of efforts to reduce automobile travel in cities. Specifically, the model gives estimates of fleet sizes and operating policies that would be needed to accommodate varying degrees of reduction in automobile travel. These estimates are important complements to the results of demand-side studies of the feasibility and desirability of policies to reduce automobile travel in cities.

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Orlando Changes Direction: From Beltway to Busway

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This paper reports on the long-range phase of an overall urban area transportation study in a three-county area centered on Orlando, Florida. The paper focuses on a major shift in perspective regarding solutions to future travel demand problems. Discussed are five transportation system alternatives with various combinations of automobile-oriented and transit-oriented systems and two major aspects of the study methodology: (a) the formulation of a land use sketch plan designed to be more compatible with a future transit system and (b) the development of a disutility modal-split model based on transit attitudes. Transportation system alternatives are defined, and the evaluation and public involvement processes that led to the selection of a preferred alternative plan are described. The implementation of the plan through a short-range transition period is described, and eight major conclusions and observations are given.

The Orlando urbanized area is in central Florida approximately 88 km (55 miles) from Daytona Beach on the east coast and 135 km (84 miles) from Tampa on the west coast. The area consists of approximately 4265 km^2 (1647 $miles^2$), includes Orange, Seminole, and Osceola counties, has a present population of 615 423, and an employment base of 249 900.

The area maintains a tourist economy encouraged by the presence of Walt Disney World, Sea World, and several other attractions and is slowly developing into a convention, financial, and governmental center. The Orlando Jetport, which has received international port status and the designation as a free-trade zone, has launched into a large-scale expansion plan involving a new $100 million terminal.

STUDY OBJECTIVES

This study was a part of the continuing Orlando Urban Area Transportation Study (OUATS) that began in 1965 under the guidelines of the Federal-Aid Highway Act. The purpose of the OUATS was to conduct the necessary analysis to permit development of a 1985 transportation plan that would meet both highway and mass transportation travel demands. The 1965 OUATS emphasized the improvement of the metropolitan highway system and placed little importance on transit.

Shortly after completion of the OUATS in 1968, tremendous growth began to occur in the Orlando urban area. This growth was initiated by such major developments as Walt Disney World, Sea World, the U.S. Naval Training Center, and Florida Technological University. Population grew almost 25 percent in 3 years, and Orlando became one of the fastest growing metropolitan areas in the country.

To accommodate these changing conditions, OUATS was revised in 1970 to develop a 1990 transportation plan. The initial result was another highway-oriented plan that included, as a carry-over idea from the initial 1965 OUATS, a metropolitan beltway (1). Mass transit was assumed to capture only 1 percent of the total trips in 1990, the same as it had done in 1970.

This beltway plan was questioned as to its assumption regarding future mass transportation, and the outcome was a proposal to conduct a long-range transit study. The primary objective of the long-range transit study was to reevaluate the traditional highway-oriented plan and investigate the potential for a significantly improved transit system to provide a more balanced and flexible solution to future travel demand in the booming Orlando urban area. Secondary objectives were to

1. Develop a land use plan that would be less dependent on construction of highways and thus discourage further urban sprawl;
2. Develop a transit demand forecasting model that could be easily updated for future planning purposes;
3. Test more than one alternative mass transit plan to assure both highway and transit supporters that all feasible solutions had been investigated;
4. Provide an estimate of future operating and capital costs and analyze all available funding sources, including fare-box revenues, for each of the transit systems tested;
5. Determine the feasibility, site selection, and cost estimates for a central downtown terminal and any required satellite terminals; and
6. Investigate the feasibility of relocating the Seaboard Coast Line Railroad for the purpose of using an exclusive existing transit right-of-way.

STUDY ALTERNATIVES

The 1970 OUATS update provided a strictly highway-oriented plan for 1990 that indicated minimal transit feasibility. The long-range transit study called for a more objective look at mass transit and assumed that no beltway would be built. Thus from these two alternatives the most optimistic highway and transit plans could be studied.

Shortly after work began on the long-range transit study, the decision was made to expand the study to include a middle approach to the undecided all-beltway or no-beltway predicament. Additional analysis was planned to investigate the future potential of transit and its effects in relieving highway congestion if only the eastern leg of the beltway were to be developed or if only the western leg were developed. After these four alternatives were agreed on, a final alternative was added: Because of the downward trend in economic conditions and resulting funding constraints, no improvements would be made to either the existing highway network or the transit system beyond those improvements already committed by the local, state, and federal governments. The five alternative transportation systems can be summarized as follows:

1. No beltway and high transit,
2. Full beltway and low transit,
3. East beltway and moderate transit,
4. West beltway and moderate transit, and
5. No beltway and modest transit.

STUDY METHODOLOGY

Land Use Sketch Plan

Because of the very low transit service levels and the sprawl pattern of land use development assumed in the 1990 projections, the daily travel demands of the region were foreseen as being met primarily by automobile on an extensive network of existing and proposed new highways. However, projections of revenues and costs indicated that only 60 percent of the required funds would be available to construct the recommended highway plan.

These factors led the East Central Florida Regional Planning Council (ECFRPC) to initiate a sketch-planning approach for the transit study to develop a more compact land use pattern envisioned to result in a transportation system less dependent on construction of additional highways (2). The sketch-planning process assembled a team of professionals familiar with the tricounty area to identify regional growth forces and constraints and to project development over the next 15 years. The team initially developed a map that embodied the consensus of opinions as to the direction of growth and development. Next, projections were made regarding the magnitude of growth expected in identified growth areas. All traffic zones in the urbanized area were divided into three categories.

1. No-growth zones were those zones that were completely developed by 1970 and unlikely to be redeveloped.
2. Residential growth zones were those zones that showed potential for additional development based on both land availability trends and accessibility.
3. Employment growth zones were those zones that showed potential for employment-oriented growth based on trends, available land, and conversion potential.

The additional population and employment anticipated between 1970 and 1990 were allocated on an individual zone basis to the designated growth zones. All other zones remained at 1970 levels. In general, zones adjacent to such major transportation routes as the I-4 corridor were assigned the population growth. Downtown Orlando was allocated the major employment growth.

Attitude Survey and Modal-Split Model

While the sketch land use plan was being prepared, the transit study work program, comprising seven major tasks, was initiated: literature review, survey research, model development, program development, input preparation, program processing, and long-range planning. The first four tasks were designed to obtain a regional modal-split forecasting procedure based on community attitudes and also to establish criteria for planning a regional transit system (3). The information obtained from the community attitude survey conducted as part of survey research included

1. Attributes considered by Orlando area residents as important in satisfying their perceived acceptable transportation service;
2. Minimum levels of service necessary to generate significant patronage on a regional transit system;
3. Trip purposes for which the future public transit system would be used; and
4. Determination of automobile-captive, transit-captive, and free-choice ridership for different system alternatives, trip purposes, and income levels.

This determination of captive versus free-choice ridership permitted use of a universal free-choice modal split versus disutility difference model for forecasting future transit ridership and automobile person trips on alternative regional transportation systems (4). The captive and choice ridership data plots are shown in Figure 1.

The basic steps of the model performed by a computer program, written as a FORTRAN subroutine inserted into the UMODEL program of the Urban Transit Planning System (UTPS), are as follows:

1. Obtain mean income level of zone of origin;

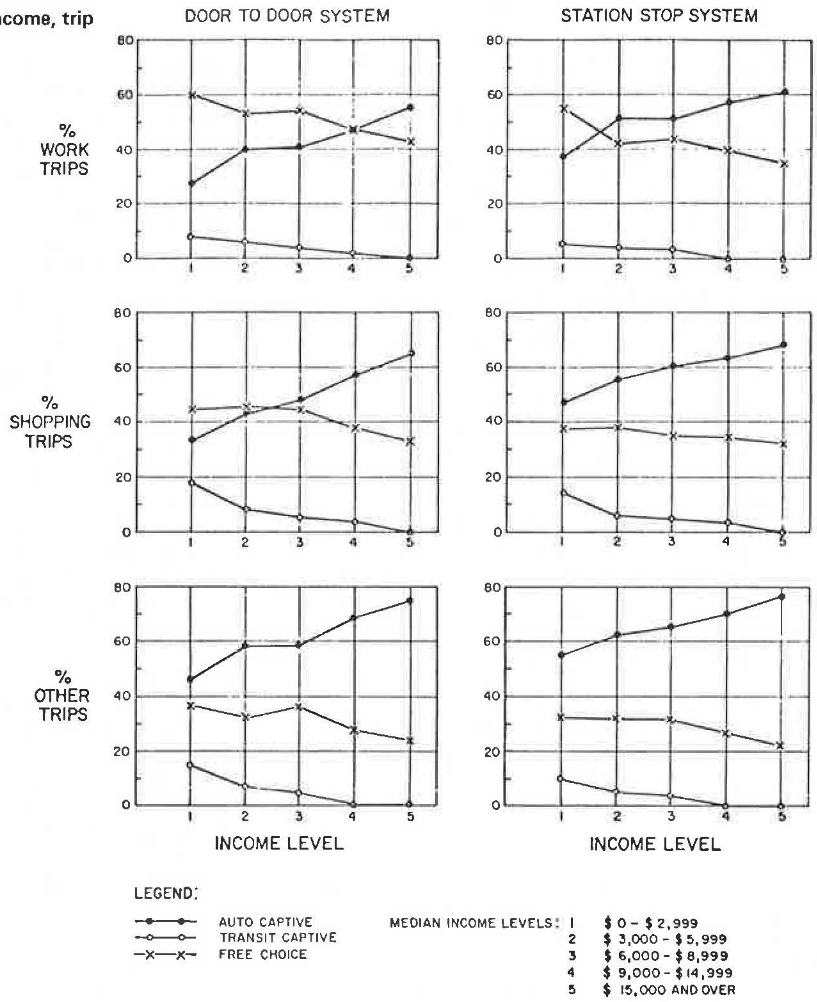

Figure 1. Captive and choice ridership by income, trip purpose, and system.

2. Obtain total person trips in trip interchange pair;
3. Obtain percentage of automobile-captive, percentage of transit-captive, and percentage of free-choice riders for the particular system being tested, trip purpose, and income level;
4. Compute cost of time for this income level as 25 percent of wage rate per minute implied by annual income for the zone;
5. Obtain service levels for this trip pair from transit and highway networks, including travel running time, walking time, waiting time, transit fare, parking cost, and highway distance;
6. Compute disutility difference by using convenience weighting of 2.5:1, running time and cost weighting of 1.0:1, cost of time from step 4, service levels from step 5, and vehicle operating cost per kilometer;
7. Find the point of universal free-choice curve corresponding to disutility difference and read off percentage of transit usage of free-choice riders;
8. Multiply percentage of automobile-captive, transit-captive, and free-choice riders by total person trips to get number of person trips in each category;
9. Multiply number of free-choice person trips by percentage of transit users determined in step 7 to get number of free-choice transit person trips; and
10. Add free-choice and transit-captive person trips to get total transit trips for zone-to-zone interchange.

1990 Forecast

Zone-level land use, population, and employment forecasts based on the previously described sketch-planning process became the input to standard trip generation and distribution models developed in earlier studies by the Florida Department of Transportation. Individual trip purpose generation and distribution models were processed for home-based trips, work, personal business, social-recreational, shopping, and school trips, and for non-home-based trips. These purposes were compressed for modal-split forecasting into three categories as shown in Figure 1.

The attitude survey results permitted the stratification of captive and choice ridership percentages by two general system types: a door-to-door system with a high level of service and a fixed-corridor system with station stops. Overall ridership percentages (rounded off) for all income groups indicated that total potential ridership on a future transit system would be lower for the station-stop system that requires intermodal transfers than for the door-to-door system of regional express, arterial, and local bus routes at frequent route spacing.

At zero difference between transit and automobile, free-choice transit work trips on a door-to-door system would be 25.5 percent of the total work trips and 21 percent on the station-stop system. Addition of captive transit riders would result in a total transit work-trip ridership of 28.5 percent on the door-to-door system and 23 percent on the station-stop system. Similarly, for shopping trips, the percentages would be 25 percent transit trips on a door-to-door system and 21.5 percent on the station-stop system. The other-trip category showed nearly equal percentages for both systems.

For the operation of the modal-split model, transit and highway networks were designed, coded, and processed to obtain zone-to-zone system service characteristics for each transit-intensive regional transportation system alternative. The resulting 1990 daily travel forecasts indicated total 1990 average daily transit trips ranging from 6.3 percent to 7.9 percent of total daily person trips; the lower percentage was found on the rapid transit fixed-guideway system alternative. Corresponding average annual ridership estimates, based on an annualization factor of 294, ranged from 66.8 to 84.2 million passengers. By comparison, forecasts prepared for alternative 2, full beltway and low transit, and alternative 5, no beltway and modest transit, indicated about 1.0 percent of total daily person trips to be on the minimal transit systems, or about 10 million annual passengers. Transit ridership during the 1974-1975 study period on the existing Orange-Seminole-Osceola Transportation Authority transit system was 2.4 million passengers, or 1.0 percent of the urban area's person trips. The transit forecasting procedure indicated a potential increase of about 600 percent in modal split or a 35-fold increase in transit ridership during the 1975 to 1990 planning period if the present bus system is expanded to a regional system with maximum coverage and a high level of service. This expansion would require an increase in bus fleet size from the current 40 buses serving the study area population of approximately 615 000 to nearly 600 buses for an estimated 1990 population of 1 million.

LONG-RANGE PLANNING

Regional transit corridors were defined as links between major activity centers, special generators, high concentrations of employment, and multiple-unit housing. Projections for 1990 obtained by the ECFRPC sketch-planning procedure were used as the basis for identifying these major transit trip generating areas. Zones with at least 1000 employees or at least 100 multiple-unit dwellings were specifically noted. Within the resulting eight major travel corridors identified between these major activity areas, potential transit routes were selected by using, as much as possible, existing right-of-way. Any of several alternative long-haul transit vehicles could operate along these corridors, e.g., express buses on exclusive busways, rail rapid transit, and transit expressway vehicles.

Alternative Transit Systems

Several different levels and combinations of transit modes were considered to accommodate regional corridor transportation requirements. The following five alternatives were developed; however, budget constraints dictated that only alternatives 2 and 4 could be selected for detailed analysis:

1. Preferential treatment for buses on existing highway facilities,
2. Busway in the median of I-4 in the north-south travel corridor,
3. Capital-intensive regional busway system,
4. Fixed-guideway system (either light rail transit, transit expressway, or conventional rapid transit) in a north-south corridor and an east-west corridor, and
5. Regional fixed-guideway system served by a feeder bus system or other local circulation modes.

Alternative 2

Following the requirements of the Urban Mass Transportation Administration (UMTA) transit network coding system, express buses using the I-4 busway, buses using arterial streets, and local circulator and feeder systems were each assigned different mode numbers. This coding permitted each type of service to be designed and analyzed separately. Moreover, initial bus headways and maximum waiting times were selected on the basis of the community attitude survey findings, 15-min maximum for daytime peak periods.

Typical sections of the proposed I-4 median busway area were evaluated with a preliminary plan of the busway and an interchange modification at South Street in downtown Orlando. This improvement would provide access from I-4 north and south to the central business district (CBD) via the existing three left ramps and a new ramp from the south. These ramps, as well as the median lanes, would be designated for use only by buses and car pools during peak traffic periods. The lanes would be open for use by all traffic during other times.

Using projections of the 1990 volume of peak-hour buses and vehicular traffic volumes and applying guidelines developed in a recent NCHRP study (5), we determined that a 25-km (15-mile) section of I-4 would warrant this preferential roadway.

The preliminary cost estimate of this two-lane median roadway and CBD ramp modification was $23.1 million. Supporting facilities including a central transportation terminal, park-and-ride areas, and maintenance facilities were estimated at $22.8 million for a total cost for the busway of $1.86 million/km ($3.1 million/mile).

Using initial 1990 estimates of approximately 19 express routes feeding into the Orlando CBD and local and arterial service adding another 7 routes, all operating at 15-min intervals, we estimated that 104 buses would enter the downtown area during the peak hour. Scheduling these buses to circulate on local streets would increase traffic congestion, raise pollution levels, and generally detract from the image of the Orlando CBD. We concluded that the all-bus transit alternatives would require construction of a central bus terminal to which most CBD-bound express routes would go. Preferential ramps from the bus-car pool roadway and special contraflow lanes would be provided for direct bus access to the terminal. In addition to the downtown bus terminal, the plans provided for park-and-ride facilities, outlying terminal areas, and demand-responsive service.

This I-4 median busway alternative with its supporting facilities was essentially common to regional transportation system alternatives 1, 3, and 4: no-beltway, east-beltway, and west-beltway. Although express, arterial, and local bus routes varied, the 25-km (15-mile) busway and downtown terminal were found to be warranted for each.

Alternative 4

The fixed-guideway system included an 83-km (50-mile) north-south route linking Sanford in Seminole County to the Orlando CBD, Disney World, and Poinciana in Osceola County. Also included was a 28-km (17-mile) east-west route extending from the Pine Hills vicinity of western Orange County to the Orlando CBD, east to the Colonial Plaza-Herndon Field major shopping center area, and south to the Orlando Jetport at McCoy. Both routes would be served by feeder systems that would include local fixed-route buses, demand-responsive operations in residential areas, and bus or people-mover circulation systems at major activity centers.

Table 1. Preliminary cost estimates of three transit systems.

Corridor	Distance (km)	Rail Rapid Transit ($)	Transit Express-way ($)	Light Rail Transit ($)
North-south from Sanford to Orlando CBD in	32			
I-4 Median		7.02	2.46	2.04
Seaboard Coast Line Railroad right-of-way		7.86	3.00	2.58
North-south from Orlando CBD to Poinciana in I-4 median	48	6.78	2.34	1.92
East-west from Pine Hills to Orlando CBD in East-West Expressway median	9	9.60	3.78	3.90
East-west from Orlando CBD to jetport in McCoy	19	8.16	3.18	2.94

Notes: 1 km = 0.6 mile.
Values are in millions of dollars per kilometer.

Park-and-ride facilities at station stops would also be required.

Two potential alignments of the 33-km (20-mile) north-south corridor north of the Orlando CBD were considered. The first was in the median of I-4, and the second was within or parallel to the right-of-way (ROW) of the Seaboard Coast Line Railroad. South of the Orlando CBD one alignment, within the I-4 ROW, was assumed.

Initial requirements for alternative transit systems were based on preliminary station locations, maximum speed, headway and dwell times, and varying ridership assumptions. Final requirements were based on computer network assignments. Preliminary cost estimates were then prepared for three types of fixed-guideway transit systems: rail rapid transit, light rail transit, and transit expressway. These estimates were based on available unit cost information (6, 7) for the three systems, escalated to 1975 dollars, and applied to estimates of physical facility requirements including structures, track and trackbed, communications, power, stations, and maintenance plan. The resulting cost estimates (excluding rolling stock) are summarized in Table 1.

As indicated, both the light rail transit and transit expressway systems were similar in average construction costs, in the range of $2.04 million to $3.0 million/km ($3.4 million to $5.0 million/mile). The conventional rail rapid transit system was nearly three times as costly as the light rail system. In the northerly section of the north-south corridor, the Seaboard Coast Line Railroad alignment was more costly for all three transit systems. These higher costs combined with the many operational problems envisioned for joint use of the active Seaboard Coast Line Railroad ROW alignment north of the Orlando CBD eliminated this alternative corridor alignment from further consideration.

PLAN EVALUATION

To analyze the proposed regional system alternatives required that a set of evaluation criteria be formulated that could be applied equally to each system alternative. Three major categories of evaluation were established: economic costs, travel service, and environmental impact. Sufficient criteria were defined to enable local officials responsible for selecting the final alternative to base their decisions on accurate, detailed estimates of impact.

For each of the five transportation alternatives estimates of the measurement items were prepared by using results of the transit and highway network assignments, recent bid prices on transit and highway projects, Florida Department of Transportation (DOT) environmental computer programs, data on transit and automobile operating costs and travel time values, and a handbook assembled by UMTA listing characteristics of various transportation systems (8).

Summary of Data

Evaluation of the resulting cost and impact estimates indicated that no one alternative could be identified as significantly superior in all categories. Alternative 5 displayed a marked advantage because it was about one-third as costly as the other alternatives. This advantage substantially decreased, however, when the significantly greater vehicle operating costs, travel time costs, and accident costs of alternative 5 were taken into consideration. At the other end of the scale alternatives 2, 3, and 4, each of which featured some type of beltway facility, were all in an approximate 1 percent cost of each other.

Alternative 5 ranked last in travel service. The other four alternatives were all within 4 percentage points of one another in providing good highway travel service (as measured by a level of service C or better). Of these four alternatives, the transit systems developed for alternatives 1, 3, and 4 were similar in that each provided high areawide coverage, good service frequency, and comparable estimated annual patronage of over 80 million passengers.

Environmental impact results were scattered. Alternative 5 had the highest energy consumption and air pollution figures because of its inability to satisfy travel demand, which in turn created lengthy travel time delays. Again alternatives 1, 3, and 4 were quite similar in providing the lowest energy consumption and air pollution figures. However, when the criteria of the effect on water quality and community disruption were examined, alternatives 2, 3, and 4 had the greatest adverse effect. This conclusion was reached because of the facility's proximity to major water recharge and surface runoff areas and also because of the relatively high numbers of families and businesses that the facility displaced.

No clear-cut overall advantages were displayed by any one alternative.

Evaluation Process

An extensive public involvement process was used to explain the data results to the area's citizens and to provide for the feedback of their comments, criticisms, and suggestions. Initial interest in the study results was generated by a series of newspaper articles and news releases followed by a public seminar. This approach brought forth several of the previously hidden influence groups in the area and served to further publicize the decision-making process. The seminar was immediately followed on successive nights by public hearings, one each in Orange, Seminole, and Osceola counties. At these public hearings, a polarization of support for particular alternatives became evident as the groups evaluated the data results in terms of their own interests. For example, the environmental issues were sensitive to such groups as the Sierra Club and the League of Women Voters, who perceived alternative 1 as best fulfilling the goals of energy conservation and control of air and water pollution. Other groups in the western part of the Orlando urban area supported alternative 4 because of the economic development advantages that it promised for the outlying municipalities on the west side. Citizens from comparatively rural Osceola County, on the south and southeast side of the Orlando urban area, believed that travel service was of primary importance and generally supported alternative 2. Since each of the alternatives best fulfilled the goals of only one interest group, the problem became the determination of the alternative that best fulfilled the overall goals of the whole region.

A key factor that emerged in the decision-making stage was the flexibility of a particular system alternative. Concern was expressed repeatedly over the unpredictability of future gasoline prices, availability of fuel, federal and state funding programs, and so forth. Nevertheless, committee members felt that action of some type was preferable to the relative inaction of alternative 1. The Transportation Technical and Citizen Advisory committees ranked alternatives 1 and 3 as their top two choices although in different order. The issue was settled when the Transportation Policy Committee, as the decision-making body of the OUATS, selected alternative 1 as the official 1990 plan.

PLAN IMPLEMENTATION

Development of a realistic staging strategy for implementation of a long-range plan was an important objective in this study. Consequently, a transition period (from 1976 to 1981) was established to define those short-range improvements to the existing system that will evolve into the adopted long-range plan.

The capital improvement program for the transition period will consist of 135 buses, 50 of which are either in service or in the process of being acquired. An expanded downtown terminal will require 24 berths; satellite park-and-ride lots, transfer sites, and terminals will be developed. The existing garage-maintenance facility will be expanded by more than 50 percent of its present size, and additional miscellaneous equipment and shelters will be purchased. For this entire improvement program, a total of $9.9 million and $9.4 million will be required for capital and operating costs respectively between 1976 and 1981, based on current estimates escalated to account for anticipated price increases over the 5-year period.

The table below gives state and local matching dollars required to receive federal funds.

Costs	Federal	State	Local	Total
Capital				
Section 5	4 182 000	522 750	522 750	5 227 500
Section 3	3 738 000	467 250	467 250	4 672 500
Subtotal	7 920 000	990 000	990 000	9 900 000
Operating				
Section 5	4 718 000		4 718 000	9 436 000
Total	12 638 000	990 000	5 708 000	19 336 000

As indicated, the Florida DOT will have to match approximately $1.0 million and the Orlando urban area will have to raise $5.7 million. Present local commitments fall short of the required match; only $2.9 million can be committed to the total $5.7 million required, which will leave a deficit of approximately $2.8 million to be raised locally. To implement the program in this time period, a strong local commitment to regional transit improvements will be required, both to ensure availability of maximum matching funds under section 5 of the National Mass Transportation Assistance Act of 1974 and to generate justification for the allocation of additional capital assistance funds under section 3.

The similar transition period for highway improvements requires $222 million, and only $88 million is available in federal, state, and local roadway funds.

Possible sources of local funds are available to support transportation improvements in the tricounty region. The requirement of state legislative action restricts the local counties from using most of these sources, except for gas and ad valorem taxes. Recently the state has recommended that local governmental bodies increase gasoline taxes by 1 cent (9). This tax would provide an estimated annual minimum $4.2 million.

CONCLUSIONS AND OBSERVATIONS

1. The decision to adopt a transportation plan without a beltway represented a major shift in thinking in the Orlando urban area from the 1973 support of the beltway. Furthermore, this decision was viewed by citizens, planners, and policy officials as a zoning decision away from sprawl and toward a more compact land development pattern. This point was perfectly summed up by the following statement from the local Seminole County, Florida, League of Women Voters.

> We view roads as development tools which can wisely be used to plan the growth of a community. Construction of a beltline and the concurrent development that would accompany it would put an unnecessary strain on already overburdened taxpayers and local governments to provide essential services.

2. Certain major events transpired during the study that may have affected its outcome. Initially, the energy crises of 1974 emphasized the uncertainty of future motor fuel prices and supplies. This uncertainty caused many officials to feel that inadequate energy conservation programs plus minimal commitment toward mass transit could severely limit the capacity of the area to prosper should another fuel shortage hit the country. Consequently, these officials favored alternative 1 as the most flexible approach to solving future transportation problems without jeopardizing the area's prosperity. Another major event that supported emphasis toward transit was the National Mass Transportation Assistance Act of 1974. This act appropriated approximately $7.8 million for the Orlando urban area through 1980. The availability of these funds and the threat of returning several million dollars to the federal government because of a lack of local matching funds may have been a contributing factor in supporting the chosen alternative. Furthermore, the shortage of highway construction funds did not help the highway interests in their effort to support the beltway alternative.

3. The large financial transportation costs estimated for the selected alternative suggest either that the local area make a stronger commitment toward achieving a slower growth rate or that area officials make a stronger commitment toward financing the required transportation improvements.

4. The area has continued to experience serious problems in financing its local toll roads. During its first year of operation, the East-West Expressway through downtown Orlando suffered an operating deficit of over $2 million that had to be subsidized by Orange

County road funds, and almost 60 percent of the county's major road funding source for that year was depleted. The heavy losses did not support any of those alternatives that included the beltway.

5. The decision reached definitely indicated support of a strong central business district in Orlando and the need for an improved downtown transit terminal.

6. The I-4 bus and car-pool roadway, although not specifically evaluated for percentage of car pools, is expected to accommodate car pools as well as express buses. Also, the benefit of existing ROW in the I-4 busway concept left open the future possibility of a fixed-guideway system should the densities in the area ever warrant it.

7. The Orlando urban area, similar to other tourist areas, is attempting to solve resident and tourist travel demand with the same system, a difficult if not impossible task. Travel characteristics of tourists are different from those of residents and are sometimes hard to quantify, especially when international markets are involved. We suggest that this problem be further explored by UMTA.

8. Finally, we observed that the adopted plan did not offer the rural areas much transit or highway facilities. This lack was an important flaw in the selected alternative and caused many of the rural areas to support the beltway alternative because they had no other choice.

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Increasing the People-Moving Capability of Shirley Highway

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Because of the dramatic increase in construction costs of rail rapid transit in recent years, the exclusive highway right-of-way for high-occupancy vehicles has emerged as a possible cost-effective alternative for transporting peak-period commuters through congested corridors. The Shirley Highway busway in northern Virginia offered the first such exclusive right-of-way when its first section was opened to buses in 1969. The busway was opened to car pools of four or more riders in December 1973 and became the principal element of the Urban Mass Transportation Administration's Shirley Highway express-bus-on-freeway project, which was conducted for 1 year until December 1974. Priority treatment accorded buses and car pools resulted in a substantial improvement in the corridor's people-moving capability during peak hours. In addition, considerable travel-time savings were realized by all commuters using Shirley Highway. This paper discusses (a) increases in the people-moving capability of Shirley Highway and (b) the reasons for the increases. The increases in the people-moving capability of Shirley Highway can be attributed to increases in commuter use of buses and car pools. Particular attention was given to bus users to determine why a large number of automobile users—many with upper-middle incomes from homes with several automobiles—switched to bus and why some bus users switched to automobiles (driving alone or car pooling).

Because construction costs of rail rapid transit facilities have risen dramatically in recent years, finding less costly means of effectively transporting large numbers of travelers through congested corridors has become necessary. One alternative includes use of exclusive right-of-way lanes for high-occupancy vehicles. Although usually referred to as "busway," many (if not a majority of) exclusive rights-of-way permit use by car pools containing some minimum number of occupants.

In 1969, the first section of the Shirley Highway busway—two reversible lanes in the median of Shirley Highway (I-95)—was opened to buses. This busway, the first in the United States, became the principal element of the Urban Mass Transportation Administration (UMTA) Shirley Highway express-bus-on-freeway project that began April 1971 and ended December 1974. The project provided express-bus service between a portion of northern Virginia and Washington, D.C., shown in Figure 1, and included the following major elements:

1. Two 18-km (11-mile) reversible lanes in the median of the Shirley Highway plus bus-priority lanes in downtown Washington;
2. The addition of 90 new, special-feature buses with new schedules on new, more direct routes; and
3. The coordination of residential fringe parking facilities with express-bus service.