit malls may have an impact on transit service and economic conditions. Since the late 1960's, over a dozen transit malls have been built or are in some stage of development in the United States. During the past several years transit malls have been built in Philadelphia, Madison (Wisconsin), and Portland (Oregon). Table 3 summarizes these transit mall projects, as well as the widely acclaimed Nicollet Mall that was constructed in Minneapolis in 1967.

TABLE 3. CHARACTERISTICS OF FOUR TRANSIT MALLS

SITE	NON-TRANSIT USES	BUS VOLUME	PEDESTRIAN VOLUME	TRAFFIC SIGNAL TREATMENT	MOVEMENT OF GOODS	AMENITIES
MINNEAPOLIS – Nicollet Mall	Taxis Emergency vehicles Bicycles	Peak hr.: Before: 20/ea. way After: 60/ea. way	Before: 1,068/block side/hr., 12-hour period After: 1,114/block side/hr., 12-hour period	Re-set for cross traffic flow (computerized traffic control system scheduled).	Alley loading; mall loading by special permit.	Extensive, including electric snow-melting mats, sign ordinance, bus shelters
PHILADELPHIA – Chestnut Street Transitway	Taxis at night, one block only day Emergency vehicles General traffic (1 block only)	Peak hr.: Before: 43 (one way) After: 41/eastbound 11/westbound	After: 3,016/block side/hr., peak periods on major blocks	Bus-triggered mid-block warning light. Signal timings set for expected bus speed. Timings on nearby street reset.	Cross st. loading; on mall by special permit in off-hours	Typical, with mid-block crossing area.
PORTLAND – Fifth & Sixth Streets Mall	General traffic on one lane for 3/4ths of blocks	Peak hr.: Before: 32 6th Ave. 85 5th Ave. Expected After: 207 6th Ave. 211 5th Ave.	Before: 444 6th Ave./ 686 5th Ave./ block side/hr., off-peak periods.	Computer controlled with progression to be adjusted for buses.	Cross st. loading; on mall by special permit in off-hours	Extensive, including bus shelters and concession booths, CRT information display.
MADISON State Street Mall/ Capitol Concourse	General traffic on Capitol Concourse	Peak hr.: Before: 60 (2-way on State St., 1-way on Capitol Square)		On Capitol Square set to make leaving concourse difficult.	Loading on alleys, cross streets, some curbside during restricted hours.	Typical

Transit malls have been found to have the following impacts:

- Transit travel time remains nearly the same since a large portion of bus delay is due to loading/unloading and traffic signals.
- Schedule reliability is improved.
- The bus system is better understood and better regarded by the public.
- Traffic diversion does not cause significant congestion on alternate streets.
- Malls with exclusive transit use of the roadway encourage motorists to obey the traffic restrictions, compared to transit malls with partial auto access.
- Malls create an attractive and popular environment for pedestrians, although malls with large numbers of buses have problems of air and noise pollution.
- Non-pedestrian accidents decrease sharply, but pedestrian injuries and fatalities do not. Factors leading to accidents include increased jaywalking encouraged by low bus volumes and narrow roadways, the conversion of a one-way street to a two-way busway and the location of sidewalk amenities too close to the curb.
- Malls are generally favorable to retail business and help foster a cooperative spirit between business and government.
- Some businesses may be hurt by inconvenient access for delivery vehicles and motorists.
- Minimal relocation of utilities, special walkways and careful phasing of work limits the negative economic impact due to construction.

Transit malls are popular in the United States and many are currently under construction or are in the final planning stages. These are summarized below:

Fulton Street, the center of downtown Brooklyn's retail district, is being converted into a two lane, 2500 feet long transit mall. Sidewalks are being widened and pedestrain amenities installed. Five bus lines, emergency vehicles and, during specified hours, delivery trucks will be able to use the roadway. The cost is approximately $4.5 million and construction is scheduled to be completed in 1979.

A four block transit mall is currently being built on Detroit's Woodward Avenue. The roadway will have two lanes in each direction and the sidewalks widened. New plantings, bus shelters, kiosks, special paving treatment and a block long canopy are elements of the project. The mall will cost $10 million. Also in Detroit, a $4.4 million pedestrian mall is being constructed for four blocks along Washington Boulevard. This consists of a 120 foot wide pedestrian area and an 80 foot wide roadway. At one edge of the roadway is a trolley line with cars of vintage 1890 purchased from Lisbon, Portugal.

Construction of Chicago's State Street Transit Mall is scheduled to begin in the spring of 1978 and be completed by December 1978. The mall will extend for nine blocks, a distance of .75 miles (1.21 km). The sidewalks will be widened, and buses will travel in both directions on the two lane roadway. There will be bays at each corner capable of accommodating 3 buses. Three-hundred buses will use the facility during the peak hour periods. A subway line passes under eight blocks of the project, and the existing subway entrances will be remodeled. The project is expected to cost $12.5 million. Nicollet Mall in Minneapolis will be extended three blocks to Grant Street during the summer of 1978.

Los Angeles plans to assess the effects of a two-way transit mall along Broadway between 2nd and 9th Streets through a 90 day demonstration in 1978. Temporary barriers and potted plants will be installed, and bus lines will be rerouted onto the transitway. Broadway is a major CBD shopping street. Present plans call for the transit mall to function 24 hours a day.

In St. Louis, a transit mall has been proposed on eight blocks (2700 feet, 810 meters) of Locust Street in the downtown office core. The Transitway would be one-way with two lanes open only to buses. Two center loading platforms per block would permit bus loading from the left lane. Sidewalk widths would be approximately doubled, to about 16 feet (5 meters). The mall is expected to carry 177 buses in the evening peak hours. The project is expected to cost $4 million.

As part of a proposed 6.4 mile (10.2 km) light rail system for the Buffalo CBD, one mile (1.6 km) of the system running along Main Street in the retail section is to be a transit mall. Construction is scheduled to begin in the fall of 1978.

Denver is planning to build an 11 block transit mall on 16th Street, the main commercial street. Construction is scheduled to begin in the spring of 1979 and be completed in 1980. The mall will include transfer facilities at each end, where bus passengers will change to the electric

vehicles used exclusively on the mall. Sidewalks will be widened, and there will be vehicle paths in each direction and a pedestrian promenade in the center.

10. AUTO RESTRICTED ZONES

An auto restricted zone (ARZ) is an area created in a congested portion of the city, such as the central business district or a shopping district, where automobile traffic is prohibited or restricted. At its core is a pedestrian and transit enhancement zone, a space set aside for predestrians and improved transit access. To this core a host of elements can be added: linear transit malls that extend or connect the core to other pedestrian activity centers, reserved bus lanes, transit and taxi facilities, peripheral parking garages, internal or feeder shuttle service, ring roads for the rerouting of through traffic, underground rapid or light rail facilities, congestion pricing for entry into the ARZ and priority treatment on highways providing access to the area.

An ARZ has several essential elements:

- It is, in general, two dimensional and not the linear pedestrian shopping streets that can be found in over seventy American cities.
- It has a core area where the automobile has been completely prohibited such as a transit or pedestrian plaza.
- Through traffic has been diverted around the area.
- Pedestrian amenities have been enhanced.
- Transit service to (and within) the ARZ has been improved.
- It is linked to other urban activity centers by transit or pedestrian ways.
- There is an internal circulation system for transit, delivery, and emergency vehicles.

Unlike the transit mall concept which has been growing in popularity throughout the United States without the need for encouragement from the Federal Government, the ARZ, with its broader reorganization of traffic in the downtown is the subject of a major developmental effort by the Department of Transportation. A two year study to evaluate the feasibility of the auto restricted zone concept and to develop initial demonstration designs in several selected cities has been completed. The following conclusions about

ARZ planning and implementation have been reached: there are substantial opportunities for ARZ's in American cities; city size is not critical to ARZ success; a strong activity base is required; a wide range of techniques is available; the complete prohibition of auto traffic is not the only option; ARZ size is a key determinant of transportation impacts; and the key transportation factor is maintaining accessibility.

Results from this study have been used to select prospective ARZ sites and to develop initial plans for demonstrations. The four potential ARZ demonstration projects (New York, Memphis, Providence and Boston) are summarized in Table 4. They offer considerable variation to the ARZ theme and provide an opportunity to test the ARZ concept in different types of environments and with different designs. Demonstrations at these sites are expected to be funded, implemented and evaluated over the next several years.

The Boston ARZ, which will be implemented in early fall, 1978, includes a transit mall, several street closings, pedestrian amenities and rerouting of buses to provide improved CBD access. It will serve to link the Washington Street shopping area to the other major pedestrian activity centers: the Boston Common, the Waterfront, and Government Center.

The Providence ARZ will provide an important pedestrian and transit link between the other major CBD activity centers: the retail district that already has a pedestrian mall, the financial district and the refurbished Union Station. Limited right-of-way space is to be reallocated to pedestrian and transit while major through circulation for automobiles has been moved to the periphery. The plan, which will be implemented in the fall, 1979, calls for a main transit terminal, two busways, a bus lane, and a pedestrian plaza in front of City Hall. Through-routing of transit vehicles and a fare free zone is alsc planned.

New York's Broadway Plaza will consist of an auto free area on Broadway betwen 45th and 48th Streets in the heart of the Theater District and a transit mall from 48th to 49th streets. Sidewalk widenings will occur as far north on Broadway as 54th Street. Traffic currently using this section of Broadway will be rerouted onto parallel 7th Avenue. Bus and taxi loading areas, a transit information center and pedestrian amenities are included in the plan which will be implemented in Spring 1980. It is anticipated that Broadway Plaza will revitalize the area economically and provide a pleasant environment for workers, shoppers, tourists and theatergoers.

TABLE 4. CHARACTERISTICS OF FOUR PROPOSED AUTO RESTRICTED ZONE DEMONSTRATION PROJECTS

Characteristics	Boston	Memphis	Providence	New York
Project Area	Core retail & financial districts of Boston CBD.	Existing special taxing district in the Memphis CBD & Medical Center area, 1.25 miles outside CBD.	Various parts of Providence CBD.	Broadway, between 45th & 59th Streets.
Area Land Use	Retail (principally) & office uses.	Office, Banking & retailing uses.	Financial district, retail center, Kennedy Plaza & Union Station.	Theater district, offices, service & light retail uses (including pornography stores).
Transit Availability	CBD is hub of regional transit network that offers a broad array of services (rapid transit, local bus, express bus, shuttle bus, rail & taxi).	CBD is served by 51 transit routes, which serve areas to north, south, & east. 23 are peak hour routes.	Within statewide transit system, 32 routes serve CBD & carry 30,000 passengers/day.	Times Square is a major subway terminus for the three lines: it is served by 5 bus routes operating up to 120 buses/hour; it is also the focus for special bus operations ("Culture Bus Loop," "Midtown Shopper's Loop," and "A Night on the Town").
Pedestrian Activity	At peak, pedestrian volumes on Washington, Tremont, Summer & Franklin are in 5,000-9,000/hour range; facilities to accommodate these volumes lacking.	Mid-America Mall is a major pedestrian area, linking 2 important areas, Court Square & Civic Center Plaza.	Pedestrian activity peaks during lunch time; a 2nd high period is between 4 & 6 p.m. Westminster Mall & section of Wybosset St. adjacent to Mall carry high volumes.	Most north-south blocks in the project area carry several thousand pedestrians at midday and evening peaks.

TABLE 4 (Cont'd). CHARACTERISTICS OF FOUR PROPOSED AUTO RESTRICTED ZONE DEMONSTRATION PROJECTS

Characteristics	Boston	Memphis	Providence	New York
Economic Viability	Since 1972, a 14% constant dollar decline in retail sales; however, vacant retail floor space is minimal & major retail establishments are showing commitment to CBD	CBD retail position declining in face of competition from suburban retail outlets.	After construction of Westminster Mall, retail sales in CBD increased by 1.5%, compared to 20% decline in rest of city.	Area considered "weak" although census figures show Manhattan CBD, including Times Square, faring better than most CBD's as retail center.
Project Status	Construction during summer 1978; completed fall 1978.	Construction during late summer and fall 1978; completed winter 1978.	Construction during summer 1979; completed winter 1979-80.	Construction beginning summer 1978; completed after 12-14 months.
Project Cost	$3,217,955.	$1,241,820.	$5,866,000.	$6,250,000.
Funding Sources	UMTA (Sec. 3) $ 795,000 UMTA (Sec. 6) 1,516,955 Urban Systems 906,000	UMTA (Sec. 6) $960,000 State 100,000 Local 181,822	UMTA(Sec.3) $3,925,000 UMTA(Sec.6) 960,000 Local 981,000	UMTA (Sec.3) $2,368,000 UMTA (Sec.6) 500,000 Urban Systems 1,498,000 State & Local 1,234,000 HUD Community Development 650,000
Primary Objectives	To increase retail sales, bus ridership & pedestrian volumes.	To connect independent elements of downtown & to coordinate their operation for short-range downtown improvement.	Promote economic vitality of CBD, enhance pedestrian environment, and improve transit service.	To promote economic development of area and create focal point to improve identity of Times Square.
Vehicle Restrictions/Road System Changes	Auto traffic eliminated from all of Winter, Hawley, Temple Place & portions of 4 other streets; circulation pattern simplified.	No major changes.	Auto traffic eliminated from Dorrance & Francis (transit malls), Kennedy Plaza/Union Station & 1-block extension of Westminster Mall.	Broadway between 45th & 48th closed to all traffic, between 48th & 49th a one-block transitway; between 49th & 54th widened sidewalks and priority treatment for buses; between 54th and 59th priority treatment for buses.

TABLE 4 (Cont'd). CHARACTERISTICS OF FOUR PROPOSED AUTO RESTRICTED ZONE DEMONSTRATION PROJECTS

Characteristics	Boston	Memphis	Providence	New York
Transit Modifications	Bus route changes exclusive transitways & contraflow bus lanes; 5 new taxi stands.	Shuttle bus service to Medical Center area; new downtown bus terminal; 2 Medical Center bus shelters; transit marketing.	Through bus routing & free fare zone downtown; new transit terminal berths, busway & terminals.	Revised bus routes due to detour caused by Broadway Plaza; special taxi and transit loading areas; transit information center.
Goods Movement Changes	Deliveries before 11 am except for certain time dependent deliveries permitted after 2 pm.	No changes.	Re-routing, creation of loading areas, & loading restrictions.	Deliveries before 11 am.
Parking Changes	Elimination of 600 spaces.	No changes.	Elimination of 242 spaces.	On-street parking eliminated.
Changes in Pedestrian System	Full pedestrianization of some streets. Increased space on others.	Sidewalk improvements.	Exclusive pedestrian areas; sidewalk improvements.	Pedestrian plazas & sidewalk improvements.

Since Memphis has already implemented a major component of an ARZ, an eight block pedestrian mall, the current project has been designed to build on this initiative. The demonstration will be focused in and between the downtown area and the Medical Center one and a-half miles to the east. The demonstration includes the development of a downtown transit terminal, sidewalk improvements, Medical Center shelters and shuttle bus service between the CBD and the Medical Center. There will be no street closures or traffic reroutings and no changes in goods delivery access. These changes occurred with the initiation of construction of the Mid-America Mall in 1975.

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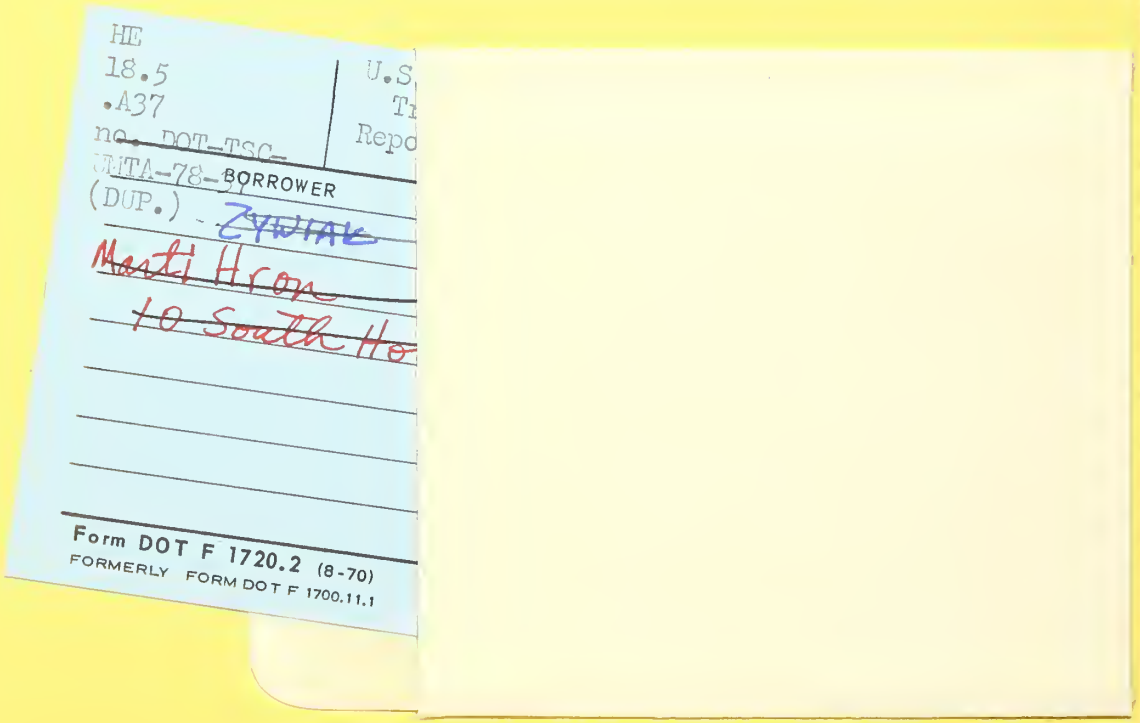
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