REPORT OF THE DEPARTMENT OF HIGHWAYS AND TRANSPORTATION ON THE

VIRGINIA COMMUTER STUDY

TO THE GOVERNOR AND THE GENERAL ASSEMBLY OF VIRGINIA

- Executive Summary
- Commuter Transportation Problems, Issues, and Policy/Program Response
- A Methodology for Evaluating Commuter Travel Options in Virginia Cities

(See Also House Documents 7A, 7B, and 7C)

HOUSE DOCUMENT NO. 7

COMMONWEALTH OF VIRGINIA
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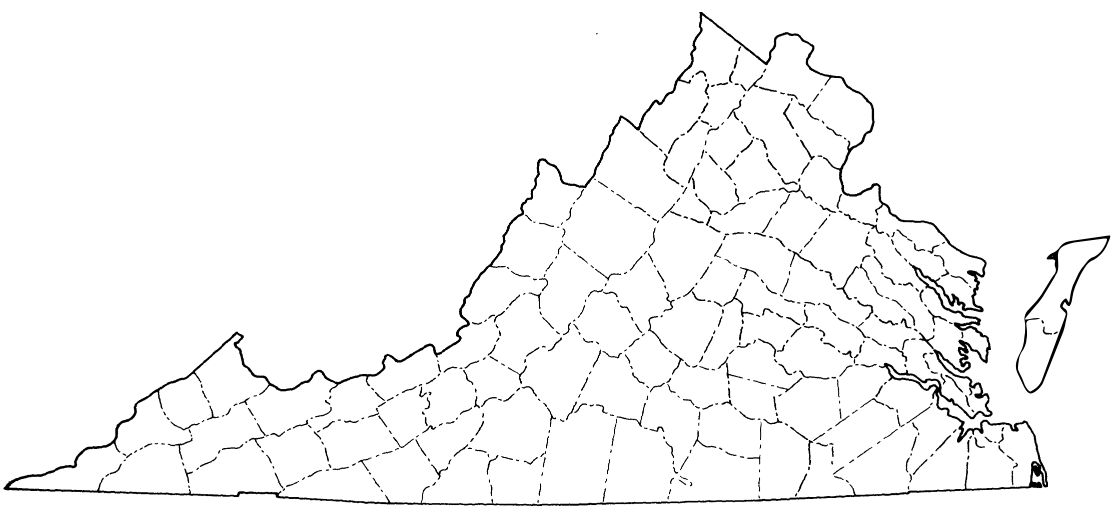
VIRGINIA COMMUTER STUDY

Executive Summary



PREPARED FOR
THE VIRGINIA
DEPARTMENT OF HIGHWAYS
AND TRANSPORTATION
BY
BARTON-ASCHMAN ASSOCIATES, INC.

In March 1980 the Virginia General Assembly, through the passage of House Joint Resolution Number 150, called for the Virginia Department of Highways and Transportation (VDH&T) to..."make a comprehensive study of alternative transportation modes available to commuters working in metropolitan centers while residing in outlying localities." The resolution cited the need to reduce traffic congestion, conserve energy, and consider alternatives to the private auto for suburban commuter travel.

In response to H.J.R.150 the Virginia Commuter Study was initiated in October 1981. The study has been divided into three major phases:

1. The identification of problems and issues associated with commuting in Virginia (with emphasis upon longer-distance commuting to central cities from outlying suburbs and rural areas) and the development of policy, program, and legislative actions to address these issues.

2. The identification of available modal options (i.e., rapid transit, commuter rail, express bus, carpooling, etc.) for such commuting as drawn from national experience and the development of a planning methodology through which the applicability of these options can be determined for urban areas in Virginia.

3. A detailed analysis of three case study areas--Northern Virginia, Roanoke, and Martinsville--in which the methodology developed in the second phase has been applied to determine the viability of various commuter options in these areas. The case study areas were chosen by VDH&T to provide a cross-section of urban area size and commuting problems in the state.

An important feature of the study has been the definition in Phase I of three future scenarios for commuter transportation in the 1980s and beyond, which reflect the uncertainties that exist with regard to energy availability and the possible decline in financial resources for transportation improvements. Viability of alternative transportation actions in the case study areas (Phase III) and alternative policy and program actions (Phase I) has been considered within the context of the scenarios to define those actions which appear appropriate under any future conditions (and thus, represent high-priority actions for implementation).

COMMUTING PROBLEMS AND ISSUES IN VIRGINIA

Commuting trips made by persons living in suburban and outlying areas and working in central cities have two important characteristics:

- -- They are longer than typical work trips made by city residents and may range in length from at least 5 miles to more than 50 miles.

- -- They are made almost exclusively by automobile.

There are usually no formal alternatives to the auto for these trips, and the only travel option for most long-distance commuters is to make informal arrangements for ridesharing with family, neighbors, and friends having a common work destination.

Because of their dependence upon the automobile, these long-distance commuters are particularly vulnerable to the effects of high fuel costs, and even more critically, to the scarcity of gasoline during fuel emergencies. They contribute to peak-period congestion in major commuting corridors, but they suffer disproportionately from corridor congestion in relation to the small percentage of corridor travel demand that they represent.

Viable modal options to the single-occupant auto for such commuting are constrained by the low density of residential development in suburban and rural areas and the increasing dispersion of employment sites in urban areas. This makes it difficult to generate enough work trips between common areas of residence and employment to support formal transit service, such as various forms of bus or rail service.

Long-distance commuters are, and will continue to be, critically impacted by the chronic highway funding problems that confront Virginia and other states. Needed highway improvements have already been deferred, and federal proposals to turn back non-Interstate highway programs to the states could significantly increase pressures for reliable and expanded funding sources at the state and local levels. Failure to develop an adequate financial response to highway needs will severely impact long-distances commuters, and could impose economic hardships upon this group, ranging from increased transportation costs to possible residential or job dislocation.

Because most long-distance commuting cannot be served cost-effectively by conventional transit modes, the worsening transit funding picture will have less direct impact on this type of commuting than it will upon commuting within cities. It will tend to reduce the prospects of extending transit service from existing urban service areas into suburban and outlying communities. However, the indirect impact of lower transit funding upon long-distance commuters could be significant. If urban transit service is cutback severely, many of the shorter urban work trips now being made by transit will have to be made by auto, and this will increase vehicular travel and congestion in corridors that are also used by suburban commuters.

FUTURE COMMUTING CONDITIONS

The future for commuters in Virginia is uncertain. The energy crises in the mid and late 1970s, the contrasting current international oil glut, the dramatic policy change in the federal role in transportation between the Carter and Reagan administrations, and increasing erosion of the nation's transportation funding base by inflation and declining gas tax revenues are some of the political and institutional developments that make it increasingly difficult to predict future commuting conditions.

The Virginia Commuter Study has defined three views of the future which reflect different assumptions as to the level of highway and public transportation funding and the price and availability of gasoline. In what might be viewed as a "worst-case" future for commuters, chronic shortages in fuel have been assumed along with a fuel price increase of at least 50 percent over the next 10 years and sharply decreased transit and highway funding by the Federal government. Under a "best case" future for commuters, federal transit and highway funding will remain at or near present levels (allowing for inflation), and gasoline will remain plentiful at an effective cost slightly below current levels. A third view of the future lies somewhere between these two. It might be termed the "expected future", reflecting a modest increase in fuel costs, a stable fuel supply, and modest reductions in federal highway and transit funding.

Ideally, Virginia's transportation programs and policies should be geared to the "expected" future, but hopefully, with most key elements also being applicable under either the "best" and "worst" futures, as well. These three scenarios or views of the future have been used to assess the viability of alternative modal options and commuter policies and programs under the range of conditions that could be encountered in the future.

EVALUATION OF COMMUTER MODAL ALTERNATIVES

When commuting problems are viewed from a statewide perspective, perhaps the most striking observation to be made is the dramatic difference in scale of commuting and associated problems that exist in Northern Virginia versus other urban areas in the state. There are problems and potential solutions that are truly unique to Northern Virginia, primarily because of the sheer magnitude of travel involved. There are over 500,000 jobs in the Washington, D.C. central employment area alone that act as a powerful magnet for Northern Virginia commuting. In contrast, there are less than 100,000 jobs in all of Roanoke County, including the cities of Salem and Roanoke. Martinsville and surrounding Henry County, which represent a relatively high concentration of industrial employment, total approximately 40,000 jobs.

Peak hour, peak direction commuter volumes in the busiest commuting corridors range as high as 1,900 person trips in the Martinsville area and 3,400 person trips in the Roanoke area versus 26,000 in Northern Virginia in the I-95 corridor! In Northern Virginia there are at least two major commuting corridors that exhibit peak hour, peak direction volumes of at least 3,000 commuter person trips at a distance of more than 23 miles from the Washington central employment area. In fact, nearly 60,000 Virginia commuters travel more than ten miles to jobs in the Washington central employment area. This is roughly the distance between downtown Washington and the Capital Beltway (I-495). In contrast, there are about 10,000 commuters in the entire Martinsville area whose work trips exceed ten miles in length.

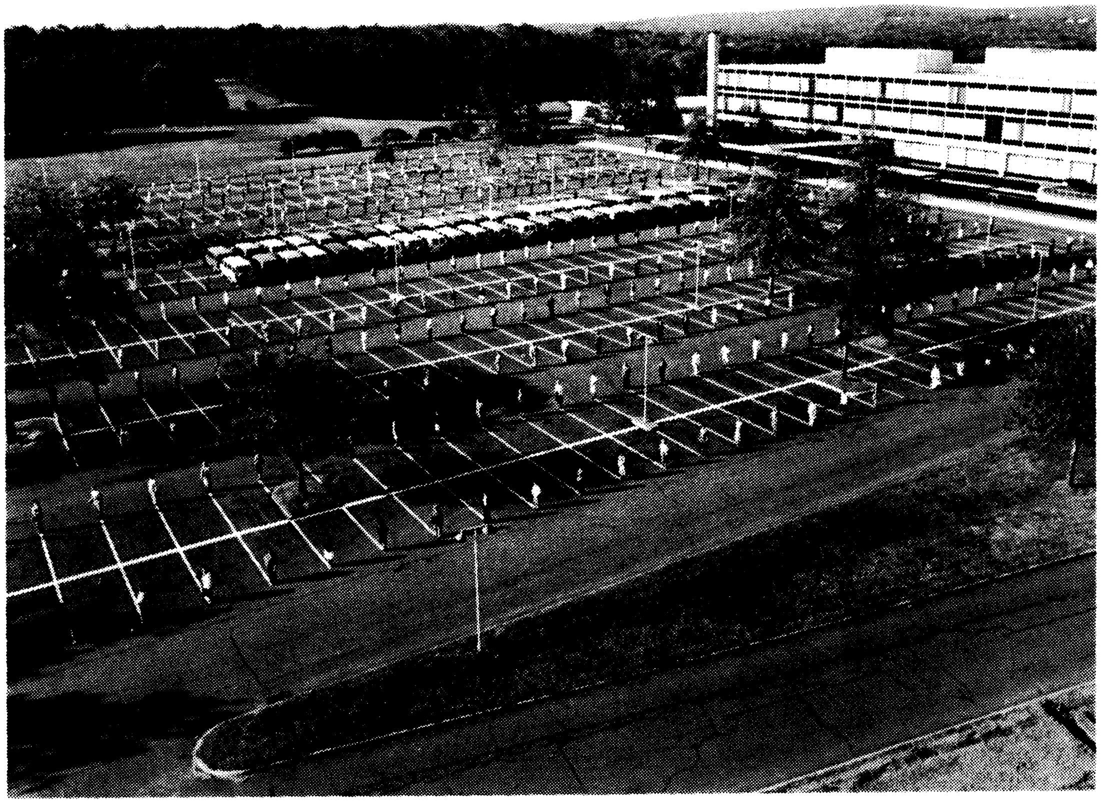
These statistics from the three case studies suggest two things:

- -- Commuting in Northern Virginia is several orders of magnitude larger than that encountered in medium and small sized urban areas such as Roanoke and Martinsville. This means that commuter volumes in Northern Virginia are more likely to support larger, more expensive transportation improvements than other urban areas in the state.

- -- There is a significant volume of long-distance commuting (i.e., more than ten miles in length) in both large and small urban areas. Given the unique problems associated with such commuting as described earlier, it clearly warrants attention by state and local agencies.

Given these significant, but varying, levels of long-distance commuting throughout the state, what do the case studies suggest in terms of viable modal alternatives? *The principal conclusion is that, regardless of urban area size or characteristics, ridesharing modes (carpooling, vanpooling, and buspooling) offer vitually the only feasible modal alternatives to the single-occupant (i.e., drive alone) auto for long-distance commuting.* This conclusion applies generally to worktrips of more than 5 miles in length for most medium-sized urban areas and all small urban areas, and to work trips of more than ten miles for large urban areas. Exceptions to this conclusion are limited to major commuting corridors in Northern Virginia, where the extent of suburban development and the volume of commuter traffic generated by Washington area employment are sufficient to warrant transit service (primarily, express bus) for trips longer than ten miles. In these Northern Virginia corridors the volume of commuting traffic has already warranted development by VDH&T of high-occupancy vehicle (HOV) lanes, which have been set aside for peak period use exclusively by buses, carpools, and vanpools. I-66 inside the Capital Beltway will soon be opened as an exclusive HOV facility during peak hours, and the present HOV lanes on the Shirley Highway (I-395) have been proposed for extension outward from the Capital Beltway to Dale City.

The high costs of transit service (bus or rail), coupled with the modest volumes of long-distance commuters in most suburban corridors render transit infeasible or a poor public investment *for serving this portion of the total commuting market.* In corridors where long-distance commuting volumes approach transit service warrants, the most cost-effective approach to a financially marginal proposition is to seek private sector provision of the service, or to bolster private operators who may already be running bus service in these corridors. Transit plays an essential role in meeting the demands of *shorter commuting trips*, primarily within medium-sized and large urban areas.



Ridesharing's impact on parking requirements and traffic congestion is dramatically illustrated by these 726 employees and the 50 vans that transport them to and from work.

(Photo courtesy of Connecticut General Corp.)

Fortunately for the commuters and tax payers of Virginia, the most feasible modal alternatives (ridesharing) for long-distance commuting are also the most cost-effective in terms of low user costs and very low public investments required. More efficient use is made of the vast existing fleet of private vehicles, while public costs for expensive new buses and trains is minimized.

Perhaps the major question associated with ridesharing in the future is whether further substantial shifts in that mode can be obtained, unless drastic increases in commuting costs and congestion force commuters in that direction. Under the "expected" future of fairly stable gasoline prices and a continuing federal role at least in capital funding for highways and transit, there may be insufficient incentive for significant growth in ridesharing, even under an aggressive program of public encouragement. Estimated results of attractive ridesharing programs in the case study areas range from a maximum shift in commuting to ridesharing of 12 percent in Martinsville to a maximum shift of 6 percent in Northern Virginia.

Although small as a percentage of total commuting, these modal shifts produce important, desirable impacts in reducing vehicle-miles of travel, pollutant emissions, and gasoline consumption, because they are drawing strongly from long worktrips. Moreover, they represent additions to an already strong base of ridesharing. For example, about 30 percent of all workers in the Martinsville area are already ridesharing, and a strong ridesharing program could boost that figure to over 40 percent.

In Northern Virginia the projected growth of suburban employment at a rate several times faster than that of the Washington central area will bring about major changes in commuter travel patterns in that area. One immediate implication is that scattered suburban employment sites (i.e., such as Tysons Corner, Springfield, etc.) will be difficult to serve with conventional transit, and local congestion in these areas is likely to grow. Ridesharing programs focused upon major employers should be a critical element in future transportation planning for such areas.

In summary, the case studies suggest that while the absolute shift in modal share of commuter travel to ridesharing may be modest even under an active promotional program, VDH&T should pursue a strong ridesharing program because:

1. Ridesharing is a very cost-effective mode of travel in terms of low user costs and low public cost per ridesharer served or vehicle removed from the road,

2. The beneficial, incremental impacts are important, and on top of an already significant ridesharing base, represent a major factor in holding down congestion, pollutant emissions, and energy consumption,

3. It is the only feasible modal alternative to driving alone for most long-distance commuters.

RECOMMENDATIONS

The emphasis in this study has been upon the commuting problems of people working in central cities and living in outlying areas. For most of these commuters, the case study analyses have shown that ridesharing modes (and in certain corridors--express bus) are the only feasible modal alternatives to driving alone. Thus, the focus in policy and program recommendations has been upon what can be done to expand and improve these modes.

Virginia has already made a good start in ridesharing promotion and support. The passage of House Bills 155 and 1091 in 1980 and 1981, respectively, clarified the legal status of carpool and vanpool vehicles and removed most of the legal and regulatory impediments to ridesharing. The recent transportation revenue package passed by the General Assembly recognized the need for a continuing state role in the financial support of local ridesharing and public transportation programs. The recommendations of this study build upon this base of existing legislation and financial support.

The following recommendations define specific policy and program actions which the state (through VDH&T) should undertake to:

1. *Intensify its current efforts to promote ridesharing in Virginia.* Local governments should be enlisted to create their own ridesharing staff capability with VDH&T offering financial and technical assistance. To provide the necessary encouragement and technical/financial assistance to local areas, VDH&T through its Public Transportation Division (PTD) will need to expand its central office ridesharing staff capabilities.

2. *Help to make equipment (vehicles) available to both ridesharers and transit riders.* A van lease guarantee program (similar to VANGO in Maryland) should be set up at the state level to aid prospective vanpoolers in acquiring vans. Similarly, the state should pursue, and be receptive to local government requests for, the provision of needed buses to private transit operators through long-term, low-cost leasing arrangements. The van lease guarantee program may require new legislation, but the leasing of buses to private operators can be done under present law. It simply needs to be pursued more aggressively by the state and local governments.

3. *In concert with local governments, give increased attention to ridesharing modes in on-going urban transportation planning.* The prospect of less revenues for capital improvements in the future mandates greater consideration of low-cost modal alternatives in continuing transportation planning efforts. Ridesharing modes have been given little attention in past urban transportation planning.

4. *Intensify and expand its current efforts in the provision of HOV facilities, park-ride lots, and other transportation system management (TSM) measures.* These actions are highly supportive of ridesharing and bus transportation and offer relatively low-cost approaches to meeting major corridor travel demands.

5. *Initiate an aggressive state employee ridesharing program in all of its departments.* Beyond the benefits provided to its employees by such a program, the state will be setting an excellent example for local governments and the private sector.

6. *Conduct an aggressive, statewide, ridesharing promotional campaign in the print and electronic media.* Current media advertising should be expanded, focussing on principal commuting markets across the state, and desirably, including the flexibility to place messages in more effective time slots, instead of depending upon random, local public service announcements.

7. *Establish a statewide financial/activity reporting system for public transportation and ridesharing.* Better information on the actual performance of transit and ridesharing programs is needed in order to evaluate their continuing effectiveness.

8. *Expand the current experimental transit and ridesharing program.* This program should move more toward innovative demonstrations now that continuing funding support for ridesharing is available elsewhere. It should reflect both ideas new to Virginia and the transplanting of promising demonstrations from one commuting environment in the state to another.

9. *Conduct an analysis of possible, further tax, fee, and regulatory incentives for ridesharing.* Several promising tax and other incentives to encourage more ridesharing need detailed analysis to assess their legal and fiscal implications.

The Virginia Commuter Study also considered many other measures relating to possible state and local action on transit and ridesharing that may have application under the "worst case" future, but which appear unwarranted at this time. These include the establishment of a separate ridesharing fund generated by new taxes, the subsidized leasing of vans, the provision of operating subsidies for commuter bus service, and the mandating of local ridesharing plans by local governments and major employers.

The total cost of the recommended policy and program actions (excluding the bus-lease program to private operators and the expanded HOV, park-ride and TMS program) is about $2 million per year. This is an extremely modest amount compared to the $32 million in FY 83 and the $32.6 million in FY 84 already appropriated for public transportation and ridesharing. Increased emphasis on making equipment available to private transit operators by lease arrangements (through local governments) can be funded to a significant degree through current appropriations for the larger urban areas. Funding available to non-designated urban areas, however, may not be sufficient to accommodate other transit needs, as well as assist in equipment replacement for private operators in those areas.

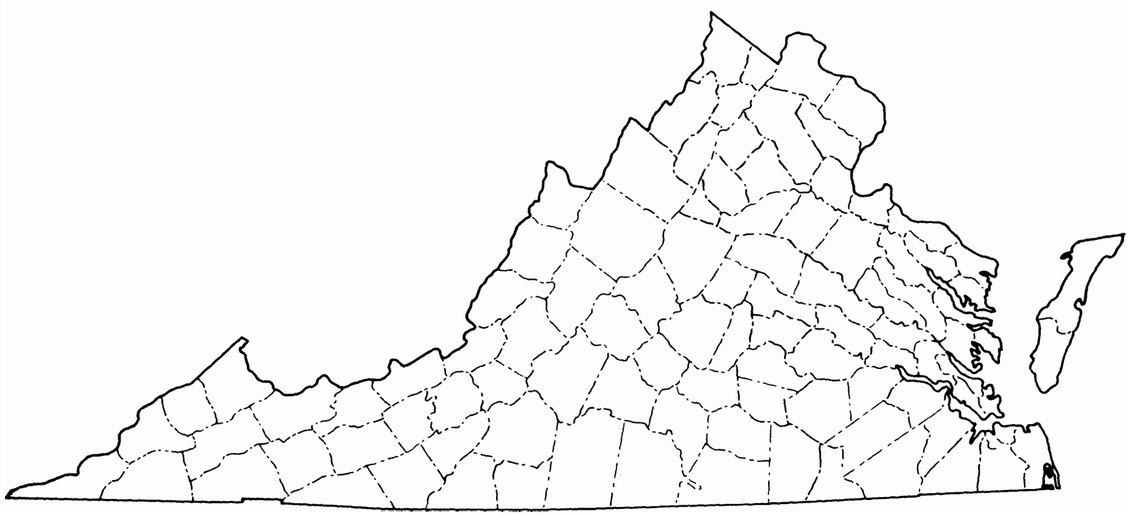
SUMMARY

Virginia need not embark on a major capital program of public transportation improvements (i.e., rapid transit, commuter rail) to serve commuting between central cities and outlying suburbs and rural areas. Such high-cost modal options are unlikely to be warranted in Virginia, except in a few high-volume corridors in Northern Virginia, which already have such options in place, under construction, or in the advanced planning stage, (i.e., Metrorail, I-95 HOV lanes, I-66 HOV operation). Strong emphasis should be placed on the encouragement of ridesharing (car- and vanpooling) and express bus service (where warranted) as modal options. Park-ride lots should be provided on the fringes of urban areas to allow transfer to urban transit (rail and bus) by suburban, long-distance commuters.

The most significant financial challange to urban transportation in Virginia will come if the federal government scales back its funding for transit. The proposed phase-out of federal operating subsidies within three years would deprive local transit systems in Virginia of from $15 to $20 million annually. This would result in serious service reductions (and possible cessation of service in some areas), unless replaced by additional state or local funds. Virginia should be preparing for this possibility by assessing the probable impacts of federal funding cutbacks upon local transit service, transit users, and the economies of local areas, and by defining alternative funding approaches to meeting essential urban transit needs.

VIRGINIA COMMUTER STUDY

Commuter Transportation Problems, Issues, and Policy/Program Response



PREPARED FOR
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DEPARTMENT OF HIGHWAYS
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VIRGINIA COMMUTER STUDY

Phase I Report
Commuter Transportation
Problems, Issues, and
Policy/Program Response

June 1982

Prepared for
The Virginia Department of
Highways and Transportation

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Washington, D.C.

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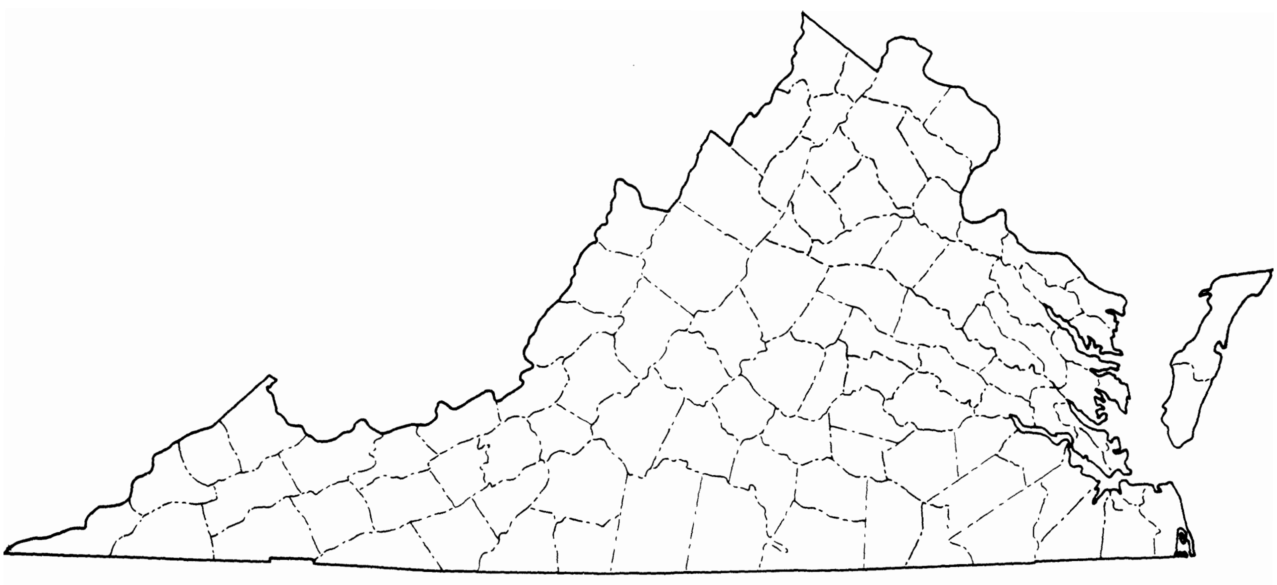


INTRODUCTION

INTRODUCTION

The purpose of the Virginia Commuting Study is to assess the feasibility of alternative transportation modes for commuters working in metropolitan centers, while residing in outlying communities. The study was prompted by the General Assembly's concern over the problems facing such commuters in a state and national climate of declining transportation revenues, high costs of building and operating transportation facilities, and an uncertain energy future. Of particular concern is the desire to identify more cost- and energy-efficient modal alternatives to the single-occupant auto, which characterizes much of today's commuting in Virginia.

Study Approach

The approach to this study has followed three broad phases:

1. The identification of problems and issues associated with commuting in Virginia (with an emphasis upon longer-distance commuting from outlying suburbs and exurban areas) and the development of policy, program, and legislative options to address these issues.

2. The identification of available modal options for such commuting (as drawn from national experience) and the development of a planning methodology through which the applicability of these options can be determined for urban areas in Virginia.

3. A detailed analysis of three case study areas--Northern Virginia, Roanoke, and Martinsville--in which the methodology developed in the second phase will be applied to determine the viability of various commuter options in these areas. The case study areas were chosen by the Virginia Department of Highways and Transportation (VDH&T) to provide a cross-section of urban area size and commuting problems that is somewhat representative of commuting conditions across the state.

An important feature of the study is the definition in Phase I of three future scenarios for commuter transportation in the 1980s and beyond, which reflect the uncertainties that exist with regard to energy availability and costs and financial resources for transportation improvements. The viability of alternative transportation actions in the case study areas (Phase 3) and alternative policy and program actions (Phase 1) is considered within the context of the scenarios to define actions which appear appropriate under any of the scenarios (and thus, represent high-priority actions for implementation).

Organization of this Report

This report documents Phase 1 of the study--commuter problems, issues, and policy/program response--and is part of a three volume major report series documenting the entire study. Other reports describe the analyses and results of Phase 2 (A Methodology for Evaluating Commuter Travel Options in Virginia Cities) and Phase 3 (An Analysis of Commuting Conditions in Three Case Study Areas). An Executive Summary provides an overview of the entire study and highlights principal conclusions and recommendations.

There are five major sections in this report:

- Commuter Transportation Problems and Issues: A discussion of commuter-oriented, peak period transportation problems and issues by mode, drawing upon recent national experience and current conditions in Virginia. Its purpose is to provide a context for the case study analysis and for policy/program recommendations.

- Future Commuter Transportation Scenarios: A description of three different views or scenarios of the future, which reflect significant changes in the context for transportation planning and implementation. Its purpose is to provide a basis for testing the continuing viability of promising commuter travel options, when basic assumptions about the future are varied.

- Current Policies and Status Affecting Commuting: A review of relevant Virginia policies and statutes in the context of federal transportation policies/programs and within a framework of regulation and financial assistance. Its purpose is to bring an understanding of current transportation programs and state authority to the development of new proposals in this study.

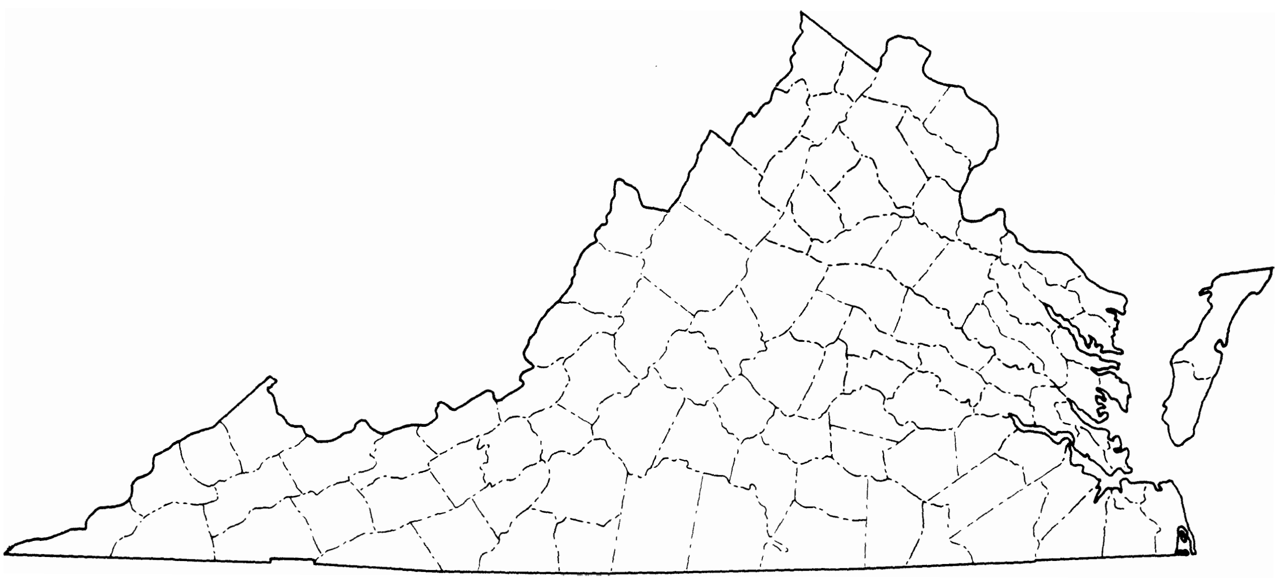
- Policy and Program Options: A description of alternative policies and program options that address the commuter transportation problems defined by this study. Its purpose is to offer a wide range of actions that are responsive to the future problems/needs raised by the three scenarios and from which comprehensive actions for both immediate and longer-term implementation can be drawn.

- Policy and Program Recommendations: A prioritized description of actions to be taken to improve commuting conditions in Virginia.

A brief concluding statement sums up the principal findings of the study and suggests a direction for future state action relative to the needs of commuter transportation.

VIRGINIA COMMUTER STUDY

Commuter Transportation Problems, Issues, and Policy/Program Response



PROBLEMS AND ISSUES

INTRODUCTION

The House Resolution calling for the current study of commuter travel in Virginia cited as rationale for the study the need to reduce traffic congestion, conserve energy, and consider alternatives for commuter travel from suburban areas into urban areas. Each of these concerns--traffic congestion, energy conservation, and modal alternatives for commuters--is important to Virginia commuters. The relative importance varies among urban areas and even among commuting corridors within an individual urban area. In some commuting corridors, congestion may be a critical problem, while in other areas, a more significant issue may be the lack of modal alternatives to the private automobile. Concern for energy conservation tends to be a consistent background issue whose significance varies with the price and availability of gasoline. Finally, implicit in all of these concerns is the key question of cost associated with providing transportation service and alternatives and the current difficulty in providing an adequate financial base for essential transportation investments.

The purpose of this report section is to provide an expanded discussion of the commuting problems and issues mentioned above, and in so doing, to develop a context for the three case study analyses, and most importantly, for the program and policy recommendations to be covered later in the report. The discussion focuses upon commuter-oriented, peak-period transportation problems and issues by mode, drawing upon recent national experience and current conditions in Virginia. Where appropriate, specific insights from the three case study areas (i.e., Northern Virginia, Roanoke, and Martinsville) are reflected, as gained through contacts and interviews with local staffs and officials in these areas. The current significance of major commuter problems is addressed, as well as their likely future importance over roughly the next decade.

The discussion is structured around three broad categories of commuter transportation issues or problems:

-- problems related to automobile commuting

-- problems related to commuting by other modes

-- problems related to the financing and implementation of transportation improvements.

Problems in each of these areas are examined from the perspective of the commuter or the user of transportation services and from the perspective of the provider of transportation services, whether a public agency or a private entrepreneur. Size of urban area introduces another dimension to the discussion of commuter problems. The three case studies for this project were selected to reflect commuting conditions in three basic size categories of Virginia communities. Table 1.1 provides a description of these community size categories and lists the specific urban areas in the state which fall within each category.

Although the smallest category of urban area in Table 1.1 relates to population of 50,000 to 100,000, many of the planning techniques employed and commuting problems analyzed in this study are applicable to smaller cities and towns that have significant concentrations of employment, and hence, commuting. While major employment sites are more likely to be found in larger communities, the real test of applicability is the existence of significant, common trip destinations, rather than area population.

Finally, it is important to remember that the emphasis in this study is on relatively long-distance commuting, generally from 8 to 50 miles or more, which typically involves travel from rural areas or small towns to the larger urban areas in the state. Thus, while the issues discussed may be as broad as highway finance in Virginia, they are interpreted particularly in terms of how they affect long-distance commuting.

PROBLEMS RELATED TO AUTOMOBILE COMMUTING

There are at least four problem or issue areas that significantly impact upon long-distance automobile commuting in Virginia today which are expected to remain as important issues through the 1980s:

- energy scarcity
- high fuel costs
- peak-period congestion
- highway maintenance levels

Two of these issue areas--energy scarcity and high fuel costs--are of particular concern to longer-distance commuters, whose vulnerability to increases in gasoline costs or difficulty of gas purchase is very high. In large urban areas, the problems created by peak-period congestion and associated travel time delays are particularly important to suburban commuters. Highway mainentance is a more subtle, but an increasingly important concern, because it affects the quality of travel experienced by the commuter in terms of road and traffic operating conditions.

Table 1.1
PRELIMINARY CLASSIFICATION OF VIRGINIA URBANIZED AREAS

Size Classification	Criteria	Urban Area
Large	Population Greater than 500,000	o Northern Virginia o Southeastern Virginia o Richmond
Medium	Population 100-500,000	o Roanoke o Newport News/ Hampton Peninsula o Petersburg, Hopewell, Colonial Heights o Lynchburg
Small	Population 50-100,000	o Martinsville o Charlottesville o Danville o Fredericksburg o Staunton-Waynesboro o Harrisonburg o Winchester o Blacksburg-Christiansburg o Bristol

Energy Scarcity

In all areas of Virginia, the travel mode for long-distance commuters is almost exclusively the private automobile. Public transit is generally not available as a travel option except in the larger urban areas, and even then, for only the inner portion of the commuting trip that lies within the urban transit service area. The long-distance commuter requires more fuel for work travel than the average urban commuter. Thus, this group is particularly vulnerable to possible future energy shortages.

The national energy crises of 1973-74 and 1979 that were created by cutbacks in the foreign oil supply triggered major concern within the U.S. government. Federal regulations issued in the late 1970s required states to prepare energy contingency plans for petroleum supply emergencies. These plans considered a wide variety of measures (both voluntary and mandatory) to restrain the demand for petroleum--based fuels and to allocate fuel resources in scarce the event of an emergency. Virtually all state plans included public information programs and gasoline sales management procedures to keep the public informed of energy supply conditions and to allocate fuel resources as equitably as possible.

In addition to state and federal contingency plans, many local areas also developed their own conservation plans. For example, the Metropolitan Washington Council of Governments prepared an Energy Conservation and Management Plan that would affect northern Virginia, and which included the following actions oriented to commuter travel:

-- Preferential parking for high occupancy vehicles (particularly within the Washington, D.C. central area).

-- Increased number of park-and-ride lots (at suburban locations to encourage use of rail and bus transit).

-- Increased use of commuter rail and private buses (reflecting increased service frequency and availability).

-- Increased parking rates for government employees (particularly for federal employees in Washington, D.C. to encourage shifts to other modes).

-- Increased application of Flextime (variable daily work schedules) to permit broadening of peak-hour travel and reduction of traffic congestion, together with associated fuel inefficiencies.

These actions are typical of those proposed in similar plans for most large, urban areas. Many of these actions could and are being implemented or encouraged outside the context of an energy emergency. More efficient use of the work-trip automobile is desirable in any event, particularly to reduce fuel costs, as discussed later in this report. Similarly, employer-based commuter travel options are important in reducing vehicle-miles of auto travel and peak-period congestion; these options too are discussed later.

As noted earlier, the energy contingency plans were developed as a response by the Carter administration to the oil supply crises of the 1970s. The past three years have seen a plentiful oil supply and a new national administration with very different attitudes and approaches to the energy issue. The federal regulations requiring state energy contingency plans have been allowed to expire or have been rescinded. Current federal policies appear to emphasize a build-up of the strategic petroleum reserve to provide an emergency fuel supply and reliance upon a free market approach to fuel resource allocation.

The current federal posture leaves the state and local contingency plans in a state of limbo. Although there are no federal requirements behind the plans, many of the actions may be resurrected and implemented by state and local agencies in the event of another fuel shortage. Federal policies developed during a period of plentiful fuel supply may also change in the face of a critical shortage. One effect of the current policy of a free market approach to fuel allocation during a shortage would likely be significant increases in commuting costs, as fuel prices are allowed to float and determine "demand". If extremely high prices result, the public may demand other actions to allocate fuel on a more equitable basis.

Discussions with local staff, officials, and major employers in the case study areas indicated that long-distance commuters apparently adjusted well to the constraints of the fuel crises of the 1970s. Employers noted an increase in carpooling and ridesharing in general with few hardship complaints from employees. It is unclear whether a more severe or prolonged fuel crisis could be weathered as well in the future. However, the increasing availability of more fuel-efficient cars provides a better means of coping with short fuel supplies.

High Fuel Cost

Gasoline prices over the past three to five years have escalated dramatically in response to the increased cost of foreign oil. Price stabilization (and decline) in recent months has been the result of a glut on the world oil market, a situation which is likely to be temporary and which could change rapidly in response to shifting Middle East political conditions. Consequently, it seems prudent to anticipate that further increases in gasoline costs are likely, if only in response to continued inflation.

When it is observed that the cost per day of a 40-mile (one-way) work trip--for fuel alone--amounts to about $7.50 to $8.00 (assuming 13.5 mpg and $1.30 per gallon fuel cost), the importance of continued increases in fuel cost to the long-distance commuter is clear. Even with continued improvements in automobile fuel economy, under federal Corporate Average Fuel Economy (CAFE) standards established in 1975, daily commuting costs for fuel could increase further. For example, if fuel costs were to double again by 1990, and average fuel economy were to increase to 21.5 mph, the daily cost of work trip commuting for a 40-mile (one-way) trip would be $9.50 to $10.00.

There are indications from research done in the Washington area that fuel costs may be less of an issue to northern Virginia commuters than to commuters in smaller urban regions. People who work in large urban areas, such as the Washington area, and live in outlying communities choose to do so for a variety of reasons. These reasons include a preference for a more relaxed, small town or rural life style, family ties, and many other factors, not the least of which is cheaper housing. In general, housing prices in large urban regions decline with increasing distance from the central area. The MWCOG recently analyzed the trade-off between housing price and commuting costs for representative commuting trips in the I-270 corridor in Maryland. MWCOG's basic conclusion was that the price of gasoline would have to increase substantially in current dollars to outweigh the difference in annual housing cost between living in, for example, Gaithersburg (about 21 miles from downtown Washington) versus Frederick (a 45-mile commute from D.C.). In this example, gas prices would have to approach $3.00 per gallon to offset lower housing prices in Frederick, although the Frederick commuting trip to D.C. would be more than twice the length of the Gaithersburg commute.

In smaller urban regions where there is less differential in housing price between central city and outlying communities, fuel costs for long-distance commuting will be a more critical issue. However, even in the large urban regions, commuters may perceive the daily or weekly out-of-pocket costs for gasoline purchase more stringently than they view the less frequent payments for housing. Gasoline costs are also more subject to sudden, significant increases than housing costs, which are tied to long-term mortgages and interest rates.

The prospects for higher fuel costs and the problem this represents for long-distance commuters, particularly in the smaller urban regions, increases the importance of developing modal options for work travel. Many long-distance commuters may be forced to change their home or job location in order to shorten their work trip and/or find a travel option to driving alone and bearing all the high costs of auto travel.

Peak Period Congestion

Congested travel conditions during the morning and evening peak hours are primarily a problem in the larger urban areas. In such areas of the state, particularly northern Virginia, congestion problems are significant, and affect major sections of freeways and arterial highways. For example, along the Shirley Highway or the George Washington Memorial Parkway in northern Virginia, peak-hour congestion may extend several miles from downtown Washington. On routes such as U.S. 50 or Virginia Route 7 leading to Washington, pockets of chronic congestion may exist as far as 20 or 30 miles from the city. This type of congestion is due both to long-distance commuters destined for the Washington area and to local work travel oriented to the closer-in suburbs.

In many urban and suburban corridors, peak period congestion is due largely to local residents making relatively short work trips. The long-distance commuter may be severely affected by this locally-generated congestion, although he may represent only a small part of the peak-hour corridor travel. Moreover, he typically has few opportunities to change his travel route in an effort to avoid congested areas. Further decentralization of employment through the creation of suburban development centers, such as Tysons Corner in northern Virginia, will introduce more congestion in the paths of central area-destined commuters. Possibly, a counter-balancing effect might be the re-orientation of more long-distance commuters from central area work sites to these suburban centers.

In many urban areas across the country, the implementation of highway and freeway construction plans designed to provide sufficient capacity to reduce present and projected congestion have not been fully achieved. In the Washington Metropolitan Area, the deletion of I-95 inside the I-495 Beltway in Maryland and D.C. is an example of a major cutback in planned urban freeway construction. Because of these changes in urban highway construction priorities, greater reliance must be placed upon achieving more effective use of existing transportation facilities. However, the prospect of increased congestion in many commuting corridors, given any significant urban growth, is very high. Without additional improvements in highway capacity in Virginia's largest urban areas, peak-period congestion will increase during the 1980s.

In the small and medium-sized urban areas of Virginia, such as Martinsville and Roanoke, congestion tends to be more localized to the immediate vicinity of major employment sites and to critical capacity bottlenecks in the arterial system. Congestion is generally of shorter duration, perhaps lasting 15 to 30 minutes in critical areas, as compared to one to two hours or more in the major corridors of northern Virginia. However, congestion tends to be defined by the public in relative terms. A resident of Roanoke or Danville may consider intolerable a level of traffic service that an Arlington resident would consider acceptable or normal. At least long-distance commuters to small and medium-sized urban areas are exposed to congestion for a much smaller portion of their work trip than in the larger urban areas.

Highway Maintenance Levels

One of the most frequently mentioned problems in the case study areas, particularly in the suburban and exurban jurisdictions, is the lack of adequate funding for general highway maintenance and secondary road improvements. Obviously, since traffic volumes are lower in these areas than in the more populous suburbs and central city, congestion is less of a problem and road conditions and safety are of greater concern.

Road condition is an important concern to long-distance commuters because of the implications for wear and tear on vehicles, as well as safety, ride comfort, and quality of highway service during the long commuting trips.

Highway financing problems that will be discussed later present a definite risk of reduced levels of highway maintenance in the 1980s. Commuters with work trips of 40 to 50 miles may typically spend between two and three hours each day on the road. Clearly, the experience of rough or broken pavement and potholes over this length of time each day can be physically and emotionally debilitating, as well as costly in auto repairs.

The primary problem lies in the need to allocate a larger proportion of capital funds to the improvement and upgrading of existing highways, as opposed to new construction. Highway maintenance has traditionally been the financial responsibility of the states with the federal government participating only in construction. However, the Federal-Aid Highway Act of 1976 redefined "construction" to include resurfacing, restoration, and rehabilitation (commonly referred to as "RRR" or 3R). This allowed federal construction funds to be used for certain types of work which were previously considered to be heavy maintenance and which are intended to extend the service life of an existing facility. The Federal-Aid Highway Act of 1978 underscored the importance of such actions by requiring that at least 20 percent of states' obligated funds for primary and secondary system improvements on highways other than freeways go into 3R projects.

The Interstate freeway system benefits from earmarked funds for the "RRRR" or 4R program with the fourth R representing "reconstruction". This program is intended to provide funds for rebuilding or upgrading deteriorated freeway sections. As the Interstate system gets older, funding requirements for the 4R program are expected to increase dramatically. For example, the proportion of Interstate mileage having pavement in need of major rehabilitation or reconstruction rose from 4 percent in 1975 to 10 percent in 1978. Thus, the "pothole crises" observed in many states in recent years will become more serious, and will make major demands upon strained highway budgets.

In Virginia, state law requires that highway maintenance expenses be budgeted before funds are budgeted for new construction. While this will tend to ensure priority funding for maintenance, there will undoubtedly be pressures to lower maintenance standards to reduce or hold down overall budgeting for this purpose to respond to scarce revenues and enable more funds to go to new construction.

This problem is discussed separately from highway financing, because of implications for priorities in the allocation of whatever future highway revenues are available (from federal, state and local sources). Long-distance, peak period commuters tend to use Primary and Interstate highway routes for the major portion of their work trips, with some usage of Secondary or other Federal Aid Urban System routes. The Reagan administration's New Federalism initiative proposes to restrict federal highway construction funding in the future to Interstate routes and possibly key sections of the Primary System; other highway programs would revert to the states. Thus, the extent to which these routes are adequately addressed by future federal funding represents a major concern for long-distance commuters.

PROBLEMS RELATED TO COMMUTING BY OTHER MODES

For long-distance commuters, there are significant questions concerning the feasibility of modal alternatives to the single-occupant, private automobile. Two key problems relate to the scatteration of residential trip origins and work destinations that is typical of long-distance work trips. Where higher densities for either home or work-place trip-ends can be achieved, the viability of non-automobile or ridesharing options is increased. Even under favorable density conditions, important issues remain regarding the extent to which acceptable transit and other modal options are applicable.

Urban Employment Density

Urban employment density is one of the primary factors affecting the viability of all group-travel options, including both conventional transit and ridesharing. In general, higher levels of transit technology (heavy rail, light rail, busway) are feasible in larger urban areas because of the greater concentration of employment and trips destinations (as well as longer travel corridors) which occur in such areas. In medium-sized and smaller urban areas both residential and employment densities are typically much lower, making transit and other group-travel modes more expensive and less cost-effective.

In general, if one end of the commuter work trip--the work place--can be located in relatively concentrated office/service or industrial areas, a greater potential for service by group-travel modes will exist. This potential can be achieved in urban areas of any size, although the frequency and size of such employment concentrations typically are greater as urban area size increases. For example, large employers (in excess of 500 to 1,000 employees) or multiple employer industrial parks or districts provide the kind of employment density that enables consideration of ridesharing and transit service options. Large employment concentrations of this type are most often found in the three largest urban regions of the state. Central business districts (CBDs) and other major suburban activity centers (shopping centers and adjacent commercial/retail/office development) also provide dense employment concentrations. Again, these concentrations tend to be larger and more significant in the larger regions.

There has been a general tendency in recent years for employment centers to scatter throughout urban areas. Lower, rather than higher, employment densities have resulted, with dispersion of employment into suburban areas being the typical pattern. Lower suburban land costs, ease of land assembly, and the high levels of accessibility provided by highway and freeway systems have been primary factors in this decentralization. While modest CBD revitalization is being achieved in many Virginia cities, this has not slowed the accompanying pace of suburban employment decentralization. This pattern is expected to continue in the 1980s.

Greater concentration of employment within "nodes" or higher density locations, such as industrial parks or major commercial activity centers, will be a key factor in the future viability of non-automobile commuter travel options. Plans for the location of such employment concentrations should be carefully formulated at the local and regional levels. The extent to which existing nodal concentrations can be strengthened and the extent to which the private sector will increase its tendency toward larger-scale, non-residential land development projects, are key factors in any potential intensification of employment densities in the 1980s.

Exurban Residential Densities

In general, the residential trip-ends of long-distance commuters are in small towns and rural areas that surround Virginia's major cities. Typically, such outlying residential areas are very low in density and non-urban in character. This makes them difficult to serve by group-travel modes.

During the 1980s, there is some potential for increased residential densities within small outlying urban areas in Virginia. This could be achieved by "housing infill," where scattered new housing construction occurs on vacant parcels located within existing urban areas. It can also be achieved by the observed trend (even in small towns) toward increased construction of multi-family dwellings, in response to rapidly increasing housing costs. To the extent to which densities increase in outlying communities, the potential for group-travel modal options for long-distance commuters is increased.

The 1970s saw relatively higher population increases in small urban areas than in large cities. The extent to which migration from large to smaller cities will increase in the 1980s is not clear. While such migration increases the population base for group-travel modes, it also increases the number of long-distance commuting trips and the attendent problems which they represent. A more effective public policy would seem to be one which encourages job creation in the outlying communities and allows more people to live and work in the same area, thereby eliminating the need for long-distance commuting. This is essentially the policy being pursued by Prince William County in northern Virginia in the ongoing update of its comprehensive plan.

Transit Service Levels and User Costs

A key problem in providing modal options for long-distance commuters lies in the need to have a peak corridor travel volume large enough to warrant its being served by public transit. The level of demand (number of trips) necessary to support transit, the cost of providing service, the relation of acceptable fares to operating costs and the extent of subsidy required, and the desirable service characteristics, particularly the means of collection/distribution at the residential end (park-ride, kiss-ride, carpool, feeder bus, etc.), all represent important dimensions of this problem. Another important dimension involves the extent to which long-distance commuter travel demand overlaps intra-urban travel demand, so that these two types of commuting trips may be served by the same transit services.

Express transit service, operating with few or no stops over much of the travel corridor served, would be attractive to many long-distance commuters, but generally not at the fare levels that would be required to pay for the service. Such express service can be provided either by rail (commuter rail, rapid rail, light rail) or bus (busway, bus on preferential freeway lanes, bus on preferential arterial lanes, bus in mixed traffic) modes. Rail modes generally are viable only in the very largest urban areas (such as northern Virginia), and typically require networks of urban service in order to generate system ridership sufficient to justify costs. Rail modes operating in single travel corridors without connection to similar service in other corridors are relatively rare. Bus modes (express service) are also likely to be feasible only in large urban regions (i.e., northern and southeastern Virginia, Newport News/Hampton, and Richmond) and possibly in the heaviest commuting corridors in some medium-sized cities. This observation has generally been substantiated by the case study analyses.

To some extent, intercity travel modes (intercity bus and AMTRAK) provide a form of transit service that could be used by long-distance commuters. However, in most cases, service schedules do not coincide with peak-hour travel times, and frequency of service is relatively poor. Consequently, intercity modes represent primarily an emergency or "last resort" travel option for long-distance commuters, frequently requiring travel in non-peak periods (to match actual bus or rail schedules), and causing considerable conflicts with work schedules.

Transit service level characteristics that are particularly important to long-distance commuters include average line-haul speed, frequency of service, and transfer capabilities. Line-haul speeds competitive with those of the private automobile are critical in inducing voluntary mode shifts, and would be important in any event to maintain present mobility levels and reasonable travel times. Frequency of service and vehicle size (or train size) are complementary service features which directly reflect demand. Only in the highest travel demand corridors in Virginia (primarily in northern Virginia) are corridor travel volumes likely to reach a magnitude where trade-offs between number of trains, number of cars per train, number of buses, and/or train or bus frequency would become important. Where appropriate, express transit service oriented toward commuter travel would be focused largely on the morning and evening peak periods, with little or no service offered at other times.

The ability to transfer from the private automobile to public transit at the urban fringe, utilizing park-and-ride lots, is also important to long-distance commuters. Although such commuters would be required to use automobiles for a portion of their trips, they could avoid some travel costs and urban congestion by a transfer to transit at the urban fringe. This transfer could be to any express transit mode (bus or rail), and could take advantage of transit services connecting employment concentrations. However, the inability of transit to serve dispersed residential trip-ends would be reflected in the necessity for commuters to drive to, typically, end-of-the-line transit stops or stations.

Finally, the high user costs associated with providing a level of transit service that would be attractive to long-distance commuters require even higher operating subsidies than conventional urban transit service (i.e., longer trip distances resulting in no opportunities for multiple equipment runs during peak periods, extensive travel time and cost for collection at the home end, etc.). County and small town governments in the exurban commuter sheds of Virginia have shown little or no interest in transit subsidies for such commuting.

Ridesharing Service Levels and User Costs

Because of the difficulty in serving the dispersed residential trip-ends of long-distance commuters with conventional transit, other forms of group-travel must be considered. These include primarily carpooling, vanpooling, and in some cases, buspooling.

The attributes of ridesharing modes for long-distance commuting are the flexibility gained from transporting small groups and the favorable costs of ridesharing compared to transit and driving alone by auto. Given the scatteration of residential trip ends in outlying areas, it is easier to find 4 or 5 people to share an automobile trip, who live reasonably near each other and work at the same employment site, than it is to find 40 or 50 people with similar travel characteristics to share a bus trip. Moreover, when a commuter is facing a total 30 or 40 mile trip each way, a five or ten mile drive to a common meeting point to form a carpool or vanpool may not be an intolerable constraint (particularly if this initial drive is in the direction of the ultimate destination and does not add significantly to the total trip distance).

Because carpools/vanpools/buspools are oriented only toward the work trip with operating costs shared among all participants, and because the heavy subsidies required by transit for off-peak operation are not incurred, an attractive out-of-pocket user cost picture is usually achieved. Assuming an average carpool size of 2.5 persons, carpool costs per person-mile should be in the range of 4-to-5 cents. Recent studies have shown costs per person-mile for vanpools and buspools in the three-to-seven cents range. These are costs which fully cover operating costs and include no government subsidy. They compare quite favorably to the 10-to-12 cents per person-mile (or more) out-of-pocket cost for driving alone.

Ridesharing "fares" typically are set to cover all vehicle and operating costs. The costs mentioned above do not include any costs or subsidies by employers to cover the costs of ridesharing program administration and support. The extent to which employers are willing to undertake such costs, and an understanding of potential savings in parking space requirements and associated costs to employers, represent major issues in vanpool implementation.

There is already a substantial amount of ridesharing by long-distance commuters in Virginia, and most of it has been achieved through actions by the commuters themselves without assistance from employers or the government. Given the obvious favorable economics of ridesharing to commuters and the general public (i.e., commuters get cheaper transportation and the public avoids the cost of transit subsidies and major capital costs), several important transportation policy questions arise, including whether it is possible to increase ridesharing by long-distance commuters above present levels, and if so, how can this best be achieved? What is the appropriate role of public and/or private agencies in facilitating ridesharing for this group of commuters? The case study analyses are providing some insights on the potential for expanding long-distance ridesharing. Based on those analyses and experience in other areas of the country, recommendations can be made on further formal assistance that might be given to ridesharing expansion.

PROBLEMS RELATED TO TRANSPORTATION FINANCING AND IMPLEMENTATION

The ability of both public transportation providers (highway and transit agencies) and private providers (motor carriers, carpool/vanpool/buspool organizers and operators) to successfully implement new commuter-oriented services is being severely challenged by growing financial pressures. Inflationary impacts on both highway and transit capital and operating costs have been massive, and growth in revenues from conventional sources has not kept pace with growth in these costs. Major problems exist in finding additional financial resources.

Highway Finance

Due to the combined effect of inflation in the cost of highway construction (including both new construction and maintenance/reconstruction of existing roads) and a probable leveling—off or decline in the rate of growth of gasoline-based tax revenues, the 1980s will see major shifts in the expenditure of highway funds and in the development of new federal and state highway revenue sources. The extent to which the allocation of highway expeditures will involve routes used by long-distance commuters (discussed earlier) represents one issue area. The incidence of new revenue sources (that is, what segment of the population and/or the traveling public will bear additional taxes, and to what degree) also will be significant, particularly if differential taxing schemes are applied to long-distance travelers that increase their travel costs disproportionately.

Improvements in auto fuel efficiency, reduction in the rate of growth of highway travel (vehicle-miles), and accompanying reduction in the growth rate of gasoline sales, all have led to a slowdown in the increase in gasoline tax revenues. For the Federal Highway Trust Fund, the annual rate of revenues growth during the 1970s was 4.5 percent, but the expected annual rate of growth between 1979 and 1985 is only 1.5 percent. This very small rate of revenue increase must be matched against an increase in costs of at least seven percent per year.

Because of these relative decreases in revenue, new sources of highway revenue are being examined by the Federal Highway Administration (and the Commonwealth). Nationally, most of the options under consideration involve user-based financing, including such measures as increasing the per gallon tax rate, converting to a sales volume-based tax rate, indexing motor fuel taxes to some measure of highway needs (with differentials by state), or developing new taxes, such as ton-mile or weight taxes. Direct facility-use taxes (toll roads) conceivably could represent another option. Cost allocation studies now underway by the Federal Highway Administration are intended to explore the assignment of various highway costs according to the types of users of existing and expanded systems. Because of the higher vehicle-miles traveled daily by long-distance commuters, these travelers will be significantly impacted by increased user taxes in terms of increased travel costs.

Another major shift in federally-funded highway programs in the 1980s will see more emphasis given to rehabilitation and reconstruction of existing routes, and much less to the construction of new routes. While during the 1960s and 1970s, major investments were made in highway expansion (including the construction of most of the Interstate Highway System), the rate of new highway capacity construction is expected to slow considerably in the future. For example, from 1970 to 1979, the percentage of all Primary System capital investment directed to new capacity dropped from 88 percent to about 20 percent. Increasing emphasis at the federal level on Transportation Systems Management, coupled with a shift away from new highway system development, is evidence of the general trend toward emphasizing greater efficiency in the use of the existing highway system.

In mid-March 1982 the Virginia General Assembly after considerable debate enacted a three percent (3%) tax on the wholesale price of gasoline and revamped the fee structure for most vehicle-related taxes and licenses to provide an expanded source of transportation revenues. While revenues from these actions fall far short of the six cents (6¢) per gallon gas tax increase that VDH&T had estimated was needed to meet critical transportation needs, they represent an increasing political recognition of the necessity to build a stronger state financial base for transportation. Over the next ten years under President Reagan's proposed New Federalism initiative, states will be expected to assume financial responsibility for all non-Interstate highway and all public transit programs (with the option of implementing state taxes to replace federal excise taxes that would be phased out by 1991).

Erosion of the total transportation funding base could well occur, if replacement of federal gas taxes with state taxes becomes an issue in state legislatures. Groups desiring to reduce the total tax burden on the public and other competing demands for funds (i.e., education, welfare, etc.) may dilute or divert revenues from transportation that are now supplied by the federal taxes.

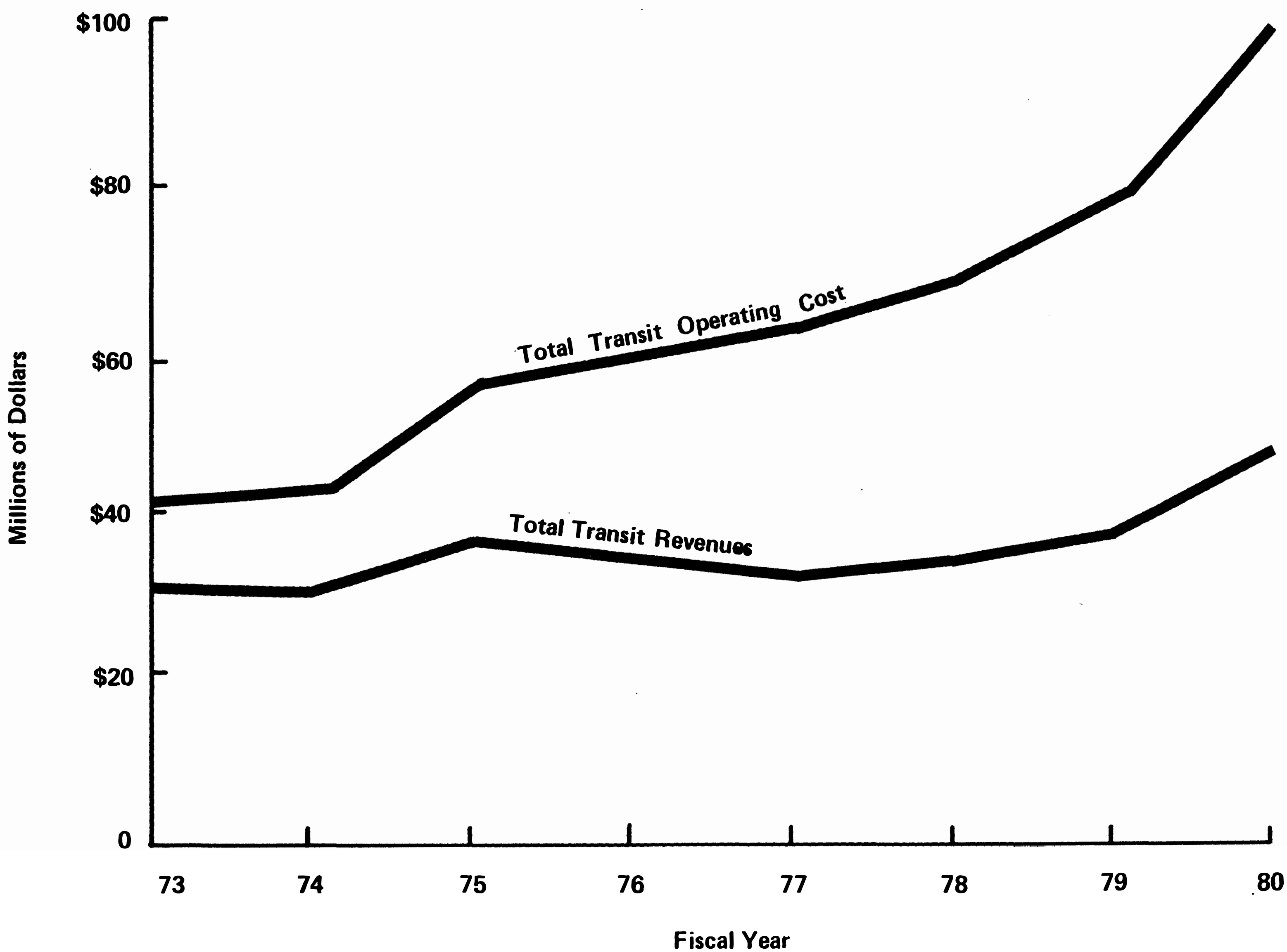
Transit Finance

Transit finance issues related specifically to long-distance commuter travel needs are difficult to separate from urban transit finance issues in general. The pattern of the past few years has shown operating costs and associated deficits for urban transit systems, including those in Virginia, growing faster than revenues from traditional local sources, particularly farebox revenues. With current inflation it is prudent to assume that this gap between operating costs and available revenues will continue and possibly increase. Under current federal operating cost subsidy formulas (50 percent of net costs), the revenue burden to be met from local sources will increase significantly during the 1980s. If recently proposed federal cuts in transit operating subsidies are enacted (complete phase-out by 1985), required non-federal subsidies will increase dramatically.

Figure 1.1 summarizes the growth in dependence on non-fare box revenues over the last four years for all of Virginia's public transit systems. Subsidies from federal, state, and local governments have increased more than fivefold between 1973 and 1980 ($10 million to more than $50 million). Table 1.2 summarizes revenue/cost ratios for each of Virginia's transit systems, in Fiscal Years 1979 and 1980. A low revenue/cost ratio means that a high proportion of operating costs are being met through government subsidies. In 1980 most of Virginia's transit systems seem to have held their own in the battle of increasing farebox revenues and holding down inflationary effects on operating costs. Some systems reported modest gains in their revenue/cost ratios, while others suffered declines--the most serious being Petersburg's drop from 0.94 to 0.66.

Table 1.3 summarizes the levels of governmental operating and capital assistance received by Virginia's transit systems in FY 80. It shows that over the entire state, 33 percent of operating assistance was received from the federal government, although this represents a drop from the FY 79 level of 39% federal assistance. An increase in local government financial support was the principal cause of this declining federal subsidy percentage. However, major federal funding is especially crucial to transit operations in the larger urban regions. This illustrates the potential serious impact on local transit operations of the planned phase-out of federal operating subsidies by 1985. The New Federalism initiative would also transfer capital funding responsibilities to the states as well by 1991.

Within this context of rapidly growing local urban transit financial needs, the cost/revenue implications of extending urban transit service to meet long-distance commuter travel needs raises serious problems. Extension of rail or bus routes into low-density residential and rural areas--even if only to accommodate peak-hour work travel--will result in high operating costs per passenger. Past experience with the elasticity of transit fares has shown that, to cause voluntary ridership diversion from automobiles, operating costs must be subsidized and fares charged which are lower than actual costs. The extent of likely subsidy required, the ability to generate that subsidy from state and local tax sources in the face of federal funding cutbacks, and the



Source: PUBLIC TRANSPORTATION IN VIRGINIA:1980,
Virginia Department Of Highways and Transportation.

Figure 1.1
VIRGINIA TRANSIT REVENUES AND OPERATING EXPENSES (1973–1980)

Table I.2
Virginia Transit System Revenues and Costs, FY-80

Transit Systems	FY-80 Total Annual Revenue 1/	FY-80 Total Annual Operating Expenses 2/	FY-80 Revenue Cost Ratio 3/	FY-79 Revenue Cost Ratio 3/
James City County Transit	$ 34,968	$ 119,036	.29	.22
JAUNT, Inc.	122,000	236,390	.52	.48
Radford Transit System	10,178	57,673	.18	.22
Harrisonburg City Bus Service	70,191	125,412	.56	.55
Bristol City Bus System	119,318	216,224	.55	.59
Winchester City Transit	41,135	163,999	.25	.23
Staunton Transit Service	96,723	245,970	.39	.43
Charlottesville Transit Service	163,364	536,557	.30	.47
Danville Bus Service	309,593	456,229	.68	.66
Petersburg Area Transit Service	322,400	487,901	.66	.94
Greater Lynchburg Transit Co.	584,198	1,494,949	.39	.39
Greater Roanoke Transit Co.	677,205	1,962,218	.35	.33
Greater Richmond Transit Co.	7,494,704	11,755,644	.64	.66
Peninsula Transportation District Commission	1,531,673	3,981,195	.38	.37
Tidewater Transportation District Commission	5,967,920	14,138,115	.42	.38
Washington Metropolitan Area Transit Authority (Metrorail)	20,079,382 (11,887,504)	43,229,870 (19,530,118)	.46 (.61)	.45 (.43)

1/ Includes revenue from regular and discount passenger fares, school and charter operations, and non-passenger income from advertizing, etc.

2/ Does not include capital outlays during FY-79.

3/ Computed ratio of revenue received to operating expenditures in FY-79 and 80.

Source: Public Transportation in Virginia: 1980, Public Transportation Division, Virginia Department of Highways and Transportation.

Table 1.3
Operating and Capital Assistance to Virginia Transit Systems, FY-80

Transit Systems	Operating and Administrative Assistance Received			Capital Assistance Received		
	Federal	State	Local	Federal	State	Local
James City County Transit	$ 54,878	$ 0	$ 7,462	$ 0	$ 65,700	$ 0
JAUNT, Inc.	71,970	0	42,420	55,880	12,573	1,397
Radford Transit System	0	3,000	46,751	0	0	0
Harrisonburg City Bus Service	0	3,000	77,455	0	0	0
Bristol City Bus System	0	15,000	97,150	0	0	0
Winchester City Transit	132,702	14,803	97,192	691,488	162,310	8,020
Staunton Transit Service	0	15,000	137,997	0	146,623	16,291
Charlottesville Transit Service	618,268	25,000	125,855	777,398	184,632	9,717
Danville Bus Service	0	25,000	103,901	0	316,400	56,727
Petersburg Area Transit Service	67,510	25,000	6,070	576,160	129,636	692
Greater Lynchburg Transit Co.	386,000	25,000	524,751	0	0	0
Greater Roanoke Transit Co.	674,530	25,000	619,821	1,019,200	246,822	15,471
Greater Richmond Transit Co.	2,742,469	100,000	2,011,487	2,243,449	494,880	3,965
Peninsula Transportation District Commission	1,501,596	75,000	1,029,395	485,101	246,822	3,333
Tidewater Transportation District Commission	3,977,633	100,000	3,272,758	1,283,176	793,193	73,061
Washington Metropolitan Area Transit Authority	5,446,734	125,000 1/	23,335,772	5,355,522	9,721,321	N/A
Totals:	15,674,290	575,803	31,536,237	12,487,374	12,520,912	188,674

1/ Paid to the Northern Virginia Transportation Commission

Source: Public Transportation in Virginia: 1980, Public Transportation Division, Virginia Department of Highways and Transportation.

resulting commuter ridership which might be attracted are critical factors affecting the feasibility of commuter transit service extensions.

Because of the heavy financial requirements of Metrorail construction, northern Virginia faces a unique problem in transit finance. The Stark-Harris Bill has made some $1.7 billion in Metrorail construction money contingent upon the development of "stable and reliable" funding sources for covering the operating costs of the Metrorail and Metrobus systems. Thus far, the U.S. Department of Transportation has said that current state and local revenue sources in northern Virginia do not satisfy this requirement. Although the recent transportation revenue package passed by the General Assembly provided up to $41.7 million over the next two years to support the capital costs of the Metrorail systems, it may not resolve the federal concern because it does not address the issue of Metro operating costs. However, there is a 2% tax on the retail price of gasoline in northern Virginia which was inacted earlier to provide funds for transit operating assistance. The issue may revolve around the adequacy of that tax as a revenue source for operating costs. (Note: the General Assembly in March 1982 repealed an additional 2% northern Virginia gas tax that was selected to go into effect later in 1982.)

The intent of the General Assembly has apparently been to lend assistance to local governments in northern Virginia in meeting their capital obligations for Metrorail, but to leave the question of operating assistance in the hands of local government. Thus, the provision of a permanent funding basis for transit operating assistance remains perhaps the greatest transportation funding problem facing northern Virginia.

Ridesharing Finance and Implementation

In comparison to the transit financing issues summarized above, the financial implications and requirements of ridesharing are generally much more favorable. Financing and implementation issues center largely on providing encouragement and stimulus to the private sector, particularly large employers, to facilitate inauguration of vanpool/buspool services, as well as the promotion of carpooling among employees.

In 1981, eleven new ridesharing programs were inaugurated in Virginia, for a total of 14 current programs. These range from the Commuter Club program that has been active since 1973 (under sponsorship of the Metropolitan Washington Council of Governments), to the New River Valley Ridesharing program in southwestern Virginia, which was inaugurated in 1981. Table 1.4 describes the ridesharing programs across the state. Most of the programs are oriented toward the matching of commuters for carpool or vanpool purposes, usually with computerized matching services. Some provide financial assistance for van leasing or operation. Table 1.5 summarizes the range of services offered.

Table 1.4
Ridesharing Programs in Virginia (1981)

Program	Estimated Service Area Population 1/	Service Area	Management
Alexandria	(103,217) 2/	City of Alexandria	Local government
Commuter Club	1,105,714	Cities of Alexandria, Fairfax, Falls Church, Manassas, and Manassas Park; Arlington, Fairfax, Loudoun, and Prince William Counties	Regional planning agency
Commuter Express	66,743	City of Lynchburg and surrounding area	Transit agency
COMPOOL	591,719	Richmond City; Henrico, Chesterfield, and Hanover Counties	Non-profit corporation
Easyride	267,520	Cities of Hampton and Newport News	Transit agency
JAUNT	143,597	Charlottesville City; Albermarle, Green, Louisa, Fluvanna, and Nelson Counties	Transit agency
Loudoun County 3/	(57,527) 2/	Loudoun County	County planning department
New River Valley	141,343	City of Radford; Giles, Montgomery, Floyd, and Pulaski Counties	Regional planning agency
Prince William County	(144,703) 2/	Prince William County	Local government
RADCO	118,674	Fredericksburg City; Caroline, King George, Spotsylvania, and Stafford Counties	Regional planning agency
RideX	Statewide		Non-profit corporation
Rooftop	50,373	City of Galax; Carroll and Grayson Counties	Non-profit corporation
TRT	795,602	Cities of Norfolk, Protsmouth, Chesapeake, Suffolk, and Virginia Beach	Transit agency
VANGO 4/	Same as Commuter Club		Non-profit corporation
TOTAL	3,281,285		

1/ Based on 1980 Census figures

2/ These figures are included in Commuter Club's total of 1,105,714

3/ Loudoun County program was discontinued after 1 year.

4/ Now known as Tysons Transportation Associates, focussing upon major employers in the Tysons Corner area of northern Virginia.

Table 1.5
Range of Services: Virginia Ridesharing Programs

Program	Services Offered					
	Program Orientation*	Carpool Matching	Vanpool Matching	Transit Information	Van Leasing	Other
Alexandria	EB	X	X	X		
Commuter Club	GP, EB, universities	X	X			Vanpool consumer information
Commuter Express	EB	X	X	X	X	
COMPOOL	EB	X		X		Ongoing employer assistance
Easyride	GP, EB	X	X	X	X	
JAUNT	GP, EB	X	X			
Loudoun County	GP	X	X	X		
New River Valey	EB	X				
Prince William Co.	CP	X	X	X	X	Vanpool loan financing
RADCO	CP	X	X	X		
RideX	GP					Long-distance ridesharing matching
Rooftop	GP, EB	X		X		
TRT	GP, EB	X	X	X	X	Buspools and shared ride taxis
VANGO	GP, EB		X			Advisory to employers

GP - General Public
EB - Employer-based

The Metropolitan Washington Council of Governments has provided leadership in the development of ridesharing programs in northern Virginia (as well as in Maryland and the District of Columbia). This leadership began with carpooling promotion and matching, and recently was expanded to include vanpool services. This is part of a general effort to broaden the concept of ridesharing to include not only carpooling and vanpooling, but also the use of taxis and other paratransit vehicles, as well as some aspects of public transit (such as buspooling).

Increasing local participation, as evidenced by Tables 1.4 and 1.5, expanded interest and effort on the part of VDH&T, and expanded private sector activities, all offer evidence of growing state and local interest and participation in promoting ridesharing. Interest now centers on such activities as updating and publicizing ridesharing matching services, taking necessary steps to implement vanpools with local public and private action, provision of convenient parking spaces for carpool/vanpools, preferential high-occupancy vehicle (HOV) treatment for vanpools and carpools on major commuting routes, coordination aid, and involvement of transit operators in ridesharing.

The recent revenue package passed by the Virginia General Assembly included for the first time a budget line item providing for financial support of ridesharing promotion across the state and for specific assistance to local communities in developing, implementing, and continuing ridesharing programs. Previously, ridesharing financial assistance to local areas had been constrained to the experimental and demonstration program with its limitation of one year funding for any project. The new budget gives the State Highway and Transportation Commission more flexibilty and financial resources to develop an effective state role in ridesharing, but the exact form of that role is still evolving. This study will offer recommendations for state ridesharing actions related to the problems and needs of long-distance commuters.

SUMMARY

Long-distance commuting in Virginia is done primarily by automobile. There are usually no formal modal alternatives to the auto for these trips, and the only travel option that many commuters have is to make informal arrangements for ridesharing with neighbors and friends having a common work destination.

Because of their dependence upon the automobile, long-distance commuters are particularly vulnerable to the effects of high fuel costs, and even more critically, to the scarcity of gasoline during fuel emergencies. They contribute to peak-period congestion in major commuting corridors, but they suffer disproportionately from corridor congestion in relation to the small percentage of corridor travel demand that they represent. Adequate highway maintenance levels are very important to long-distance commuters, particularly on Interstate and Primary highways, because of the length of their trip (and the resultant amount of time spent on the road) and the associated concern for safety, ride quality, and wear-and-tear on themselves and their vehicles.

The ability to define viable modal options to the single-occupant auto for long-distance commuting is constrained by the scatteration of residence locations in outlying communities and the increasing dispersion of employment sites in urban areas. In effect, it is difficult to generate sufficient volumes of work trips between common areas of residence and employment to support formal transit service, such as various forms of express bus or rail service. Excessive collection times at the residential end of work trips in outlying areas and excessive trip costs are serious constraints on the provision of transit service to long-distance commuters. Ridesharing modes (carpooling, vanpooling, buspooling) offer cost-effective alternatives to transit or driving-alone, and they are less constrained than conventional transit by the problems of collecting riders in low-density areas.

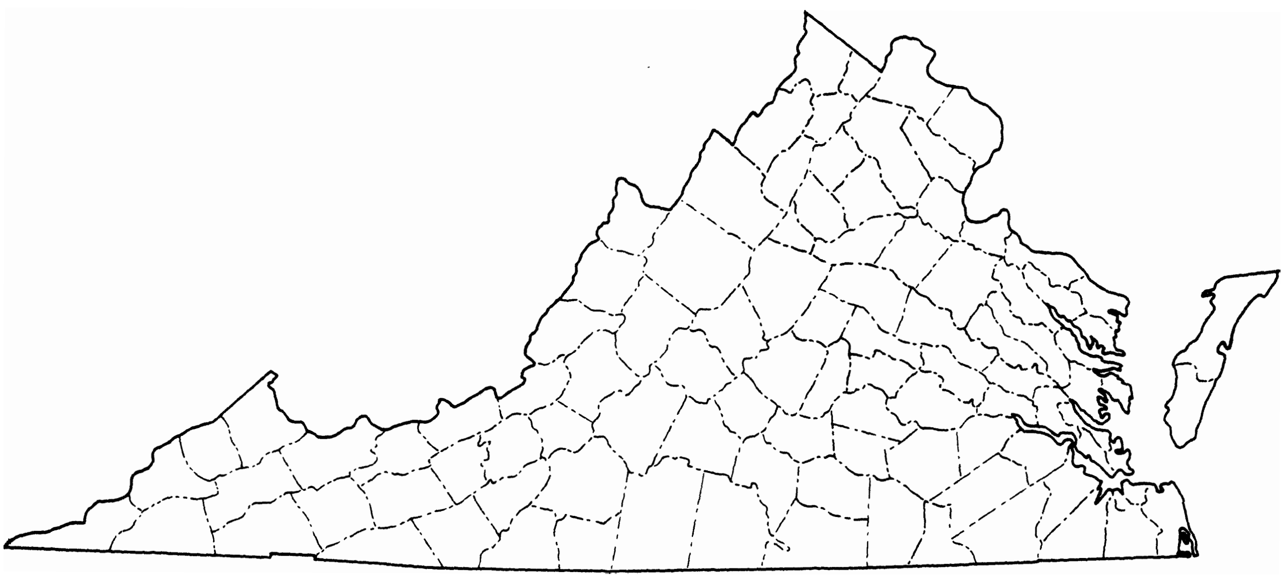
Even if improved modal options through ridesharing and public transportation can be provided to long-distance commuters, highways will continue as the overwhelming means of travel (i.e., carrying the carpools, vanpools, and buses). Thus, long-distance commuters are, and will continue to be, critically impacted by the chronic highway funding problems that confront Virginia and other states. Needed highway improvements have already had to be deferred, and federal proposals to turnback all non-Interstate highway programs to the states will dramatically increase pressures on the states to develop reliable and expanded funding sources. Failure to develop these funding sources will severely impact long-distance commuters, and could impose economic hardships upon this group, ranging from increased transportation costs to possible residential or job relocation.

Because most long-distance commuting cannot be served cost-effectively by conventional transit modes, the worsening national transit funding picture will have less direct impact on this type of work travel. However, the indirect impact could be significant. If urban transit service is cutback severely, many of the shorter urban work trips now being made by transit will have to be made by auto, and this will increase vehicular travel and congestion in corridors used by long-distance commuters.

Ridesharing offers the most feasible modal alternatives to the single-occupant auto for long-distance commuting. There is a need, however, for more attention to, and financial support of, ridesharing assistance in terms of participant matching, van procurement, promotion, and in some cases, financial subsidy. Given the new financial resources and program flexibility from the recent state revenue package, VDH&T must now develop an effective policy and program response to the needs of both long-distance and urban commuters.

VIRGINIA COMMUTER STUDY

Commuter Transportation Problems, Issues, and Policy/Program Response



COMMUTER TRANSPORTATION SCENARIOS

INTRODUCTION

Recent years have seen major shifts in several basic factors which greatly influence transportation planning in the U.S. The energy crises of the mid and late 1970s, the contrasting current international oil glut, the dramatic policy change in the federal role in transportation between the Carter and Reagan administrations, and the increasing erosion of the nation's transportation funding base by inflation and declining gas tax revenues are some of the political and institutional developments that have made it increasingly difficult to plan transportation improvements. When faced with planning for an uncertain future, a useful technique is to describe the future in several different ways, reflecting variations in one or more major factors which are highly influential of the facilities or systems being planned. Plans can then be assessed for their continued viability under the range of future conditions represented by the various scenarios.

For this study it is important to examine the viability of promising commuter travel options in Virginia, when basic assumptions about the future are varied. This workpaper presents three different descriptions or scenarios of the future, which reflect significant changes in the context for transportation planning and implementation.

Because funding availability is critical to the viability of most transportation proposals, assumptions regarding future public funding levels, particularly federal funding, for auto/highway and transit improvements are fundamental. Both highway and transit funding levels are included as major scenario variables.

In addition to funding, the availability and price of petroleum-based fuels for transportation use represent major potential constraints for urban travel, particularly long-distance commuter travel. A number of major studies have been conducted in recent years regarding the economics of energy resource supply and demand in the United States, and these are used to set the bounds of fuel availability and price as major scenario elements.

Assumptions regarding fuel efficiency (miles per gallon) of future automobiles also are important in determining the translation from cost per gallon to cost per vehicle-mile, and its impact on average auto operating costs.

This discussion of scenarios is divided into three parts. First, a brief description of three scenarios for the near future (1980s) is given in terms of basic dimensions, as well as the types of impacts on commuter travel options which might be expected. Second, the scenarios themselves are more clearly described, with reference to national and state-level funding issues and options, and national-level studies which have explored the impacts of projected energy consumption patterns on urban travel needs. The third section discussed the probable impacts of the scenarios upon the most promising modal alternatives for long-distance commuting in Virginia (as determined from the case studies). An understanding of how these modal alternatives are likely to be influenced by changes in the basic scenario descriptions will be important in defining a flexible and responsive set of project and policy/program/legislative recommendations.

The application of these scenarios in assessing specific commuter options from each case study area will be described in the case study reports.

STRUCTURE OF COMMUTER TRANSPORTATION SCENARIOS

Four external factors--transit funding levels, highway funding levels, fuel availability, and fuel cost--can have significant impact on the viability of commuter travel options in Virginia cities. In the future, commuter options involving major capital and/or operating costs will be hard-pressed, if federal funding is cut-back severely. One revenue option associated with reduced federal funding for both highways and transit, is a significant increase in gasoline taxes as a user-based revenue source for state and local government. Transit fares also might be increased to provide additional fare-box revenues. In both cases, significant impacts on the cost of long-distance commuting would result.

Given these four factors, it is possible to identify the following areas of impact on commuter travel options, as a result of scenario variations:

-- Fiscal feasibility. What commuter travel options would be difficult to implement under conditions of reduced federal funding? What options would stand a better chance of implementation if 1980-1981 funding levels were maintained (or even increased)?

-- User cost. What would be the impact of major transit fare increases on those commuter options which involve transit? What would be the impact of major gasoline tax increases on automobile operating costs, both for drive-alone commuters and for carpooling/vanpooling? With reduced highway funding, fewer improvements in highway capacity might be expected, eventually leading to higher congestion levels. A "user cost" in terms of increased travel time, for both highway and transit commuters, also might be expected. How significant might this be?

-- Mode choice. Under scenarios where either or both user costs (transit fares, auto operating costs) increase, or travel times increase, associated changes in the attractiveness of commuter travel options as a mode choice also should be expected. To what extent will group travel or transit/ridesharing options be more or less attractive?

For simplicity, three basic scenarios for commuter transportation are described. These represent "worst case," "best case," and "expected" projections of the basic economic variables outlined above.

"Expected" conditions reflect some change from current conditions, but nothing drastic. "Worst case" conditions assume significantly reduced federal funding levels for highways and transit, restrictions in fuel availability (potentially leading to rationing or other supply controls), and significant increases in fuel costs (such that projected gains in vehicle fuel efficiency are overcome). "Best case" assumptions reflect the reverse of these, a return to pre-1980 highway and transit federal funding in terms of percentage funding levels, no restriction on fuel availability, and moderation in fuel cost increases.

Table 2.1 describes the three scenarios. While it might be possible to hypothesize different combinations of low or high transportation funding with energy price and availability, this was not attempted. While other features of urban growth and development in Virginia cities, especially with regard to the location and density of urban fringe and small-city population increases, could also influence commuter travel options, limited data availability precluded their analysis. Similarly, other national-level scenario investigations have shown that the relationship of changes in family income, auto ownership, and household size have difficult-to-establish relationships with commuter travel patterns, and consequently were not examined.

The application of these three scenarios in analyzing the viability of various options is intended to yield those lower-risk commuter travel options which appear needed and applicable under any scenario. Such options should be given higher priority for implementation. In general, one might expect that lower-cost or conservative options, shown to be viable under other demand and implementability criteria, also would be viable under any scenario. In some cases, however, a low-cost option may represent an inadequate, short-range response to a longer-range commuter travel need requiring a higher-level improvement. Similarly, the moderately priced or "proven" options might be more viable under one scenario than another, and this might be even more likely for the more costly or "experimental" options.

SCENARIO DESCRIPTIONS

In general, since each of the scenarios might be characterized as "low", "medium", or "high", for the different dimensions by which the scenarios are defined, it is convenient to focus on these dimensions to describe the assumptions which underlie each scenario. In other words, the national and state conditions (and related factors) associated with varying levels of transit funding, highway funding, fuel availability, and fuel cost are best described in relation to one another, within each of these dimensions. The four different

Table 2.1

SUMMARY OF SCENARIO DIMENSIONS

Scenario	Factor			
	Fuel Cost (constant dollars)	Fuel Availability	Highway Funding	Transit Funding
Constrained	Increased 50%	Low with short-term "crises"	Severe reductions in federal funding; no increase in state/local funding	Severe reductions in federal funding; no state/local replacement
Expected	Increased 10%; inflation effect offset by improved vehicle fuel efficiency	Stable supply	Moderate reductions in federal funding; modest increase in state funding	Moderate reductions in federal funding; modest increase in state funding
Unconstrained	Decreased 20%; larger drop partially offset by increased taxes	No interruptions in supply	Significant federal funding maintained through 30% increase in gas tax	Significant federal funding maintained through 30% increase in gas tax

dimensions are described in this way below, beginning with assumptions associated with the "expected" or "medium" scenario.

Fuel Cost

There has been considerable speculation in recent years regarding the future extent of real (in constant dollars, without considering the additional effects of inflation) increases in the price of petroleum-based fuels, as well as other non-renewable energy resources (natural gas, coal, etc.). Recent work by Argonne National Laboratory has resulted in mid-range estimates of gradual price increase that fall near the middle of other price increase projections. Based on an average annual rate of increase of 2.0 to 2.5 percent, the Argonne work estimated that the price of gasoline (excluding taxes and inflation) in 1978 constant dollars is projected to increase from 68 cents in 1975 to $1.20 in the year 2000, a 76 percent gain. This is taken as the expected level of real price increase in gasoline (and diesel fuel) in Virginia. The absolute increase by 1990 is 40 percent (95¢ per gallon) over 1975.

Countering these real price increases is the current major trend toward down-sizing of automobiles, with corresponding increase in fuel efficiency. The Corporate Average Fuel Economy (CAFE) standard for 1985 new vehicle production of 27.5 mpg, established in 1975, now is actually being exceeded by the industry, on a pro-rated (1975-85) basis.

Projections of the impact of CAFE standards on average fuel efficiency, for both new and existing cars in the total automobile fleets, also have been made by Argonne and others. These projections represent the expected case, and show an increase in average miles per gallon for the total automobile fleet of 66 percent between 1975 and the year 2000, an increase from 13.5 mpg to 22.5 mpg.

The net effect of these baseline or expected trends in fuel price and vehicle feul efficiency is that the two almost cancel each other in terms of cost per vehicle-mile of travel. Net cost per vehicle-mile is projected to increase by only 5 to 10 percent, in constant dollars, between 1975 and the year 2000. In fact, between 1985 and 1995, the price per vehicle-mile is actually expected to drop, as the rate of improvement in fuel efficiency exceeds the rate of price increase. For example, in 1990 the real price of fuel consumed per vehicle-mile of travel is expected to be 12 percent lower than the real price in 1975.

For purposes of this study, low and high variations in fuel price assume that CAFE fuel efficiency projections described above are held constant. The price of gasoline then is assumed to vary by plus or minus 50 percent in relation to the base case projection. This falls within the range of price increase projected in other studies. In general, the concensus in the energy field is that the "best case" or "low" level of fuel price increase is rather unlikely, while higher price increase (but perhaps not up to an additional 50 percent) are a reasonable possibility. An increase in fuel cost of 50 percent would have a significant impact on out-of-pocket auto operating costs for long-distance commuters and would not be overcome by increased fuel efficiency.

Fuel Availability

A recurrence of the temporary fuel shortages which occurred in 1973-74 and again in 1979, due to political turmoil in the Middle East, is generally regarded as likely over the coming years. The severity of future shortages of gasoline, in particular, is related to the extent of continued reliance on imported oil, and certainly is related to the unknown severity and duration of possible future supply disruptions. While uncertainty regarding future fuel availability is high, an expected case can be set forth which assumes that the types of Energy Contingency Plans employed in several states in 1979 or the use of fuel from the strategic petroleum reserve will be adequate to deal with a 10 percent (and perhaps even with a 15 percent) supply shortfall, over a period of a few months.

A wide variety of Transportation Systems Management (TSM) measures have been employed to achieve greater energy conservation in periods of shortfall. These cover such varied conservation measures as increased carpooling to work, encouragement of multipurpose or linked trips, improved vehicle maintenance, enforcement of the 55 mph speed limit, voluntary sales management activities on the part of gasoline station operators, and restricted weekend use of recreational vehicles. Indirect conservation measures include employer-sponsored carpools and vanpools, preferential parking for multiple-occupancy vehicles, park-ride lots for transit, or four-day work weeks and other flextime or staggered work hour options. Experience and prior analyses have shown that combinations of such actions can achieve voluntary energy savings on the order of 5-10 percent or more .

The constrained or worst case scenario assumes energy shortfalls in the range of 20 percent. Given these conditions, at the national level, it may become necessary to implement a gasoline rationing plan. Under the previous administration, the U.S. Department of Energy prepared a draft rationing plan for implementation, subject to congressional approval, by the President. That plan called for the shortfall to be shared equally among all states. Priority allotments would be given to insure the maintenance of essential public services, including public transportation, and protection of the public health, safety, and welfare. Certain businesses and governmental organizations, including agricultural production, with significant off-highway gasoline requirements, also would receive priority. Eligibility for ration coupons would be determined on the basis of motor vehicle registration, with, in general, each private vehicle receiving the same number of coupons, regardless of the relative use to which the vehicle might be put. The sale or transfer of ration coupons on a voluntary basis would be allowed, so that some redistribution of coupons to those with greater travel needs could be achieved, but with the associated inconvenience of seeking available coupons.

With or without such a rationing plan a limited fuel supply would force up the price of gasoline. One study estimates that a 30 percent shortfall would yield a price for gasoline which is $1.34 higher without price controls than with price controls, an increase of more than 100 percent. The extent to which price controls would be applied is unclear, although the present administration's attitude toward deregulation is such that substantial price increases would be likely.

The "best case" assumption of fuel availability is simply that there will be no interruptions in fuel supply, and therefore, no associated governmental contingency/conservation/rationing actions or additional price increases.

Highway Funding

As indicated earlier in the discussion of problems and issues for commuters in Virginia, the present mismatch between traditional user-based revenue sources and rapidly escalating highway construction and maintenance costs has created a near-crisis in highway funding. It appears likely that the resolution of this crisis will involve an increase in the total amount of user-based taxes collected, as well as revisions in the method of collection and the level of government responsible. While these changes are only now being worked out, under the expected condition assumed for these scenarios, a 25-50 percent increase in present gasoline taxes[1/] is assumed. The proportion of tax increase allocated to federal or state taxes is not addressed. Under President Reagan's New Federalism initiative, increases in user fees (i.e., in this case, gas taxes) would most likely come from the states as they assume full responsibility for most transportation funding.

The best case or unconstrained scenario from a user perspective (i.e., a "user" in terms of one requiring more or improved transportation service), would be an even more dramatic increase in gasoline taxes, as the most likely means of paying for continued highway improvements. A recent study of energy conservation options proposed a 50 percent increase in gasoline prices--via taxation--as a means to help reduce unnecessary automobile travel by making it more expensive. While this form of economic disincentive has quite a different purpose from that of raising additional revenues to continue to fund transportation improvements, the additional tax revenues collected could well be put to that purpose. The impact on the automobile traveler would be the same in terms of changes in behavior in response to significantly increased auto operating costs.

In this same national-level study, a 50 percent increase in gasoline pump prices (via taxation) would raise the average 1980 price of fuel from $1.25

1/ The 25-50 percent increase would include the recently enacted 3 percent tax on the wholesale price of gas in Virginia.

per gallon to $1.88 per gallon, increasing the present national average tax of 14¢ per gallon to 77¢ per gallon. This translates to an increase in auto out-of-pocket operating costs of 9¢ per mile by the year 2000, after accounting for the increase in automobile fuel efficiency, and the present trend of increase in gasoline costs, described above. Combined with other energy conservation policies, this price increase was found to have a significant potential impact on work travel mode choice, and an even more dramatic impact on non-work travel behavior.

Similar increases in auto out-of-pocket operating costs should be assumed in analyzing impacts on work travel behavior of Virginia commuters. It also should be assumed that related tax increases would provide ample funds for construction of needed highway improvements across the state, and for maintaining all major commuting facilities at high levels of performance and capacity.

The worst case scenario assumes no further increase in gasoline taxes, and therefore a continued deterioration in roadway conditions. Particularly in major travel corridors used by long-distance commuters where increases in peak-hour capacity are often desired, no increases in capacity are assumed under this scenario. Highway service levels would decline, and there would be increases in peak-hour congestion and travel time for commuters. This would occur particularly in areas of the state experiencing continued urban and ex-urban or small city growth. For analysis purposes, a 25-50 percent increase in peak-hour work trip travel time should be assumed.

Transit Finance

The Reagan administration's proposed elimination of federal transit operating assistance by 1985 will place severe financial burdens on local transit operators and local levels of government in general. The possibility of increased state participation in subsidizing local transit operations also exists. Aside from these changes in governmental subsidy of transit operations, operating costs have increased at a faster rate in recent years than ridership and farebox revenue. In fact, in Virginia and most states, increases in fares have not kept pace with increases in the general inflation rate.

As a result, under the expected scenario, some modest increases in transit fares are assumed, on the order of 20-25 percent over existing fares. Other local revenue sources, it should be stressed, also must be developed in order to permit only this modest increase in fares. Most popular among potential local revenue sources have been local retail sales taxes, either on all goods or on gasoline purchases only. Other types of motor vehicle user charges, such as taxes on vehicles, parking charges, or bridge or highway tolls, represent additional local (or state) revenue sources for transit under the argument that improving transit service will remove more automobiles from congested peak-hour roadways, to the benefit of remaining highway users. Other potential revenue sources include property tax increases, personal income and payroll taxes, or specific excise taxes (liquor and cigarettes).

These types of additional local government revenue sources have potential for funding transit operating costs, and also can provide the economic basis for capital improvements via the sale of revenue or general obligation bonds. It is recognized that such tax increases have serious political overtones in a general climate of high inflation and family pocketbooks already strapped to meet existing expenses. Nevertheless, some balance must be struck between increased fares and increased local transit funding, in order even to maintain present transit service levels.

Under the best case (unconstrained) assumption, current federal and state funding programs would be maintained at levels at least keeping pace with inflation. Federal transit operating subsidy would remain beyond 1985. Fares, which have lagged behind inflation in recent years, would also be increased to provide additional financial support for modest increases in transit service levels. Federal transit operating subsidy would remain beyond 1985.

Under the worst case scenario, federal operating assistance would be eliminated and capital assistance significantly reduced. There would be not state action to replace these funds. As a result, transit service levels would be reduced, as low ridership routes are cut and off-peak service is curtailed. Fares would be raised in an unsuccessful attempt to help fill the funding gap. In this climate of reduced transit service, the potential for inaugurating new services oriented toward longer-distance commuters would be very low. Out-of-vehicle travel times for transit users, even in the peak-hour, would be expected to increase (including both walk and wait time).

Summary of Scenario Characteristics

The preceding sections have given a general description of three possible futures for Virginia commuters. The key variables in these futures are gasoline costs and supply and governmental (particularly federal) policies toward funding support for highways and transit. The scenarios were defined as a means of assessing the viability of modal options in the future. This requires that the changes which they reflect be expressed in specific time and cost parameters that, in turn, can be used to estimate modal shares (or commuter response) that would occur as a result of these changes. Table 2.2 summarizes the assumed, key time and cost descriptors of the three scenarios. They have been used in the case studies to conduct sensitivity analyses of modal shifts for representative commuting trips. These analyses employ sensitivity tables based on coefficients from previously calibrated logit mode choice models. Simply stated, these analyses estimate what happens to the relative role of a modal option in serving commuting travel under the assumed future conditions.

It should be emphasized that the specific scenario descriptors in Table 2.2. are illustrative of costs and service levels that could occur under those futures. They are intended to imply order of magnitude and direction of costs and service level changes that can be used in a sensitivity or parametric analysis to guage future impacts on commuting.

Table 2.2

SCENARIO DESCRIPTORS FOR SENSITIVITY ANALYSES[1/]

Descriptor	Scenario: Constrained	Expected	Unconstrained
Fuel Cost	+50%	+10%	-20%[2/]
Highway Service Levels	o 30% increase in peak-hour travel time.	o 5% increase in peak-hour travel time.	o 5% decrease in peak-hour travel time.
Transit Service Levels	o 20% increase in peak-hour headways.	o 10% increase in peak-hour headways.	o 10% decrease in peak-hour headways.
	o 20% decrease in speed.	o 5% decrease in speed.	o 5% increase in speed.
	o 30% increase in fares.	o 25% increase in fares.	o 20% increase in fares.

1/ Impacts above and beyond recently enacted 3% tax on wholesale price of gas in Virginia.

2/ Net effect of an increase in gas tax partially offsetting a larger decrease in non-tax gas cost.

The results of these analyses of scenario impacts on specific modal options are presented in each of the case studies. The following section describes the basic relationships that are likely to exist between the scenarios and the principal long-distance commuter options that have emerged from the case studies: ridesharing and express bus service.

SCENARIO IMPACTS UPON MODAL OPTIONS

As noted earlier, the primary objective in the use of scenarios in this study is to identify low-risk commuter travel options which would appear needed and applicable under any scenario. The case studies have identified ridesharing (car-, van-, and buspooling) and express bus service as the most feasible modes for addressing the needs of long-distance commuters. Each of the scenarios will exhibit certain impacts that are favorable to, or supportive of, these modal options, and other impacts that will be unfavorable to their implementation and successful application.

Table 2.3 summarizes key impacts of the scenarios upon ridesharing and express bus service as commuting modes. The sensitivity analyses in the case studies (using the time and cost scenario descriptors in Table 2.2) produce insights on scenario impacts upon modal options in specific areas and corridors. The scenario impacts in Table 2.3 provide a background for defining and assessing alternative policies, programs, and legislative actions to address the needs of long-distance commuters in the next section of this report.

Perhaps the principal conclusion to be drawn from Table 2.3 is that ridesharing emerges as the strongest modal alternative to drive-alone under any scenario. Concurrently, the costs of providing express bus service are exacerbated in the constrained and expected scenarios, and the demand or pressure for express bus service in the unconstrained future is dampened by plentiful, reasonably-priced fuel and stable highway service levels. The private sector is mentioned as the most probable provider of long-distance express bus service under virtually any scenario. This is because the costs of public sector transit operations are likely to be prohibitive for most long-distance commuter markets, and local/state officials have shown little interest in subsidizing such service (particularly when ridesharing offers a cheaper--to the taxpayer--modal alternative).

Table 2.3 also indicates that ridesharing in the unconstrained future, and to a great extent in the expected future, will continue to require extensive promotion and "selling". Moreover, financial and operational incentives will be required under those scenarios if substantial modal shifts to ridesharing are to be achieved (i.e., above the levels of one to five percent increases in ridesharing achieved under typical promotional/matching programs).

Table 2.3

SCENARIO IMPACTS UPON MODAL OPTIONS

	Scenario Impacts					
	Constrained Future		Expected Future		Unconstrained Future	
Modal Options	Favorable to Modal Option	Unfavorable to Modal Option	Favorable to Modal Option	Unfavorable to Modal Option	Favorable to Modal Option	Unfavorable to Modal Option
1. Ridesharing (Carpooling, vanpooling, buspooling).	- High cost and tight supply of fuel will be incentives for more ridesharing - Constrained highway funding will increase congestion because of inability to increase system capacity. Increased congestion will be an incentive to ridesharing (particularly if HOVs can be given prioirty treatment). Public and private sector interest in ridesharing as a low-cost solution to congestion will increase. - Constrained transit funding will result in reduced transit service, which, in turn, will force former transit users to find alternative travel modes. Ridesharing is prime candidate alt. mode. Will also increase congestion making ridesharing even more attractive. - Tax breaks and other ridesharing incenives that are politically infeasible under other scenarios may be acceptable under this scenario.	- Constrained highway and transit funding could reduce funds available for ridesharing support unless benefits are clearly defined. Similarly, funding for actions supportive of ridesharing could be affected (i.e., HOV facilities, park-ride lots, etc.). - Ridesharers will suffer increased travel-time and costs as a result of increased congestion and higher fuel costs. Deteriorating travel conditions (i.e., poor road maintenance) will adversely affect ridesharers (as well as other motorists).	- Fuel costs remain high enough to make ridesharing economically attractive. - Highway funding will not satisfy all needs and congestion will increase slightly. This could be a slight incentive for ridesharing (particularly if HOVs can receive development patterns. - Limited transit funding will result in lower service levels. This could push some commuters to ridesharing.	- Readily available fuel at a reasonable cost will soften interest in ridesharing. - Public funds for ridesharing support could be limited because of pressures from highway and transit needs. priority treatment).	- Increased revenues could mean more funds will be available to support ridesharing. - Increased highway funding will improve road maintenance. Ridesharers will (with other motorists) benefit from improved travel conditions.	- Lower fuel costs offset by increased fuel tax; net effect is little change in fuel cost to user. This coupled with plentiful fuel supply will soften interest in ridesharing. - Readily available and reasonably priced fuel will mean continued support of low density - Modest increase in highway funding will improve ability to address congestion. This could soften interest in ridesharing. - Modest increase in transit funding could have a minor effect in softening ridesharing interest through transit service improvement. This could be offset by increased transit fares.
	CONCLUSION: Ridesharing will be the only feasible modal alt. for most long-distance commuters. User costs will remain attractive despite higher fuel costs. Public support costs are low and private sector can play big role.		CONCLUSION: Ridesharing will continue to be a "hard sell" despite attractive economics to participants. Major forces of fuel supply/cost and highway/transit funding are not conducive in this scenario to major shifts to ridesharing. Could be important in certain corridors and employment centers and as a contingency action.		CONCLUSION: Less incentive to rideshare. Probably a softening of interest in ridesharing particularly by the private sector. Would have to sell ridesharing on basis of personal economics and environmental concern.	

Table 2.3

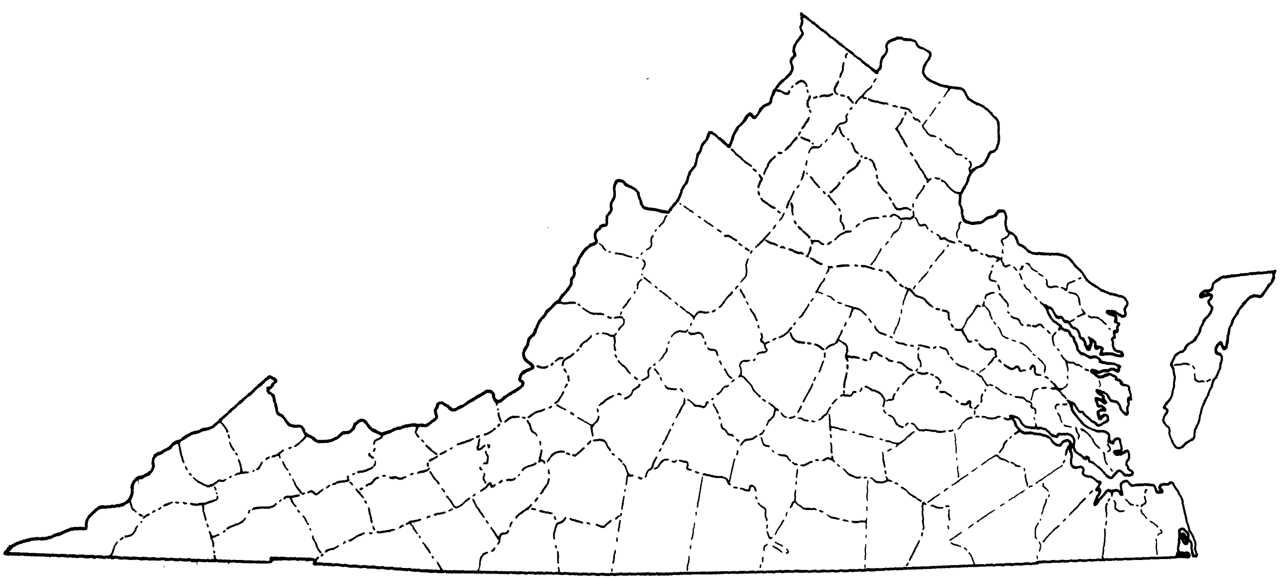
SCENARIO IMPACTS UPON MODAL OPTIONS (Continued)

	Scenario Impacts					
	Constrained Future		Expected Future		Unconstrained Future	
Modal Options	Favorable to Modal Option	Unfavorable to Modal Option	Favorable to Modal Option	Unfavorable to Modal Option	Favorable to Modal Option	Unfavorable to Modal Option
2. Express Bus	- High fuel cost and scarce supply will be incentives for increased transit usage. Constrained highway funding will result in more congestion, which could be an incentive for more transit usage (particularly if transit can get priority treatment over other traffic).	- High fuel cost and scarce supply will increase transit operating costs and fares. Higher fares could counteract increased desire to use transit. - Increased congestion could reduce transit service levels, unless transit is given priority treatment. - Constrained transit funding will reduce ability to provide service in face of increased demand. Users may not be willing to pay cost of service. Need: Methods to hold down costs of transit service and increase private sector role in providing service.	- Relatively stable fuel costs and supply will help to hold down transit operating costs.	- Reasonable fuel costs and plentiful supply will dampen transit demand. - Deterioration in transit funding will reduce ability to provide service, particularly marginally feasible express service. Emphasis will be on urban service for captive or dependent riders.	- Increased transit funding will improve ability to provide service.	- Status quo in fuel costs and plentiful supply will soften interest in transit. - Slight improvement in highway service levels could dampen interest in transit. - Probability of increase[illegible] fares could dampen response to possible service expansion. - Continuation of high auto use will tend to support low density development patterns and sprawl, which are difficult to serve with transit.
	CONCLUSION: Express bus service will have only a limited role unless operating costs can be constrained and service can be given priority treatment over other traffic. Application also constrained to few corridors where volumes and travel patterns warrant express service. Will be important to find ways to increase private sector role.		CONCLUSION: Limited role for express bus. Only in corridors where volumes and patterns warrant express service. Problem is in holding down user costs to be attractive to auto drivers.		CONCLUSION: Not much potential except in major corridors where volumes and patterns warrant express service. Even in these areas, problem will be in holding down user costs as compared with perceived auto costs. Handle more on a private sector, contract service basis.	

Table 2.3 also indicates that ridesharing in the unconstrained future, and to a great extent in the expected future, will continue to require extensive promotion and "selling". Moreover, financial and operational incentives will be required under those scenarios if substantial modal shifts to ridesharing are to be achieved (i.e., above the levels of one to five percent increases in ridesharing achieved under typical promotional/matching programs).

VIRGINIA COMMUTER STUDY

Commuter Transportation
Problems, Issues,
and
Policy/ Program Response



CURRENT POLICIES AND STATUTES AFFECTING COMMUTING

INTRODUCTION

Government, whether federal, state or local, may do -- and for many years has done —a variety of things which affect commuter transportation. As a broad generality, government may express its policies (explicit or implicit) through statutes and regulations. These statutes and regulations may establish the environment in which transportation operates and they may affect the finances of the operation through levying of fees or taxes (or exemption from fees or taxes) and through appropriation of public funds.

Passenger transportation traditionally has been regulated on a geographic basis:

- o interstate (federal regulation)
- o intrastate (state regulation)
- o intra-county or intra-city (state or city, county regulation, delegated from state)

The mobility of the twentieth century has negated many of the traditional boundaries within which this regulatory stratification originally operated. Commuter travel, in particular, crosses city and county boundaries, and in circumstances where a state line is near or within a "commuter-shed", ignores state boundaries with impunity.

The review which follows attempts both to organize the bewildering array of government regulations and statutes and to focus on the question of commuter transportation. Because the primary interest is in the Commonwealth of Virginia's regulations and statutes and because the Commonwealth has the dominant influence through its powers, the review will concentrate on its statutes and regulations, with reference to inter-state (federal) regulation only as appropriate to particular circumstances.

Unlike regulation, financial assistance to commuter transportation is a much more recent phenomenon. For the past several years federal, state and local governments have participated directly in providing various kinds of financial assistance which encourage or support commuter transportation.

Thus, the material which follows reviews state policy affecting commuter transportation, in the context of federal policy, in a framework of (1) regulation and (2) financial assistance, with sub-sections directed to modes, levels of government and types of regulation and assistance as appropriate.

REGULATION OF OPERATIONS

Title 56, Motor Carrier Laws of the Commonwealth of Virginia, empowers the State Corporation Commission (SCC) to regulate "common carrier(s) by motor vehicle", including those who carry either passengers or property (or both). It does not include common carriers who use rail.

In general it requires any person (or corporation, etc.) who carries persons for compensation to apply for and be granted a certificate of convenience and necessity prescribing the points and routes to be served, as well as the specific type of service (i.e.: passenger or property; unrestricted or restricted; regular or irregular routes; etc.). These statutes are oriented primarily to operators of service between cities and towns or outside cities and towns: inter-city bus lines.

If a carrier operates entirely within the State of Virginia, it is not subject to certification and regulation by the federal Interstate Commerce Commission (ICC), but only by the SCC. If a carrier (public or private) operates exclusively within the corporate limits of a city or town, such operation is not subject to SCC regulation (Para. 56-274 (11) of Title 56, Virginia Motor Carrier Laws).

Companies holding certificates from the SCC (and ICC where applicable) may and do operate three kinds of service in Virginia:

- -- scheduled, point-to-point over regular routes
- -- charter
- -- employee-haul

Certification by the SCC is required for the first two of these services but not for employee-hauling. In order to be certificated, a carrier must demonstrate that the service (scheduled, point-to-point, with route described) is in the public convenience and necessity.[1] Apparently, if a carrier is certificated for point-to-point and/or charter operations, he also may engage in employee-hauling. But if an operator wishes to provide only employee-haul service (or other exempt services), he does not need to be certificated. (See material below on exempt services.)

According to a recent report by the University of Virginia on the inter-city bus industry in Virginia, a number of companies offer both scheduled, regular-route service, <u>and</u> charter service, and with minor exceptions, cross-subsidize the regular-route service from the more profitable charter operation. Six of the certificated operators also offer "employee-haul" or commuter service

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1/ See Title 56 for the full description of conditions which must be satisfied.

which, although not regulated in Virginia, is regulated by the ICC when it crosses state lines (three of the companies do).

Because they serve commuters, employee-haul services are of interest to this study. Although not regulated by SCC, employee-haulers are required to show proof of insurance and pay a nominal permit fee. They are entitled to transport employees to and from one or more work places that must be identified on the permit. Commuter service could also be operated by a special charter party carrier, who contracts to provide service for a certain fee (regardless of the number of passengers transported) and with no individual fares charged to riders by the carrier. This type of service is subject to SCC regulation. Because it is cheaper (in terms of fees) and simpler to operate commuter service under an employee-haul permit than as a special charter party carrier, employee-hauling is the most common form of commuter bus service apart from regularly-scheduled, common carrier bus service.

The primary class of service offered by inter-city carriers (still primary, although the inter-city bus report points out that many of the small carriers do much more charter business than point-to-point scheduled business) usually is not oriented to commuter transportation. It is operated from a designated terminal in one city or town to a terminal in another city or town. In some cases the carrier may stop for passengers outbound or leave passengers inbound at points other than the designated terminal, but this does not overcome the basic problems with the use of inter-city service for commuting: service frequency and scheduling, as well as routes, generally are not conducive to commuter use.

A number of public transportation passenger services are excluded from the requirement for certification under the Motor Carrier Laws. Some of these are of potential application to commuter transportation and several have been added recently, specifically, to facilitate certain kinds of commuter transportation. Among the excluded types of operation, potentially relevant to commuter transportation, are:

- taxi
  - having a seating capacity of not more than six passengers
  - operating in a city, town or county which regulates them
  - not operating on a regular route or between fixed termini
- motor vehicles
  - used exclusively in transporting employees to and from specified places of work (employee-haul, mentioned above)
- motor vehicles
  - controlled and operated by a <u>bona fide</u> cooperative
  - used in the conduct of the business of the cooperative
- motor vehicles
  - transporting not more than fifteen passengers
  - engaged in a shared-ride operation
  - passengers share in cost in an amount not to exceed expenese of the operation

- o motor vehicles
  - -- used exclusively within the boundaries of a city or town
  - -- used exclusively within the boundaries of a city or town <u>and</u> adjacent counties where the vehicles are operated by or under contract with the county (or counties)
- o motor vehicles
  - -- transporting domestic help and laborers under very restricted circumstances
- o mini-buses (not less than seven or more than sixteen passengers)
  - -- controlled and operated by a non-profit organization
  - -- transporting members of the organization
  - -- transporting elderly, handicapped or economically disadvantaged members of the community served by the organization
  - -- not operating over a route or on a schedule in conflict with a certificated carrier (i.e.: a non-exempt as discussed earlier)
- o motor vehicles
  - -- operated under the exclusive regulatory control of a transportation district commission

In addition to these excluded operations, several other non-excluded operations offer possibilities for commuter transportation.

Paragraph 56-281 of the Motor Carrier Laws specifies that

> " . . . the transportation of passengers by an urban-suburban bus line which is hereby defined as a bus line the majority of whose passengers use the buses for traveling a distance not exceeding forty miles, measured one way, on the same day between their places of abode and their places of work, shopping areas, or schools shall not be deemed an operation over the route of any common carrier of passengers holding a certificate of public convenience and necessity."

In effect, for operations under these conditions, if <u>other</u> conditions for certification are met, "urban-suburban" bus lines may operate over routes or between points for which authority is already granted to other operators.

Paragraph 56-281.2 permits the SCC to grant certificates to applicants "to serve irregular routes on an irregular schedule within a specified geographic area." However, only vehicles carrying fewer than sixteen passengers may be used, and it is not clear that an "irregular" service would be of interest to commuters.

Taxi operating outside cities or towns must obtain permits to operate from the SCC (although they are not considered common carriers). Cities, towns and counties are granted authority to regulate taxi operation <u>within</u> their boundaries.

Special provisions apply to "sight-seeing" carriers and to "special or charter party" carriers, but the definitions and purposes of these classifications are such that neither is applicable to commuter transportation.

More to the point, which of these excluded and non-excluded types of service offer reasonable potential for commuter transportation across city/town/ county lines (over regular routes, with regular schedules where relevant)?

- o clearly, certificated inter-city carriers under scheduled point-to-point rights or charter rights
- o equally clearly, shared-ride operations, so long as the vehicle carries not more than fifteen passengers. There apparently is no restriction on ownership of the vehicles, but charges may be no greater than required to cover cost.
- o operators who transport employees to and from specified places of work (employee-haul)
- o "urban-suburban" bus lines on routes not longer than forty miles.

Other circumstances under which commuter transportation might be provided can be identified among the various excluded classes described earlier. But most are so specialized as to be prohibitive in a practical sense.

In addition to the requirement for certification, and in some instances, regardless of exemption from that requirement, various permits, warrants exemption cards, classification plates and stamps or decals are required for operators, and most operators are required to carry liability insurance. Certificated inter-city carriers must meet all of these requirements.

Although a detailed review of other applicable statutes has not been performed, House Bill 1091 (1981 General Assembly) relieved ridesharing operations (defined above) of a number of requirements. These included:

- -- insurance requirements
- -- greater standards of care than imposed on other drivers or owners of motor vehicles
- -- equipment and special accident reporting requirements
- -- tax on fuel purchased in another state or road user tax on commercial buses
- -- workmen's compensation coverage for driver (although circumstances are different if the vehicle is owned or leased by the employer)
- -- liability of employer if he does not own or lease the vehicle
- -- treatment of ridesharing payments or reduced transit fares as income
- -- municipal licenses and taxes
- -- payment of overtime compensation or minimum wage for driver
- -- vehicle is not a "bus" or "commercial" (if it seats not more than 16 persons, including the driver)
- -- driver is not a "chauffeur"

The general effect of these provisions is (1) to permit organization and operation of ridesharing in a vehicle larger than a personal automobile, (2) to permit sharing in the cost of operating the vehicle without getting into the business, and (3) exemption from many requirements imposed on certificated carriers and other operators which, although exempt from formal certification by the SCC, still must meet these other requirements.

Operators who wish to provide employee-haul service must obtain a special permit from the SCC.

Apparently, urban-suburban bus lines must meet all of the requirements imposed on certificated carriers (i.e.: they are not exempt), but they may operate on routes held by another certificated carrier without meeting the "adequate service" restrictions (Paragraph 56-281) of the Motor Carrier Laws.

In summary, the regulatory statutes of the state would seem to provide ample latitude for establishment of a variety of commuter transportation services. However, the definition of a regulatory context which permits operation does nothing to encourage operation nor does it necessarily guarantee that it can or will attract sufficient patronage or income to succeed.

This conclusion leads to a review of Virginia's activities in encouraging and assisting commuter transportation services through financial assistance and tax relief within the context established by regulation.

FINANCIAL ASSISTANCE

The practice of providing financial assistance to public transportation operations in Virginia has evolved in a climate provided by federal legislation, and in response to that climate.

There are a number of "categories" of federal assistance to local transportation agencies, and the categories, "names", and extent of participation have changed frequently over the 18 years during which federal public transportation assistance has been available.

Briefly, the current major categories, "names" and funding rates for federal assistance programs are:

(1) For urbanized areas of over 50,000 population:
   a. Capital Assistance
      (Section 3)
      80% of project cost
   b. Operating Assistance
      (Section 5)
      50% of net operating loss

(2) For areas under 50,000 population (and rural areas):
   a. Capital Assistance
      (Section 18)

80% of project cost

b. Operating Assistance
(Section 18)
50% of net operating loss

c. Administrative Assistance
(Section 18)
80% of administrative costs

(3) Unrestricted by size of area

a. Demonstration Grants
(Section 6)
varying percentages

b. Planning Assistance
(Section 8)
varying percentages, usually 80%

Generally, four broad categories of financial assistance are provided by the state:

(1) Capital Assistance
- -- 95% of the local share of project cost (i.e.: if federal assistance is obtained at 80%, then 95% of the 20% local share, or 19% state assistance; if no federal assistance is involved, then 95% of cost)

(2) Administrative Assistance
- -- 50% of the local share of administrative costs

(3) "Experimental Public Transportation Projects"
- -- 95% of development, implementation and promotional costs
- -- 95% of operating costs (for 12 months)

(4) "Public Transportation Promotion, Operations Studies and Ride-sharing Support"
- -- 100% of VDH&T promotion program
- -- 80% of the local share of development, implementation and continuation of ridesharing programs
- -- 50% of the local share of operations planning and technical studies

The "Experimental" program is the only one offering operating assistance.

Actual funding for each of the categories is specified for each of the major urbanized areas, and for the "experimental" and "ridesharing support" programs. Table 3.1 shows the amount for each category for the 1982-84 biennial budget.

Federal assistance is oriented primarily to urban-centered transit operations, but does affect long-distance commuter transportation within (or near) the boundaries of the urban area receiving the assistance (particularly in the larger areas such as northern Virginia, Richmond, Tidewater, Peninsula, and Roanoke). Section 18 funds may be used for rural commuter travel, but the limitation of 50% federal participation in operating assistance has caused financial problems for potential operators (i.e., finding the local 50%), and there is some confusion between the rural-to-rural or rural-to-small-urban

Table 3.1
VIRGINIA FINANCIAL ASSISTANCE FOR PUBLIC TRANSPORTATION FOR THE 1982-84 BIENNIA

Budget Element	Year 1	Year 2	Total
TOTAL	32,018,235	32,617,835	64,636,070
WMATC	112,500	112,500	225,000
NVTC (northern Virginia)	20,634,400	21,106,000	41,740,000
Tidewater	2,914,790	3,023,790	5,938,580
Richmond	2,876,710	2,526,710	5,403,420
Peninsula	1,753,210	2,578,210	4,231,420
Roanoke	521,615	333,615	855,230
Lynchburg	357,790	357,790	715,580
Tri Cities	113,750	111,750	225,500
Bristol	30,650	29,650	60,300
Charlottesville	259,300	389,300	638,600
Danville	255,900	180,900	436,800
All areas	1,567,620	1,367,620	2,935,240
Experimental Public Transportation Projects	420,000	350,000	770,000
Public Transportation Promotion, Operations Studies, & Ridesharing Support	200,000	150,000	350,000

Source: Item 644, Chapter 684 of the Code of Virginia, Appropriations Act for FY 83 and 84.

intent of Section 18 and commuting, which may be rural-to-large-urban or small-urban to large-urban.

VDH&T (Public Transportation Division) and the Energy Division of the Office of Emergency and Energy Services have cooperated in a program to administer the "incentives" funds from the state, in combination with other federal and state funds, to promote ridesharing programs. While not aimed specifically at the long-distance commuter, they have obvious relevance. Table 3.2 shows FY81 funding by area with funding sources. Note that "Demo" (the state "incentives" program) and State Energy Conservation Plan funds appear in almost every project.

TAXES AND FEES

Common carriers are subject to a number of taxes and fees, some of which apply to all motor vehicles, some to all corporations and some specifically to carriers. According to the previously-referenced inter-city bus report, "the taxes represent a relatively small portion of the companies' variable cost." The report also reviews the taxes in greater detail.

Several tax and fee exemptions deserve mention.

- the state fuel tax is refunded for regular-route operations upon application
- urban-suburban carriers are exempt from a 2% sales tax on vehicle purchases (for vehicles with over 7 seats)
- urban-suburban carriers are exempt from a 0.2% gross receipts tax

Although neither the inter-city bus report nor the review "Ridesharing and the Laws of Virginia" addresses the point directly, it seems clear that ridesharing operations are not required to pay those taxes or fees which are levied on motor carriers or on corporations. The Ridesharing Laws report indicates that ridesharing operations, which meet the requirements of the definition cited earlier, "need only meet the standard (permit, license tag and fee) requirements of passenger cars."

SUMMARY

Nominally, Virginia regulates operators who might provide long-distance commuting service. A carrier may not obtain a certificate to provide service without demonstrating that it is in the public convenience and necessity. But rights between most points already are held by a currently operating carrier

Table 3.2
VIRGINIA RIDESHARING PROGRAM FUNDING FOR FY81

Program	Total Project Budget	Funding Source(s)
Alexandria	$ 15,000	SECP, local
Commuter Club	160,000	HPR, SECP
Commuter Express	54,000	Demo
COMPOOL	111,512	Demo, SECP, PL
Easyride	96,028	UMTA Sec. 6
JAUNT	31,250	Demo
Loudoun County	38,000	Demo
New River Valley	48,855	Demo, SECP, local
Prince William County	65,637	Demo
RADCO	15,000	SECP, local
RideX	65,900	SECP, internal
Rooftop	20,809	SECP, STEP
TRT	50,000 (estimate)	UMTA Sec. 5, local
VANGO	10,000	
TOTAL	$ 781,991	

Funding Abbreviations -- Explanation/Administered by:

Demo -- State Aid to Experimental Mass Transit and Ridesharing Projects/VDH&T
HPR -- Highway Planning and Research/VDH&T
Internal -- Internally generated funds
Local -- Local government funds
PL -- Planning funds/VDH&T
SECP -- State Energy Conservation Plan/OEES
STEP -- Small Town Emphasis Program
UMTA sec. 5 -- Federal Operating Assistance/UMTA
UMTA Sec. 6 -- Services and Method Demonstration (Section 6)/UMTA

(although he might not serve the route), and the difficult economic circumstances have discouraged new entrants. Bluntly, the rights to most routes are already held, and although many may not be worth operating, the current holders are loathe to lose them.

A patchwork of legislation, culminating in the ridesharing laws in 1981, provides exceptions to certification and other requirements in Virginia which permit ridesharing outside of regulated motor carrier rights. Regulatory policy, in summary, is contradictory: while operators are regulated, there are so many exceptions that the regulation is virtually irrelevant to commuter service.

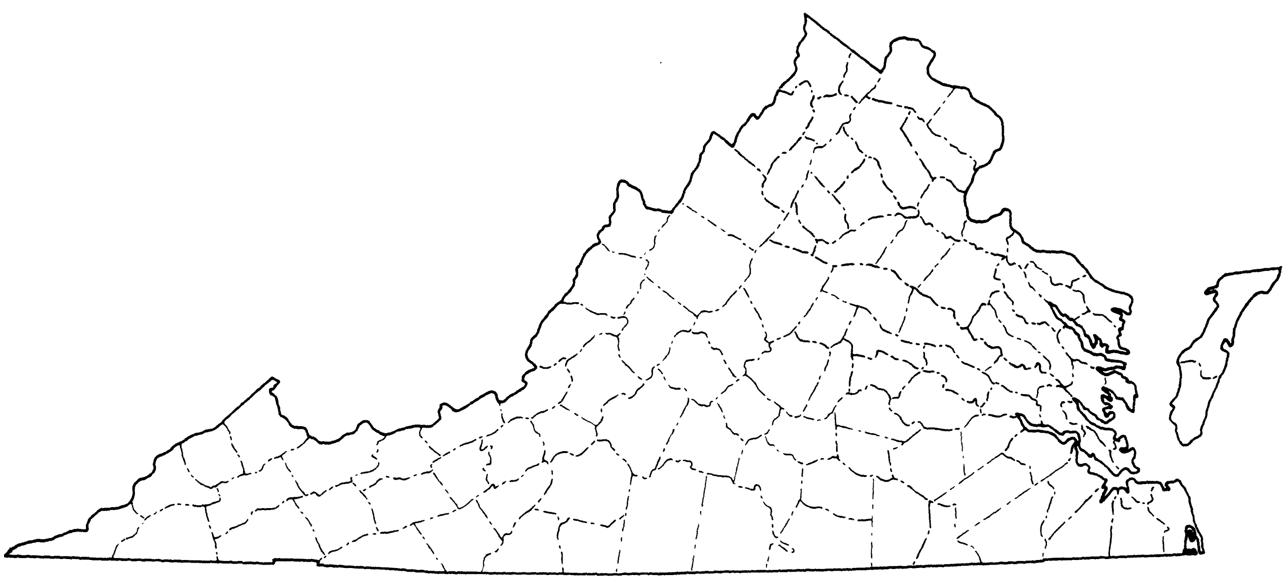
Exemption from taxes and fees presents a similar picture. Regardless, the amount of money involved is small relative to other costs of operation.

Current financial assistance policies, however, represent a solid conviction that the state wishes to avoid any commitment to long-term operating assistance. The relatively generous terms of capital assistance and the open nature of the "experimental" and "ridesharing" programs contrast with ineligibility of operating costs for assistance under long-term programs and the twelve-month limit on "experimental" grants.

In summary, the state has removed most of its regulatory barriers affecting commuter options and has taken the position that it is willing to assist in starting public transportation and ridesharing programs (through assistance with capital, administrative, and planning costs), but it is <u>not</u> willing to participate in operating costs --contending that this is a local (and federal) problem.

VIRGINIA COMMUTER STUDY

Commuter Transportation Problems, Issues, and Policy/ Program Response



POLICY AND PROGRAM OPTIONS

INTRODUCTION

The context established by federal and state policy on public transportation and ridesharing provides a number of opportunities for improving or enhancing the circumstances for long-distance commuters in Virginia. Action by the General Assembly in March 1982 significantly increased the level of funding available to the Public Transportation Division (PTD) to support ridesharing and public transportation and granted new authority for the use of state funds in support of ridesharing activities. As a result, the PTD and VDH&T are now in the position of making decisions about future activities for which funds and authority are available in addition to looking ahead to new authority and programs which appear to have potential.

Based on this study's analysis of current and future commuting problems and needs in Virginia, a series of policy and program actions have been defined to address these needs. They would be initiated primarily by the PTD, but they could also involve, in varying combinations, action by the General Asssembly, local governments, and the private sector.

These policy and program actions could more appropriately be termed "options", because they provide choices for the state as to level of investment and extent of involvement in improving commuter transportation. The "options" outlined in the following sections range from extensions or enhancements of current activities to more significant changes in authority, funding, and staff involvement. Some of the options may be undertaken within current funding and authority. As such, they define currently available choices which may be made by the PTD and VDH&T, and they are noted as such. Other options require increased funding, new authority and, in some cases, a true policy shift on the part of the state. Such options may only be considered politically and financially feasible under a constrained future where severe shortages in fuel supply and/or major cutbacks in federal funding for transportation may require drastic responses by the state.

Finally, it is important to understand the emphasis of these policy and program options upon ridesharing. The primary objective of this study has been to assess the problems of commuting between outlying communities and central cities in Virginia and to propose actions (policy, program, and legislative) to address these problems. The implicit assumption in this study emphasis is that most commuters making shorter, urban work trips are likely to have modal alternatives available to them in the form of transit, ridesharing, bicycling, and in some cases, walking. However, the case study analyses have shown that the only feasible modal alternative to drive-alone for most long-distance commuters is ridesharing. Conventional transit service is not a cost-effective approach to meeting these travel needs. Thus, the policy and program options discussed below are primarily oriented to the expansion of ridesharing as a signficant modal alternative for commuters in Virginia. While ridesharing's inherent economic attraction to commuters increases as trip lengths increase, the options to enhance ridesharing will be beneficial and attractive to a wide range of commuters-- both urban and suburban.

The options have been classified into two principal categories:

1. Those related to the administration, promotion, and provision of technical assistance for ridesharing and public transportation, and

2. Those related to the provision of ridesharing and public transportation vehicles and service.

The description of each policy and program option includes an assessment of its perceived viability under each of the three future scenarios of commuting conditions in Virginia. These assessments are later summarized to identify those options that are likely to have application only under one scenario versus those that appear valid under more than one scenario, and thus, may be "best bets" or low-risk actions. This assessment process draws heavily upon the discussion of scenario impacts upon ridesharing and express bus service as presented earlier in the scenarios section of this report and as summarized in Table 2.3.

OPTIONS RELATING TO ADMINISTRATION, PROMOTION AND TECHNICAL ASSISTANCE

Option 1: PTD Central Office Ridesharing Activity

Broadly, there are two sub-options available for PTD central office (Richmond) ridesharing activity, one which represents a continuation of current roles and activities of the PTD, and another which is a more active, aggressive role with increased staff and direct reponsibility for providing project implementation and technical advice.

The higher level of central office activity would be appropriate in combination with the limited, voluntary role for local ridesharing offices described in Option 2. Conversely, a more limited level of activity in the PTD (administration, advisory, "start-up", and consultation oriented) would be appropriate with an expanded level of activity and expertise in local ridesharing offices.

1.A. Limited PTD Central Office Activity. This sub-option maintains the PTD's present activities relating to ridesharing: administration, information, and to a limited extent, promotion.

Personnel of the PTD now administer federal and state programs offering assistance to ridesharing. Until the recent passage of legislation with its extended authority, state ridesharing assistance has been limited largely to the experimental program, while federal assistance has included similar Section 6 demonstration grants and occasional funds from Section 5 (operating assistance) and Highway Planning and Research funds. An important additional role has been coordination with the State Office of Emergency and Energy Services and the allocation of funds available for ridesharing through state and federal energy conservation programs.

Informational activities have ranged from publication of guides on legislative actions and changes regarding ridesharing to the provision of technical advice and assistance to local agencies, private firms, and others interested in establishing ridesharing operations. An important function has been the monitoring of ridesharing activity throughout Virginia.

Promotion has been largely informal consisting of the provision of information regarding opportunities under present programs and assistance in establishing demonstration projects.

In addition to continuation and perhaps some enhancement or intensification of these activities, the new program of state assistance for "develoment, implementation and continuation of ridesharing programs" presents the PTD with a new area of administrative responsibility. The PTD would have planning and general implementation responsibility for ridesharing activities funded by the state, although project implementation would be carried out by local governments, regional agencies, transit districts, non-profit organizations, and the private sector.

This sub-option is probably most applicable under the expected and unconstrained or "best case" scenarios. In those circumstances, conditions for long-distance commuters are not expected to worsen significantly, and minimal state activity seems the likely response. While the activities represented by this sub-option certainly would be appropriate in the constrained or "worst case" scenario, they would be inadequate, unless coupled with an expanded effort by local agencies.

Because this sub-option is heavily dependent upon other agencies or organizations to assume the initiative in providing ridesharing services, effectiveness is uncertain, although cost would be relatively low. If external circumstances caused increased interest and activity by local government or the private sector, this approach could become very cost-effective for the PTD, but it might also quickly be over-taxed in attempting to satisfy the demand for assistance.

I.B. Expanded PTD Central Office Activity This sub-option assumes the largest central office staffing commitment to ridesharing. In addition to staff who would carry out the administrative and promotional actions defined above in I.A, experienced staff members would be available to local and regional agencies and major employers to assist in implementing ridesharing programs. The aggressive nature of this option would involve active "selling" of ridesharing to employers, taking the initiative in contacting employers to stimulate their interest in ridesharing, and explaining the steps involved in implementation. Major employers would be encouraged to hire their own ridesharing coordinators and set up appropriate internal programs.

Effective technical assistance of this type would be enhanced by ridesharing offices at the local level within the PDCs, city/county governments, or transit districts. It is possible that such local offices, with experience, could deliver the bulk of the necessary technical assistance to employers, with central office staff called in only to deal with special problems or issues. However, this option anticipates limited local staffing and capability.

The state would take the leadership in the planning/design of an aggressive technical assistance program, and would have major responsibility for its funding. However, both state and local government would have implementation responsibilties, with higher levels of state involvement at the beginning, but with more delegation to local and regional agencies after a year or two.

Total annual cost for this suboption would range between $250,000 and $400,000, perhaps shared between state and local agencies. For example, the Maryland VANGO program has a staff of ten, mostly delivering technical assistance, but with certain other duties associated with carpool matching in Baltimore and the administration of a vanpool lease guarantee program. An initial central office staff of 4 to 6 persons might be appropriate in Virginia, perhaps with regional responsibilities assigned to each staff member.

Major commitment to this sub-option would seem appropriate for the "worst case" or constrained scenario, where major employers and others desiring to set up effective ridesharing programs could benefit from prompt assistance, which would reduce implementation time and difficulties. Since greater funding responsibilities fall to the state (by federal default) under the constrained scenario, this sub-option would provide a potentially effective way to implement ridesharing programs whose primary implementation costs would be borne by others (largely the private sector). The aggressive selling aspect of this option, however, suggests applicability under the unconstrained scenario as well, since employers will be less inclined to bother with ridesharing when employee pressures or interest are relatively low.

Again, this is an option for which cost-effectiveness is difficult to establish. However, since state expenditures would be almost entirely in the promotional/administrative area, and associated actions in implementing ridesharing (and assuming associated costs) would lie primarily with those receiving technical assistance--largely the private sector (individuals and employers, both large and small)--the payoff could be quite high. Actual effectiveness would depend on the number of employers and others who sought and received sufficient technical assistance to decide to go ahead with their own ridesharing programs and the ultimate success of those programs.

Option 2: Establish Local Ridesharing Offices

This option represents the establishment of local ridesharing offices and programs in areas throughout the state having significant ridesharing potential. Compared with Option 1, it represents a more decentralized approach to a statewide ridesharing program. Whereas Option 1 reflects a centralized function by state (PTD) staff, Option 2 would utilize the staff of local governments, transit districts, and other agencies--working on the scene and supported financially by a combination of VDH&T and local funds.

As noted above, the emphasis in Option 2 would be upon areas that evidence a strong potential for and/or local interest in ridesharing. It is not proposed that ridesharing offices be created in every county or even in every PDC (except possibly under the constrained future scenario where a severe deterioration of commuting conditions may warrant widespread action).

The primary ridesharing program function should be housed ideally within the public transit agency for those urban areas in the state that have transit service. This would ensure maximum coordination of transit and ridesharing service, and facilitate provision of ridesharing as a possible substitute for more costly transit operations in marginal service areas.

While the transit agency might carry the primary ridesharing program function (particularly, coordination) in the large urban areas, other local jurisdictions, such as counties, should also develop ridesharing offices. For example, a suburban or outlying county might emphasize resident-oriented promotional efforts and commuter matching in its ridesharing program, while the transit agency or a close-in suburban county or central city might emphasize contacts with major employers in its program.

As with the case of Option 1, the level of activity (and funding support) in local ridesharing offices may vary considerably. At one end of the range, the offices might carry out a modest promotional/informational function. At the other end, they might reflect a more aggressive, personal contact program that actively pursues ridesharing opportunities and even includes such functions as van lease arrangements.

Coupled with the variation in activity levels is the institutional question of voluntary versus mandatory action in the creation of local ridesharing offices. Generally, in the unconstrained and "expected" scenarios, the legislature would be unlikely to require the creation of ridesharing programs by local governments. However, commuting conditions could become so serious under the constrained scenario that the legislature may take such strong action to deal with the problems of congestion, fuel shortages, and lack of modal alternatives.

To reflect all these possibilities, four sub-options relating to local ridesharing offices are defined:

A. Limited activity; voluntary local action.

B. Expanded activity; voluntary local action.

C. Limited activity; mandatory local action.

D. Expanded activity; mandatory local action.

While any of these sub-options are possible, the third seems least likely to occur. If commuting conditions warrant legislative action to make local ridesharing programs mandatory, they are also likely to warrant more than a program of limited activity. Sub-option 4 would relate primarily to the constrained scenario, while 1 and 2 could logically fit under the expected or unconstrained futures.

The earlier report, "A Methodology for Evaluating Commuter Travel Options in Virginia Cities", defined four levels of staffing and activity for local ridesharing programs:

1. Staffing consists of one half-time person whose duties include ride-sharing promotion and manual carpool matching for the general public and assistance to major employers in their ridesharing efforts as time permits. A promotion budget of $2,000 is included, plus $2,000 in miscellaneous costs.

2. Staffing consists of one full-time and one half-time position. Program emphasis is on promoting and assisting employers in developing ride-sharing surveys, and computerized carpool and vanpool matching services are provided. Included in the budget is $5,000 for promotion costs, $3,000 in computer expenses, and $4,500 in miscellaneous costs.

3. Staffing consists of two full-time and one half-time positions. In addition to Level Two activities, services include assisting in buspool matching and organization, vanpool leasing, and other technical assistance in vanpool formation. Assumes greater use of matching services by the general public than was assumed for Level Two. Computer expense of $8,000, promotion expense of $10,000 , and miscellaneous costs of $7,000 are included in the annual budget.

4. Staffing consists of three full-time positions and two part-time positions. Program provides same basic services as Level Three program but covers a larger area or a more responsive clientele; includes more field effort to contact major employers. Promotion budget is doubled to $20,000 per year, annual computer costs are $20,000, and miscellaneous costs are $10,000. Acquisition of a microcomputer may be warranted.

Estimated annual budgets range from $14,000 for Level 1 to $150,000 for Level 4.

It is difficult to develop a total, statewide estimate of local office costs, because of the possibility of multiple offices in the large urban regions and the wide variation in local interest and initiative that exists under a voluntary approach. However, to provide at least an "order of magnitude" estimate, a statewide budget of $1.5 million per year would fund 25 local offices with an average budget of $60,000 each.

Since there are 16 urban areas or regions in the state with populations of 50,000 or more and allowing for more than one office in the larger regions, 25 local offices represents a reasonably strong, statewide effort that is achievable under a local voluntary approach (with an aggressive "sales" effort by VDH&T to encourage local action).

Under present legislation, VDH&T could cover 80% of the costs, requiring $1.2 million in state funds for the level of effort described above. To put this number in perspective, current state funding for public transportation promotion, operations studies, and ridesharing support totals $350,000 for the next two years. While there is flexibility for shifting of funds from other program areas to ridesharing support, it is clear that larger budget authorizations from the General Assembly would be needed to support a substantial statewide program of local ridesharing offices.

There is little doubt that the size and intensity of this option (compared to current staff and funding levels) and its "location" throughout the state would significantly increase ridesharing activity of all types. The development of a locally-based program keeps the primary implementation responsibility at the local level where it is closest to the people (commuters) that it is intended to serve. Certainly, too, there would be economies of scale in state level support and coordination activities and significant cross-breeding of ideas and activities among local agencies and personnel.

Option 3: Expanded Emphasis on Ridesharing in State and Local Transportation Planning

Traditional urban transportation planning has been concerned largely with capital investments in projects to effect major expansions in highway and street capacity. Only fairly recently has planning reflected transit or transit-oriented activities, and have annual transportation improvement programs reflected projects other than highway construction and improvement.

This option calls for increased emphasis on ridesharing activities, projects, and programs in both short- and long-range transportation planning. This increased emphasis would occur in local planning agencies and at the state level. Ridesharing projects should be included as integral elements of the annual Transportation Improvement Program for each area, and the role of ridesharing as a modal alternative should be given increased emphasis in the development of regional transportation plans.

Additional costs to current plannig efforts should be negligible. Increased emphasis on ridesharing activities at the planning stage should lead to increased implementation activity, and ultimately, a more balanced and cost-effective transportation program. The planning methodology developed in this study can be used to estimate and evaluate the potential role of ridesharing and public transportation in the on-going urban transportation planning processes in Virginia's cities.

Option 4: Extend Local Authority for Ridesharing Incentives

This option establishes local authority for various ridesharing incentives and service provision, presumably through revisions in local government enabling legislation where local authority is not now available. As with several other options, local actions could either be permitted and encouraged or they could be mandated, and there are levels of activity which range from a relatively passive to a very active, direct role. Two levels of activity are identified as sub-options and each is further identified as voluntary or mandatory.

Examples of actions for which local governments would be granted authority as a first level of activity would include:

-- control of commuter parking (granting of public street parking permits).

-- establishment and operation of park-ride lots, either by lease or purchase of land or by contractual arrangements with private or institutional owners of parking facilities, such as shopping centers or churches.

At a second level, in more extreme circumstances, such as anticipated in the constrained scenario, local governments would be authorized to:

-- raise funds for ridesharing activities through a local ridesharing tax levied on a square foot basis for employers, offices, stores, etc. Those who would be subject to the tax might be granted relief, if they establish their own, internal ridesharing programs.

-- require new developments to provide facilities to encourage ridesharing, such as preferential parking facilities. Overall parking requirements might be relaxed in return.

-- establish HOV lanes on local streets and highways, with authority to restrict operation of single-occupant vehicles.

-- require employers to charge for parking.

-- charge for parking on public facilities and land.

Local governments now have authority for some of these activities, and a detailed review of local government charters and existing enabling legislation would be required to determine precise legislative needs. Regardless, responsibility for implementation of changes would lie at the state level. Little, if any, state funding would be required.

The unconstrained scenario would provide a climate in which the necessity for local authority of the sort described above would not be perceived as necessary, and passage of new legislation would be difficult. On the other hand, in the constrained scenario, conditions may warrant such strong, local actions. This argues for taking preparatory action in the expected future toward such measures as a contingency, so that local action could be taken quickly, if needed. The authorizing legislation might also contain a "trigger" which permitted the Governor (or other state officials) to require local governments to implement some of the actions in extreme circumstances.

Overall, cost-effectiveness should be high, although there obviously would be variations according to the type of action and local circumstances.

Option 5: Establish Financial/Patronage/Activity Reporting System for Public Transportation and Ridesharing

Although the PTD has summarized and reported activity, patronage, and cost/funding data for public transportation and ridesharing, much of their information on ridesharing has resulted from essentially *ad hoc*, largely voluntary response to surveys of known operations (particularly those under the experimental program).

There is some danger in jumping too quickly to a formal, institutionalized, mandatory reporting system. Its requirements easily can be bureaucratic and onerous for the information provider. Yet, the simple need to know what is going on in ridesharing offers a compelling incentive for some sort of monitoring, and the need to determine program effectiveness mandates information for program evaluation.

At this point, given the desirability of a reporting system for monitoring and evaluation of ridesharing (and other public transportation) activities, it is premature to move to specific recommendations. Too many questions are unanswered:

-- What purposes would be served by the system?

-- Who are its potential users?

-- Who should respond? Program administrators? Providers? State/federal assistance recipients? Individual vanpoolers organizers or operators? Carpoolers?

-- Should a consolidated "system" be attempted, combining transit and other forms of ridesharing?

-- Is there--or should there be--a tie-in with federal reporting requirements (like Section 15)?

-- How frequently should information be updated?

One approach might be to commission a review of questions such as these, as well as activities in other states, to provide a sound basis for system design as an end product of the study. Clearly, the Public Transportation Divison would have the primary role in planning, funding and implementing such a reporting system.

Cost obviously will vary, depending on what is done. At one extreme, the modest organizational effort aimed at enhancing current activity could be a $20,000 to $40,000 (annually) activity: one person, perhaps, with clerical/ secretarial assistance. A more comprehensive system could involve somewhat higher annual costs, and probably would require higher start-up costs. A reasonable study, culminating in a detailed data system design (including software), could range up to $40,000 to $50,000, with implementation to follow. Funding would be a legitimate activity as part of the administration of ridesharing assistance.

Institutional implications are uncertain, but it is obvious that improved monitoring and evaluation would facilitate activities under all three scenarios.

Option 6: Study of State Tax, Fee, and Regulatory Incentives for Ridesharing, and Option 7: Implementation of Proposed Revisions

Current statutes in Virginia already provide some relief from taxes, fees, and regulation for ridesharing, whether carpool, vanpool or various forms of bus transit. For example, individual vanpool operations, which meet the statutory definition of a "shared ride" undertaking, are classified the same as general passenger car operators even though they oeprate a larger, more specialized vehicle. They are exempt from much of the common carrier regulation, but common carriers can receive refunds of state motor fuel taxes, while vanpools are not eligible for such a refund. Safety and insurance requirements vary for different classes of operators, even through they all carry passengers.

There are a number of possiblities for revision in Virginia statutes, fees, and regulations. Those which follow are derived from examples in recent federal legislation, the Model Ridesharing Incentives Law (draft), and a review of Virginia statues, regulations, and explanatory material. The possibilities are placed in broad categories: personal or individual; carpool or vanpool operators; employers; and transportation service providers.

a. Individual

- o deduction from personal state income tax of fares paid for commuting via transit, costs of carpool or vanpool participation, and other costs of commuting by modes other than "drive-alone"

- o direct personal state income tax credit of $100 (or some appropriate figure) for using a non-"drive-alone" mode for some number or percent of days each year.

b. Carpool and Vanpool Operators

- o refund of state motor-fuel tax.
- o deduction from personal state income tax of vanpool operation and maintenance costs.
- o deduction from personal state income tax of a pro-rata share of operating and maintenance cost of automobile use in carpooling.
- o state income tax credit of some percent of the purchase price of a vehicle to be used for vanpooling.
- o deduction from personal state income tax of all (or scheduled portion) of the cost of acquiring a van for vanpooling.
- o tax-free status for a small amount of income derived from ridesharing operation.

c. Employers

- o deduction of costs of an employee ridesharing program (match service, vehicle acquisition, etc.) as ordinary business expense.
- o accelerated depreciation schedule for vehicles used in ridesharing.
- o tax credit of x% (or $x) for establishing and operating a ridesharing program (or a percentage of the cost of a ridesharing program).

d. Transportation Service Providers

- o refund of motor fuel tax to providers of commuting services (as now done for inter-city, fixed route scheduled service)
- o exemption from sales, gross receipts, or other taxes for providers of commuting services (as now done for various classes of operators).

At this stage, these possibilities must be regarded as suggestions or examples, rather than recommendations for several reasons.

First, considerable detailed study is needed to further specify--and identify--possible revisions in current regulations, taxes, and fees. Competent legal advice is necessary.

Second, careful research into the broad implications of such regulatory and tax changes (and others which might be developed) is imperative. For example, automobile liability insurance apparently requires that the vehicle-owner in a carpool (or vanpool) not derive any income (above cost) from the operation. If this is the case, a change in Virginia income tax statutes to allow small amounts of tax-free income from ridesharing could cause difficulty in obtaining liability insurance.

Moreover, the fiscal impacts of the various forms of ridesharing tax or fee relief are unknown. Although the amount of income lost to the state likely would be small, this is not certain. On the other hand, the effect of such incentives in increasing ridesharing and transit use is generally untested. The report Intercity Bus Service in Virginia makes the point that fees and charges are a very small part of operating cost in that industry, compared to wages, capital and depreciation, and operating and maintenance costs.

Perhaps this option might be initiated by a legal review of current regulatory, tax, and fee provisions in Virginia statutes and regulations, accompanied by a preliminary estimate of the fiscal and other implications of changes (including implications for the commuter and service provider, as well as the state).

If, from this review, it appears that action is appropriate and likely to be beneficial overall, then a detailed revision of current statutes and regulations could be undertaken with the objective of encouraging ridesharing and transit use and of putting all classes of operators on relatively equitable footing. The review/study would be initiated and administered by VDH&T through the PTD. Implementation of any subsequent recommendations would require legislative action, as well as revision of policies and regulations by the State Corporation Commission and the Highway and Transportation Commission.

Option 7 simply represents the implementation of recommendations that might evolve from the study/review defined above.

Option 8: Major Ridesharing Promotional and Market Effort

Under this option, the PTD would design and fund a major promotional effort designed to encourage voluntary ridesharing activities. This effort could be a one-shot media "blitz" lasting two or three months, or it could be a periodic one-week exposure effort, repeated bi-monthly (or at some other interval) over the course of a year or so. Local ridesharing offices and transit operators would also be involved in implementing the promotional effort, with newspaper ads, radio and TV spots, and other media exposure tailored to the specific commuter markets of a region. The promotional effort could be designed to be repeated in some form every year, as a state commitment to the encouragement of ridesharing.

The target of the promotional effort would be all forms of ridesharing, particularly those where voluntary action by individuals--with associated very low public cost for achieving participation--is involved: carpooling and vanpooling initiated by individuals. Major employers also could be targeted, encouraging them voluntarily to set up ridesharing programs, with some expenditure on their own and with available state assistance emphasized.

Over a one year time frame, $50,000 to $200,000 (or more) could be spent, depending on the type of coverage and repetition desired. If an advertising agency were hired, this likely would increase costs. The number of regions involved, and the number of media outlets in each region (TV and radio stations, newspapers) would be a factor in costs. Funding could be drawn from either the administrative or the promotional budget categories identified in current legislation, with the former an unspecified proportion of each of the regional area grants (totalling about $33 million per year); the latter is allocated an average of $175,000 per year for the next two years.

Under Virginia law, public funds may not be spent to buy space or time for advertising in the print and electronic media. This restriction has constrained previous (and current) transit and ridesharing promotional efforts in the media to public service announcements and advertisements, with the attendant lack of control of placement, use, and frequency. This represents a significant impediment to a more aggressive marketing effort, and it would appear appropriate for the Public Transportation Division to investigate the possibility of establishing an exception (even if narrowly defined) to the current state law.

Under the "worst case" or constrained scenario, higher fuel costs and increased congestion are likely to "force" an increase in ridersharing, without any <u>promotional</u> effort on the part of state or local government. Media compaigns under this scenario would be concerned less with "selling" ridesharing and more with conveying information on where and how to get assistance from state and local agencies. Under the "best case" or unconstrained scenario, there will be less incentive on the part of individuals to participate voluntarily in ridesharing, particulalry if fuel costs decline somewhat in constant dollars as they have in recent months. It appears that under this scenario, promotional efforts to increase ridesharing would be most required; however, the need for increased ridesharing also will be harder to sell to major employers and the public. Under any scenario, an effective promotional campaign presupposes a well-established and active statewide ridesharing program with staff resources to respond to public inquiries and requests for assistance.

The impact of similar promotional campaigns upon ridesharing participation has been difficult to establish. Where campaigns were developed in some states during the 1979 energy crisis, the crisis itself was a major factor in increased participation and it is impossible to estimate the positive incremental effects of the campaigns. They at least addressed the anxiety of commuters, helped to dispel mis-conceptions concerning fuel conditions, and indicated to the general public that state and local governments were acting to minimize the undesirable effects of energy shortages.

It may be useful to query transit operators in Virginia who have conducted media campaigns to determine associated increases in ridership and what approaches seemed to work best, although this is a different form of commuter response. Cost-effectiveness will be difficult to establish; image-building is a large intangible, in terms of showing state leadership, concern, and commitment.

Option 9: Establish State Ridesharing Fund

Special state taxes would be instituted on motor fuel and motor vehicles, motorcycles, and bicycles to provide an expanded source of revenue for a ridesharing program.

Given the current state committtment to the funding of ridesharing activities from the Highway Maintenance and Construction Fund (HM&CF), a special new tax for ridesharing is likely to be politically infeasible and probably unnecessary, except under the constrained scenario, where severe pressure on the HM&CF would occur.

OPTIONS RELATING TO THE PROVISION OF RIDESHARING AND PUBLIC TRANSPORTATION EQUIPMENT AND SERVICE

These options are more directly related to the provision of ridesharing and transit equipment (vehicles) and service than the first category. The level or extent of state involvement (both financially and in terms of staff assistance) can vary considerably by option. Some options are simply expansions of current efforts, while others represent significant new policy directions for the state.

Option 10: State Employees' Ridesharing Program

This option involves the establishment of an in-house state employees' ridesharing program, similar to those advocated for major employers in general. While it would be planned by VDH&T and the PTD would take a lead role in advising and assisting in implementation, each major state department would be responsible for implementing and carrying out its own program. Obviously, some activities could--and should--be performed in cooperation with local governmental programs (as would be the case with major employers in the private sector). Other activities might be the responsibility of the individual state agency, or might be shared among several state agencies (as would be appropriate, obviously, in the Richmond area).

As is the case in several other options, various levels of activity are possible. A first level might be an extension of current efforts in ridesharing promotion through a more concerted effort to cover all state agencies, both in Richmond and across the state.

Activities which might be undertaken at a second level include:

-- establishment of an "in-house" matching program within each department, or additional financial support for local programs which serve a significant number of state employees.

-- establishment of preferred parking for ridesharing vehicles.

-- instituting a state employees' ridesharing fund to support ridesharing activities.

-- charging parking fees for state employees' facilities and instituting payroll deductions, both to be placed in the state employees' ridesharing fund.

-- establishment of "flex-time" to reduce peak traffic and facilitate ridesharing arrangements.

A third level of activity could include:

-- acquisition of vans for leasing or outright loan to state employees for vanpooling.

-- maintenance of ridesharing vehicles at state facilities with reimbursement of cost by vanpool participants.

-- use of state fuel supplies at cost for state employee vanpools or buspools.

The first level of activity basically is now in effect, and it is appropriate even if the "unconstrained" future were to occur. However, it would represent an inadequate response to commuting needs in the constrained future, and the second or third levels would be appropriate. In the "expected" scenario, some activites described under the second and third levels might be difficult to justify, but others would be reasonable.

Net cost of the program to the state would vary, depending on which activities were undertaken, and whether a payroll deduction and parking fee were established. Cost-effectiveness--from the state's point of view--would also be dependent on the source of funds. The cost-effectiveness of specific activities within the program would vary from quite high for low-cost activities such as preferred parking to uncertain for purely promotional activities.

Finally, an "example-setting" program by state agencies would seem to be an important ingredient of any major effort by Virginia to urge greater private sector and local government involvement in ridesharing.

Option II: Increased Emphasis on Experimental Program

This option anticipates a more aggressive program of public transportation and ridesharing experimental projects on the part of the PTD.

Under earlier legislative authority, over 30 projects have been funded by VDH&T, covering a wide variety of actions in a range of geographic locations and operating environments. Funding in recent legislation is maintained at a level similar to prior years for experimental projects, but now includes a new category for "promotion, operations, and ridesharing support," and flexibility is provided to shift funds among "experimental programs, the "promotion" program and the "all areas" group in general state aid. Given these new possibilities, the PTD has increased latitude in assembling a coordinated set of "experimental" projects.

Given that current law authorizes support of up to 80% of the cost of "continuation" of ridesharing projects, prospects for successful, long-term implementation of "experimental" projects are considerably enhanced, even given the legislative intent to avoid continuing, direct operating assistance.

This option anticipates a review of the status and outcome of earlier experimental projects in the context of other options suggested in this document, of the emphasis on ridesharing for long-distance commuter trips inherent in this study, and of other needs, requirements and programs in the Public Transportation Division. This review should identify productive and effective experimental projects which either might be continued (or re-instituted), given new funding for continuation, or might be "transferred" to new, promising geographic locations.

Clarification appears to be needed regarding the intent of the "experimental" program. One interpretation would be that a particular kind of project might be tried in two or three different contexts (i.e., city size, location, commuting characteristics), after which it would no longer be "experimental", but would be fundable only under other programs. Alternatively, repetition in a different geographic area might be regarded as "experimental", given that each geographic locale (and set of circumstances) may be said to be unique.

Depending on the exact program chosen for funding, local participation would be required, althrough the majority of funds would come from VDH&T. Implementation of the program primarily would be the resonsibility of VDH&T, while project implementation would be a joint activity with local agencies.

This option appears to be appropriate under all three scenarios. Given that funding is available now to continue an on-going ridesharing activity, and that the major thrust of this option is to increase its effectiveness, it represents a positive, cautious response in the "best case" scenario, and a solid initial activity in the "worst" or constrained scenario.

Costs of projects in the past three fiscal years have ranged from $12,000 to $114,000, with an average of about $50,000. However, there are so many unknowns regarding the extent of the program, many of which are dependent on the suggested review as well as basic decisions regarding intent, that a total dollar figure is difficult to estimate. At an average of $50,000 and a program level of 8-10 projects each year, the appropriation of $420,000 and $350,000 for experimental projects for the next two fiscal years clearly would be exhausted.

The cost-effectiveness of experimental programs frequently is low in comparison to on-going programs and usually is difficult to measure. Clearly, one criterion of effectiveness on which specific value is difficult to place, but which is unarguable, is the establishment of a continuing, cost-effective service as a result of an experimental project.

A related issue which might be addressed as part of this option is the relaxation of the present 12-month limit on operating assistance to experimental projects. Understanding that the state does not wish to make a commitment to sustained operating assistance, there still are several arguments for extending the 12-month limitation. Perhaps the most compelling is the recognition that commuters are creatures of habit who do not readily change their commuting arrangements. Twelve months generally is regarded as a minimal period of trial operation, particularly when a local government or transit authority must be convinced of a project's viability before assuming financial responsibility for its continuation. Recognizing that the Public Transportation Division has followed a policy of granting funds for a period longer than 12 months, with the time limitation applied only to specific operating costs, the restriction to some extent may constrain the type of projects undertaken as well as the nature of implementation. A more effective policy would allow the extension of demonstration projects for a duration of up to two years, if warranted.

While the primary purpose of this discussion is to present <u>policy and program</u> options related to ridesharing, it is appropriate to note some specific experimental program subjects that illustrate the innovative thrust that the program should have:

- In Tyson's Corner, a congested Virginia suburb of Washington, landlords and tenants of this huge shopping and office complex are underwriting the cost of a rideshare broker-coordinator and a mini-bus circulation operation through per employee and per square foot annual fees. Neither federal nor state assistance is used in the operation. Although the level of cooperation and participation found at Tyson's Corner may be difficult to duplicate in other less congested locations, the concept of private sector participation is increasingly attractive (and necessary) given potential public federal funding constraints. The VDH&T's experimental program could be used to define similar opportunities in other major activity centers and lay the necessary groundwork to attract private action.

- The National Capital Park and Planning Commission has taken an active and leading role in implementing and coordinating vanpool and carpool activities in the Washington suburb of Silver Spring, Maryland. Its activity suggests that quasi-public and special-purpose agencies can have a role in ridesharing. The Silver Spring program is a highly-personalized effort to survey and match interested employees to the most appropriate ridesharing arrangement. It offers another example of tailoring a ridesharing program to a specific major employment center, in this case by a quasi-public planning agency. Opportunities to repeat this experience could be sought in the experimental program.

- The Metropolitan Washington Council of Governments is initiating a program of carpool and vanpool matching at sites throughout the region through remote computer terminals. Potential ridesharers may visit one of several sites (generally, in local government offices) to explore matching possibilities in MWCOG's central ridesharing computer file. The objective is to maximize convenience of access (i.e., eliminate the need for a special trip to one central office) and provide quick interactive commuter response.

- Local transit operators could be encouraged to provide vanpool assistance in corridors where scheduled service (or other types of service) is not economical. Apparently, the Greater Lynchburg Transit Company and Tidewater Regional Transit already are providing such service, or a varient, and several examples are known in other states. Perhaps the most significant aspect is the centralization of ridesharing service and coordination with fixed-route service to provide continuity and common agency implementation for the consumer-user.

Option 12: Vanpool Lease Guarantee

This option is similar to the VANGO program in Maryland in which the state (or more correctly in Maryland, a quasi-public corporation created and funded by the state) co-signs van leases between individuals and private sector van leasing companies. The state agency simply guarantees the lessor that it will assume lease costs, if an individual vanpool operator defaults. In the event of such a default, the state seeks a new vanpool driver to take over the lease.

The success of the lease guarantee program consequently depends upon a vanpool operation of sufficient scale that turnover of operators can be accommodated by circulating existing leases, as well as guaranteeing new ones as participation grows. This option clearly would be tied to a promotional campaign to sustain interest and growth in vanpool participation.

Planning, funding, and implementation responsibilities for this option would lie at the state level. Vanpool participants seeking lease guarantees might, as individuals, have been encouraged to consider vanpooling via local or regional promotional efforts, but the lease guarantee program itself would be a specific state-level program. Cost of the program above other staff costs for a state ridesharing program as described in other options (such as Option 1) would involve probably one central office staff person half-time, or about $15,000 of actual administrative cost. In addition, a fund of several thousand dollars ($30,000 was established in Maryland, but has been little used) should be established from which guaranteed leases would be paid until a new lessee could be found.

Given its low cost, a lease guarantee program could be applicable under <u>any</u> of the scenarios. It is largely a program which facilitates and speeds the inauguration of vanpooling on the part of potential vanpool operators, which is desirable under any scenario. Experience with the Maryland program shows the cost-effectiveness of this option to be high, although administratively and promotionally, it was exercised in coordination with other local and state ridesharing activities. Indeed, the program is evolving into a more decentralized vanpooling promotion and matching effort at the local (primarily, county) level, with only the mechanics of the lease guarantees being handled in the central VANGO office.

Option 13: Van Lease/Re-Lease/Provide at Subsidy

Under this option the state would take a more active role in the actual provision of vans for ridesharing. The state would serve as a "middle man" in leasing vans from private sector leasing operations, and then make them available at a discount either to transit operators, non-profit corporations, or to individuals for vanpool operations. The latter would be done under a re-leasing format. If the re-leasing were not done at a discount or subsidy, there would be little point in the state serving as middle man. Instead, Option 12 (lease guarantee) would suffice, since vanpool operators could contract directly with the private sector lessor.

Given an inflationary economy and the relatively high cost to commuters of van purchase or lease in the private sector, such a program could be effective in stimulating vanpool participation. The intent of this option would be to provide further incentive to the formation of vanpools at a level greater than what could be achieved under the simple lease guarantee program in Option 12. It probably is most in line with the "best case" scenario, where other external factors--such as significant increases in the cost of fuel--are not already "forcing" major interest in ridesharing. Essentially, it represents an incentive program to encourage vanpooling, during a time (scenario) of relatively mild interest otherwise.

Depending on the program details, costs and implementation responsibilities could vary widely. Costs would hinge on the degree of subsidy and extent of participation. For example, if van leases were discounted 25 percent, and 100 vanpools each year were formed under this arrangement, annual costs to the state would be on the order of $50,000 to $75,000.

If the state leased discounted vans directly to individual operators, it would have primary program implementation responsibility. If, instead, the state leased vans to public transit operators or local governments, who then make them available to commuters, these local entities would share in implementation responsibilities.

A problem associated with this option is the question of the state's liability for vanpool accidents, injuries, etc., if the state actually owns or leases the vehicles. Moreover, if the state is leasing the vans at a subsidy or discount to encourage vanpooling, there is an administrative obligation to monitor the program in some way to insure vehicle use for commuting purposes. This would be very difficult to do and may require onerous reporting and burdensome checking procedures by the state. These and other problems suggest that this option may be a less desirable approach to stimulating vanpooling than tax breaks or other types of incentives (see Options 6 and 7).

Option 14: Bus Purchase/Lease/Provide at Subsidy

The objective of this option is to make buses available to public or private operators for the purpose of establishing buspools, subscription bus service, and express service for long-distance commuters.

Under current legislation, the state can provide 95% funding of the non-federal local share for local purchase of buses to be used for such purposes (including 95% of total costs where no federal grant is involved). Local governments or transit districts may operate/establish this service, or they may, in turn, lease the buses to a private operator who provides the service. This procedure is illustrated by the present proposal by Prince William County to purchase refurbished buses with state assistance, and then lease them at nominal cost to a private operator. The County would hold title to the buses, and the private company would provide the service. As long as federal and state capital funds are available, this approach should be actively pursued by state and local agencies to assist private operators in meeting this long-distance commuting need. This approach is applicable to the unconstrained future scenario where continued federal funding support for transit programs is assumed.

If federal capital programs are cut-back in the future (as assumed in the constrained scenario and to a lesser extent, in the expected scenario), state and local governments would be faced with assuming a larger capital responsibility than the 19% and 1% shares, respectively, that they now incur. While the state under current law could cover 95% of total costs, extensive use of this arrangement could quickly develop into a major capital commitment of state funds, exceeding the level of current appropriations. Current national administration plans call for reductions in the federal share for capital assistance from 80% to 75% under the proposed Section 9 capital formula program (which would comprise 90% of all federal transit capital funds) and 50% under the scaled-back Section 3 discretionary grant program (which would comprise the remaining 10% of all capital funds).[1] The current Section 18 small community and rural program would be replaced by a new Section 21 capital-only formula program for non-urbanized areas, reflecting a 75% federal participation rate.

If the above (or a similar) change is made in federal transit capital assistance, this option would reflect a continuation of the state's current policy of covering 95% of the non-federal share of project capital costs. This, of course, expands the state's financial commitment because the 95% figure would apply to 25% or 50% of project costs, instead of the current 20%. This general level of state involvement represents the likely situation under the "expected" scenario.

Under the constrained scenario, more severe cut-backs in, and possible elimination of, federal capital assistance could occur, particularly for non-urbanized areas (i.e., any available federal funds would likely be channeled into keeping urban transit systems afloat). Several sub-options might be considered at this point:

- Increased local share of capital costs (i.e., the state and local governments would split costs 60/40 or 70/30). However, local governments, in particular, would be hard pressed to generate their share, given the general financial constraints of this scenario.

- State purchase of buses and lease at a discount to transit operators. Part of bus acquisition costs would be recovered by the state from lease payments over a period of several years. With an extended amortization schedule, lease payments could be kept low enough to allow transit operators to cover these costs in their fare structure, given the premium type of service they would be providing to the long-distance commuter.

1/ As reflected in the proposed Transit Assistance Act of 1982, which was introduced in Congress on April 13, 1982.

Either of the above sub-options would imply a significant financial commitment by the state. Given the current price of a bus -- $150,000 to $160,000 (although refurbished buses could be a cheaper alternative, if available), costs to acquire only 10 to 12 buses annually could reach $1.5 to $2.0 million per year.

Option 15: Expanded Program for HOV Lanes, Park-Ride Lots and Other TSM Measures

The Secretary and the Transportation Commission would establish and publicize a policy and a concerted state program to provide--and encourage local governments to provide--facilities and improvements to enhance conditions for long-distance (and other) commuters. These would include park-ride lots directed either at connections with scheduled commuter transit service or toward assembly of bus-, van-and carpools. In larger areas, where demand is warranted or an incentive seemed appropriate, it would include construction of additional lanes on major routes for HOVs, or where circumstances permit, the designation of existing lanes for HOV operation.

In addition to projects such as HOV lanes and park-ride facilities, a number of low-capital TSM actions could also be undertaken to provide incentives to shared-ride and transit vehicles and to provide marginal improvements in capacity. The former could include ordinances giving preference to buses, traffic signal modification to permit bus pre-emption, special speed limits, and reduction or elimination of tolls. TSM actions could include minor facility modifications at capacity bottle-necks, intersection and traffic control improvements, or any of a number of traffic engineering activities.

Funding could be drawn from several sources (i.e., ridesharing program funds, the Highway Construction and Maintenance Fund, and various federal funds), but management and promotion of the program established under this option would be placed in a single location within the VDH&T. This might be the Public Transportation Division, but regardless, the program would require close and careful coordination with other ridesharing activities.

As with many other options, costs would vary according to the nature and number of projects. While the need for such projects might be greatest and potential demand highest under the constrained scenario, funding would be critical and in short supply. Although more funding would be available in the unconstrained scenario, there may be less interest in low-capital actions. In the "expected" future, establishment of a concerted TSM program would supply emphasis and an administrative structure, which could be responsive to ongoing needs and any crises which emerge.

Finally, it is recognized that state and local transportation agencies are already required by federal regulations to develop a TSM plan element as part of an annual and continuing transportation improvement program. The action proposed in this option would direct greater attention in current TSM plans to problems of long-distance commuting. It would also develop TSM improvement proposals directed at improving commuting conditions in outlying communities and smaller urban areas where such planning may not be occurring at present.

Option 16: Operating Subsidy for Commuter Express Bus Service

Currently, Virginia law does not permit the use of state funds for transit operating subsidy (with the exception of operations under the 12-month experimental program). Revision of legislation to permit use of state funds for commuter express bus operations would likely be joined by efforts to secure operating assistance for all forms of public transportation. This would represent a major change in current state policy.

Acknowledging the change in state policy represented by such an action, this option defines a possible "minimum subsidy" program for long-distance commuter bus service. Probably the most cost-effective approach to such a program would be to orient it primarily to private transit operators in concert with the efforts in Option 14. Most private operators use old equipment and have not been able to replace equipment out of current revenue. Option 14 offers a possible approach to the problem of providing equipment to such operators at a price that is not financially crippling. With that assistance, private operators should be able to provide commuter service at reasonably attractive fare levels that may, in fact, require little or no operating subsidy.

The following example illustrates typical costs. Assuming a single hypothetical route of 20 miles carrying 40 passengers on each of two morning and evening trips, daily passenger trips would be 160, vehicle miles 160, and vehicle hours about 8. Daily total costs per passenger would run between \$3.50 and \$4.50 (for both trips) or about 9¢ per passenger mile. This figure compares favorably with current drive-alone auto travel costs, but is somewhat higher than vanpooling or carpooling costs. The patronage, cost, and operating assumptions are somewhat optimistic, but these per passenger costs are not out of line with fares charged now by private operators.

On an annual basis, the service hypothesized above would cost between \$50,000 and \$75,000 per vehicle operated. If a 10 to 20 percent subsidy were provided to ten such operations across the state, the total annual subsidy would be on the order of \$50,000 to \$150,000. On a per passenger per day basis, this would amount to a subsidy of about 35¢ to 70¢.

This option is most likely to merit consideration in the constrained or "worst case" scenario under which local transit operators will be hard pressed to initiate or continue financially--marginal routes.

Option 17: Additional Highway Capacity

This option involves the construction of significant additional highway facilities to reduce congestion and delay experienced by long-distance--and other--commuters.

Although some provision of additional highway facilities is anticipated in the "expected" future, this option is relevant primarily in the "unconstrained" future in which funding availability is good and fuel price and availability are not expected to maintain, much less increase, pressure or demand for ridesharing.

PROGRAM/POLICY OPTIONS UNDER SCENARIOS FOR THE FUTURE

The preceding discussion of policy and program options has described such option's general applicability under three scenarios of the future. These assessments are summarized in Table 4.1.

Some of the options are shown as applicable or appropriate, given any of the three scenarios, while others are applicable only under two or even one future. Basically, all of the options are appropriate under the "constrained" or "worst case" scenario. Those which are not indicated as such in Table 4.1 are either superseded by options representing higher or more intense activity or are ruled out by anticipated funding difficulties under the constrained scenario. Where "sub-options" are defined, the substitution of higher intensity activities for lower ones is obvious.

There are at least ten options which appear to be appropriate regardless of scenario or future conditions. They are largely administrative and promotional/informational:

- Increased PTD Central Office ridesharing activity (Option 1).
- Establish local ridesharing offices (Option 2).
- Expanded emphasis on ridesharing in state and local transportation planning (Option 3).
- Establish financial/patronage/activity reporting system for transit and ridesharing (Option 5).
- Study of state tax, fee, and regulatory incentives for ridesharing and implementation of recommended actions (Options 6 and 7).
- Major ridesharing promotional and marketing effort (Option 8).

Table 4.1
APPLICABILITY OF POLICY/PROGRAM OPTIONS UNDER SCENARIOS

Policy/Program Option	Applicability of Option Under: Constrained Scenario	Expected Scenario	Unconstrained Scenario
1. PTD Central Office Ridesharing Activity			
A. Limited Activity		X	X
B. Expanded Activity	X	X	X
2. Establish Local Ridesharing Offices			
A. Limited activity; voluntary local action		X	X
B. Expanded activity; voluntary local action	X	X	
C. Limited activity; mandatory local action	X		
D. Expanded activity; mandatory local action	X		
3. Expanded Emphasis on Ridesharing in State and Local Transportation Planning	X	X	X
4. Extend Local Authority for Ridesharing Incentives			
A. Limited activity; voluntary local action		X	
B. Expanded activity; voluntary local action	X		
C. Limited activity; mandatory local action	X		
D. Expanded activity; mandatory local action	X		
5. Establish Financial/Patronage/Activity Reporting System for Transit and Ridesharing	X	X	X
6. Study of State Tax, Fee, and Regulatory Incentives for Ridesharing	X	X	X
7. Implementation of Proposed Revisions to State Tax, Fee, and Regulatory Incentives for Ridesharing	X	X	X
8. Major Ridesharing Promotional and Market Effort	X	X	X
9. Establish State Ridesharing Fund	X		
10. State Employees' Ridesharing Program			
A. Limited Promotional/Informational		X	X
B. Active (matching, preferential parking, etc)	X	X	
C. Direct (vehicle provision, maintenance, etc.)	X		
11. Increased Emphasis on Experimental Program	X	X	X
12. Van Lease Guarantee Program	X	X	X
13. Van Lease/Re-Lease/Provide at Subsidy			X
14. Bus Purchase/Lease/Provide at Subsidy	X	X	
15. Expanded Program for HOV Lanes, Park-Ride Lots, and Other TSM Measures	X	X	X
16. Operating Subsidy for Commuter Express Bus Service	X		
17. Increased Provision of Highway Capacity			X

- Increased emphasis on experimental program (Option 11).

- Vanpool lease guarantee program (Option 12).

- Expanded program for HOV lanes, park-ride lots, and other TSM measures (Option 15).

The level of activity within an option may vary by scenario, such as noted for central office and local office roles in Options 1 and 2. Some further central and local office activity above present levels is appropriate under all three scenarios. In the expected and constrained scenarios, more activity and aggressiveness on the part of the PTD will be a primary input in assisting long-distance (and all) commuters. At the other extreme, in the unconstrained case, gradual softening of public interest in ridesharing will need to be met by increased activity to maintain current levels of ridesharing activity. This effort would probably have to be shouldered by an expanded central office because of possible waning local initiative.

Increased emphasis on the experimental program and study of a reporting and evaluation system are important for the PTD and VDH&T to carry out their basic mission effectively.

A review of taxes, fees and regulations, in part building on the recommendations of the "Inter-City Bus Study", as well as attempting to anticipate potential effects of de-regulation and possible tax changes at the federal level, appears to be both appropriate and prudent. The lease guarantee program is a low-cost, high-payoff activity which could function usefully in any circumstance. The success of Maryland's VANGO program also provides strong support for this action.

The ten options described above can be considered "low-risk" actions which appear to have value under any scenario. Two additional options have considerable merit under the expected scenario, particularly on the "down side" of that scenario or under the constrained scenario:

- State employees' ridesharing program (Option 10).

- Bus purchase/lease/provide at subsidy (Option 14).

Three options appear applicable only under the constrained scenario. Basically, they represent significant shifts in policy and would definitely require legislative action for implementation. All three are politically difficult and would be hard to implement outside of dire circumstances, such as might exist under the constrained scenarios.

- Extend local authority for ridesharing incentives (Option 4).

- Establish state ridesharing fund (Option 9).

- Operating subsidy for commuter express bus service (Option 16).

Finally, two options appear applicable or feasible only under the unconstrained scenario:

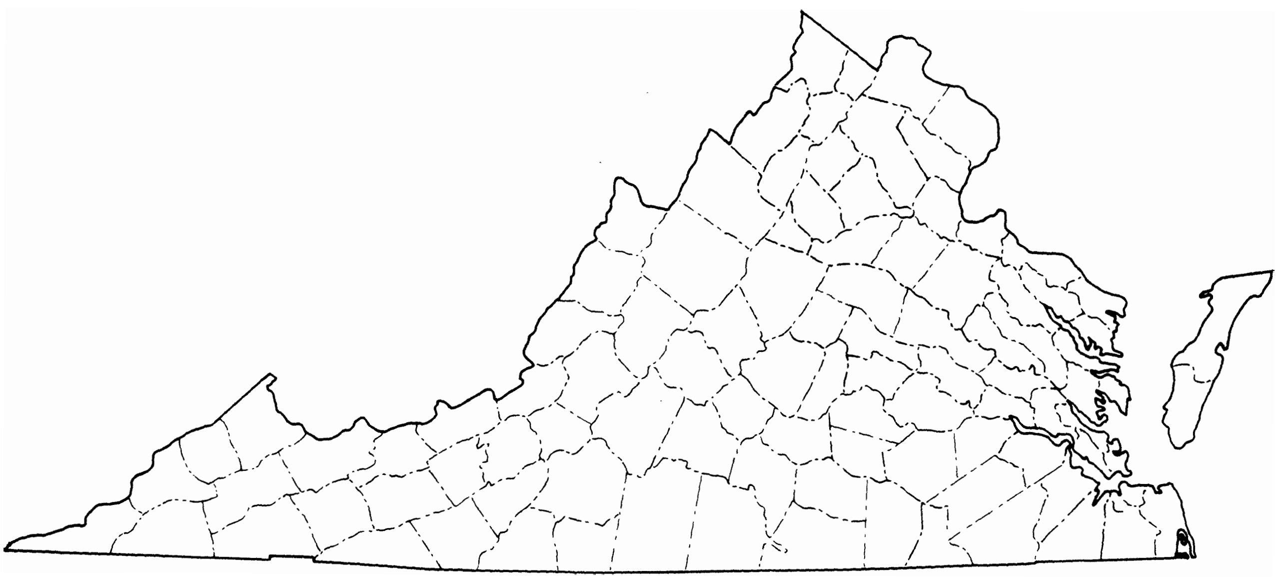
- Van lease/re-lease/provide at subsidy (Option 13).

- Provide significant, additional highway capacity (Option 17).

Option 13 may be needed to stimulate continued ridesharing under an unconstrained scenario in which public interest in ridesharing is likely to be weakest among the scenarios. The provision of significant, additional highway capacity (beyond meeting bare essentials) is likely to be financially possible only under the unconstrained scenario.

VIRGINIA COMMUTER STUDY

Commuter Transportation Problems, Issues, and Policy/ Program Response



POLICY AND PROGRAM RECOMMENDATIONS

INTRODUCTION

Expectations of the future (i.e., the occurrence of one of the scenarios or some permutation of them), the viable modal options identified in the case studies, availability of funds, and political viability all affect the selection of options from the earlier list as recommendations.

It is difficult to anticipate that the future will be as stark and clear-cut as the constrained and unconstrained scenarios portray it. Reality and prudence suggest that fuel price and energy expectations in the constrained scenario are probably unlikely (although the funding anticipations may be less so). Common sense suggests that preparation for the expected is the best course of action, with contingency actions directed toward the possible worst events.

The case studies have narrowed the list of generally viable modal options for long-distance commuters to four, identified in an earlier report section as car-, van-, and bus-pooling, and in certain areas, some form of express or commuter bus transit.

Funding considerations, as well as current authority, suggest the wisdom of pursuing moderate cost options and of making careful, detailed analyses of costs and other implications of options which reflect changes in established state policy. Significantly, as a result of the recent legislative funding action, VDH&T (specifically, the Public Transportation Division) and local governments now have more funds to draw on for transit and ridesharing than in the past. However, this favorable posture may be of brief duration, if proposed federal cuts in transit funding are carried out.

"Political viability" of possible actions includes three different aspects. First, there is public acceptance and interest. This is influenced by cost--and taxes--but it also is a function of the context established by trends in fuel costs, fuel availability, and federal highway and transit programs. This is not to ignore the influence of other factors such as the pattern of urban/suburban development or the cost of housing, which are largely outside individual, local, or state control. Second, and influenced by the first, there is the political climate within which state policy is established. Clearly, a climate permitting (or favoring) actions described under some of the options cannot occur without public interest and acceptance and the public's influence on the direction of state policy. Finally, the General Assembly and other state officials must implement (or permit implementation of) several of the options through specific legislation. Only in very unusual circumstances can this occur without public interest and acceptance and perception of a climate of acceptability by the legislators who must vote on these actions.

RECOMMENDED ACTIONS

The recommendations which follow attempt to balance these and other considerations in selecting from among the options outlined earlier:

1. VDH&T and the Public Transportation Division should begin immediately to implement:

   Option 3: Expanded Emphasis on Ridesharing in State and Local Transportation Planning

   Option 5: Establish a Financial/Patronage/Activity Reporting System for Public Transportation and Ridesharing

   Option 6: Study of State Tax, Fee and Regulatory Incentives for Ridesharing

   All of these are relatively low in cost and are within the present authority of the Department.

   Expanded emphasis on planning of ridesharing activities as part of ongoing urban transportation planning programs can be accommodated within the current (or slightly expanded) budgets of these programs. Operationally, VDH&T's planning staff could carry out this function (using some of the planning techniques developed in this study) in coordination with staff assistance, if necessary, from PTD.

   As was noted in discussion of the options, the study of possible revisions of state tax, fee, and regulatory provisions affecting ridesharing incentives and establishment of a monitoring/information system offer fundamental insights and data which are critical to carrying out the responsibilities of the Department and PTD. They require no new authority, and their cost is reasonable.

2. Increased emphasis should be given to the experimental ridesharing program: Option 11.

   Although the specific amount appropriated for the experimental program over the next two years is somewhat smaller than in past biennia, increased flexibility of funding is authorized. Generally, adequate funds are available, and if examination of the current program activities and their effectiveness warrant, additional funds (above the specific line item appropriation) may be used.

   With the availability now of other funds for establishing and continuing local ridesharing operations, the experimental program should move more toward innovative transit and ridesharing demonstrations, reflecting both ideas that are new to Virginia and the transplanting of promising demonstrations from one area of the state to other areas.

3. An active promotional campaign should be continued, and the possibility of removing the restriction on funding direct media placement should be investigated: Option 8.

There are a number of alternatives available for promotional activity (see earlier discussion of Option 8). All are constrained to some extent by the dependence of the state on public service, unpaid, placement by the media. The possibility of relaxing this constraint for transit and ridesharing promotion should be explored by legal counsel. The specific course of a continued emphasis on promotion is dependent on this and other unknowns, but professional advice--through agencies with experience in marketing and promotion of ridesharing and transit--is warranted in any event. One alternative would be a small contract to obtain expert advice in the design of a continuing promotional program, followed by contracts for preparation of material and actual media placement (paid or unpaid). Such an approach could spread total cost over the two years of the biennium.

4. VDH&T and the PTD should review carefully the relative merits of increased central office ridesharing activity (Option 1) and expansion/support of local ridesharing offices, statewide (Option 2): comparative costs, effectiveness, type of activity, and other variables. Some combination of these two options should be undertaken as soon as possible.

The objective is improved ridesharing programs and capabilities for the public, and increased assistance and promotion are provided by these options. While the cost of supporting local offices may be higher, they are likely to result in a higher level of effectiveness and activity. One combination of the two might start with an increase in staff and activity within the PTD with the intent of (1) providing more direct assistance, (2) reinforcing existing local ridesharing offices (i.e.,: in PDCs, cities/counties/towns, transportation districts or with transit operators), (3) using a combination of experimental, "local" and other funds for initiating, continuing, or enhancing local ridesharing program/activities, and (4) encouraging establishment of local programs and offices in areas of high ridesharing potential where none now exist. Over a period of time, as local programs mature and circumstances dictate, the central office program could shift to the less active consultative role suggested in Option 1A, while the local offices assume an increasingly active role.

Desirably, local ridesharing office functions should be housed within, and staffed by, local or regional agencies with appropriate state financial support. De-centralization of VDH&T ridesharing staff to local offices is not proposed.

Although the cost of establishing and operating local ridesharing offices in the 15-20 principal urban regions is greater than the funds available in the promotional and development appropriations for the biennium, re-allocation authority and use of parts of local appropriations should supply adequate funds to begin a significant move in this direction.

5. A van lease guarantee program, similar to Maryland's VANGO should be instituted: Option 12.

   This option has the dual advantages of relatively low cost and proven effectiveness. While it should be particularly attractive in Northern Virginia, it is applicable throughout the state. The most appropriate legal context for setting up such a program under Virginia law should be determined (i.e., is a quasi-public corporation as in Maryland the best approach under Virginia statutes?).

6. PTD staff should initiate the first level of a state employee's ride-sharing program (Option 10A) through review of existing state ride-sharing activities and contacts with other state departments. Feasibility of second (and third) level activiites also should be examined in detail.

   As noted earlier in the discussion of Option 10, a state employees' ridesharing program is not only advantageous in terms of the benefits it would bring to participants per se, it would also serve as an example to major employers in the private sector and as a source of experience for PTD personnel.

   Direct cost should be low, because the primary resource is existing PTD staff, with contributed time and effort from other state departments.

7. The Highway and Transportation Commission through policy action should direct attention by VDH&T to an expanded program of HOV facilities, park-ride lots for transit riders and ridesharers, and other TSM measures: Option 15.

   VDH&T should more aggressively pursue implementation of such measures on its own, and in cooperation with local agencies and the private sector. Particular attention should be directed to major commuting corridors evidencing significant volumes of long-distance commuting traffic. Analysis of commuting patterns for urban areas across the state using forthcoming data from the 1980 Census and sketch planning techniques developed in this study can help to define prime areas for such improvements.

8. Immediate attention should be given to a policy and program for providing equipment to operators of long-distance, commuter bus service: Option 14.

Current law allows VDH&T to assist in funding up to 95% of total costs, if no federal grant is involved, of buses purchased by local governments or transit districts, who may then lease the equipment to private operators. This has apparently not been done too often in Virginia, and the state has basically relied on the initiative and interest of local governments to precipitate action to aid private operators. This study has shown that to the extent express bus service is applicable to the needs of long-distance commuters, it is most likely to be feasibly provided under the cost/service parameters of a private operator (i.e., because of, typically, lower operating costs than public operations). VDH&T, working with local governments, should take a more aggressive policy stance in assisting private operators in acquiring equipment at affordable lease costs to continue to serve this commuter market.

9. PTD staff should investigate the feasibility of various provisions in local government enabling legislation for incentives to ridesharing: Option 4.

   PTD should review the examples of local authority cited in the earlier discussion of this option and in the model ridesharing incentives legislation, as well as other sources, to determine their appropriateness for use in Virginia. They should be reviewed with legal and legislative personnel knowledgeable in current local government enabling law. Based on the results of that review, a package of legislative recommendations should be developed, some of which may be held out as contingency actions to be taken in event of an energy supply emergency.

10. Other options that appear unwarranted at this time or that have scenario flaws should be reviewed, and where appropriate or necessary, investigated for future action:

    - Option 9: Establishment of State Ridesharing Fund
    - Option 13: Van Lease/Re-Lease/Provide at Subsidy for Vanpooling
    - Option 16: Provide Operating Subsidy for Commuter Bus Operations

    The lease/re-lease program for vans has significant problems or flaws and should be set aside in favor of possible vanpool incentives that may evolve from the proposed study in Option 6.

    Establishment of a State Ridesharing Fund and provision of commuter bus operating subsidies clearly are options which are inappropriate now, but which may be reconsidered, if events suggest a trend toward the constrained scenario future.

COST IMPLICATIONS

The preceding discussion of options has already defined the general cost implications of the recommended policy/program actions. However, Table 5.1 provides a more specific summary of costs, noting both first year and subsequent year costs for continuing programs.

The proposed actions are reasonably affordable, even under current appropriations for the next two years. Many are referenced as candidates for funding under Item 644.13 (Public Transportation Promotion, Operations Studies, and Ridesharing Support) of the FY83 and 84 appropriations act. This section was allocated a two-year total of $350,000, which would not cover all of the actions in Table 5.1 that were referenced to that section. However, VDH&T does have flexibility to transfer funds between this section, the experimental projects section (Item 644.12), and the mass transit aid for all areas (Item 644.11).

Some of the cost figures in Table 5.1 are particularly flexible and can be modified to fit initial funding constraints. For example, the state might move more or less rapidly than indicated on expanding central and local office ridesharing programs--depending upon available funding.

LEGISLATIVE REQUIREMENTS

Fortunately, Virginia is well-equipped with legislation to accomplish most of the proposed programs for commuter transportation improvements. One significant action--the van lease guarantee program--will probably require new legislation. It should be studied further by PTD and appropriate state legal counsel to determine the most appropriate implementation approach. The Maryland program offers a useful model.

A second action which could merit legislative change is relaxation of the constraint on use of public funds for media advertising relative to a ridesharing promotional program (see Option 8 discussion). This is not exactly a critical legislative constraint, but a change could improve the "reach" and effectiveness of state investments in such a program.

The most significant legislative actions are associated with options that appear unwarranted at this time or under the expected future. They relate to such actions as creation of a special state ridesharing fund, expansion of local government authority in creating ridesharing programs and incentives, provision of transit operating assistance by the state, and possible legislation to implement tax incentives for ridesharers. These actions may merit consideration in the future, if commuting conditions deteriorate significantly,

Table 5.1

COST SUMMARY FOR RECOMMENDED POLICY AND PROGRAM ACTIONS

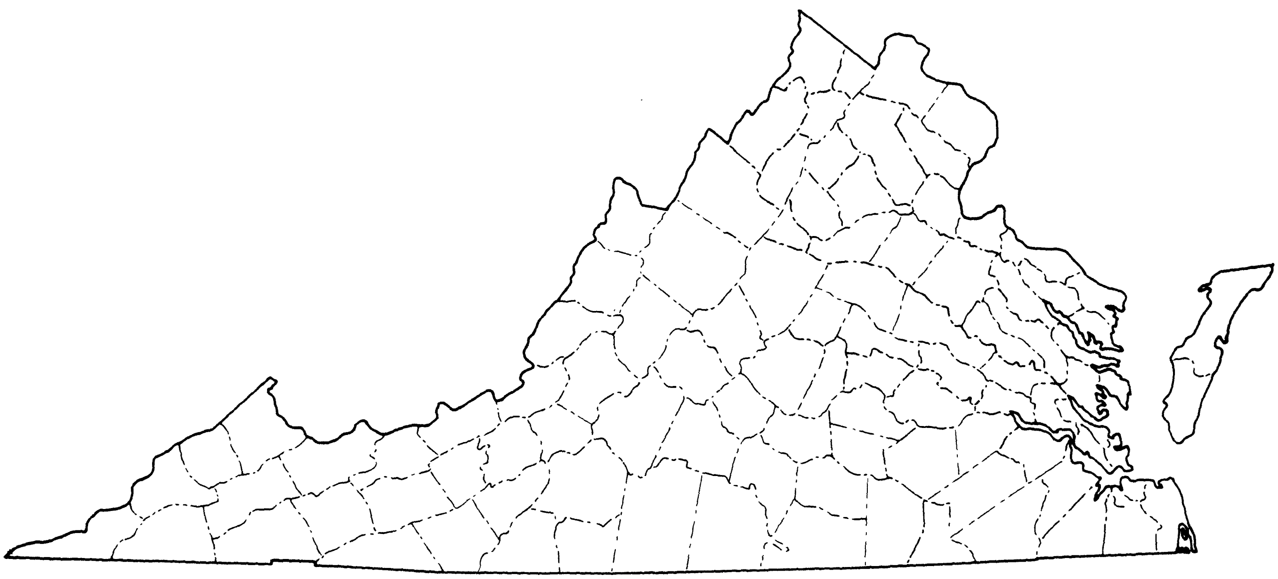
Recommended Action (Option Number)	Costs/Funding Sources[1/]
o Ridesharing Emphasis in Transportation Planning (3)	o Additional costs are negligible and should be absorbed within transportation planning study budgets for urbanized areas.
o Reporting/Information System (5)	o $50,000 for initial study to design system; probably $40,000-$60,000 annually thereafter for system operation (beyond current PTD staff costs); funding source: Sec. 13a.
o Tax/Fee/Regulatory Study (6)	o $50,000 for study (i.e., for consultant or by PTD staff); funding source: Sec. 13a.
o Experimental Program Emphasis (11)	o Desirably, about $500,000 annually; funding source: Sec. 12.
o Major Ridesharing Marketing and Promotion (8)	o $200,000 for initial one-year, statewide (but targeted) program; $100,000 annually thereafter for continuing effort; funding source: Sec. 1-11 or Sec. 13.
o Central Office Ridesharing Program (1)	o $100,000 for initial year rising to $150,000 annually if van leasing program is adopted; assumes strong local office program; funding source: Sec. 13.
o Local Office Ridesharing Program (2)	o $200,000 for initial year rising to possible $1,000,000 annually after 3-5 years for major statewide program; funding source: Sec. 13 and Sec. 1-11 (i.e., draw on state funds allocated to major urban areas).
o Van Lease Guarantee Program (12)	o About $15,000 annually in additional central office staff costs (see Option 1 above); $30,000 one-time lease guarantee fund; funding source: Sec. 12 or 13.
o State Employees' Ridesharing Program (10A)	o Minor costs can be absorbed within present PTD and other state agency budgets.
o Expanded HOV, Park-Ride, and TSM Program (15)	o Cost estimate should be developed in current statewide plan project; funding source: HM&CF and various federal programs.
o Commuter Bus Capital Assistance (14)	o Costs could vary considerably; assume average level of $1.0 million annually for next 3-5 years.
o Further Investigate Options (4, 9, 13, 16)	o PTD staff costs to study options with other state agency assistance.

[1/] Funding source references relate to sub-sections of Item 644, Chapter 684 of the Code of Virginia: Appropriations Act for Fiscal Years 1983 and 1984. For example, Section 13a refers to Item 644.13a of Chapter 684 of the Code.

such as under the constrained scenario. As a contingency measure, they should be given further study by the PTD so that implementation can be expedited, if necessary, in the face of possible emergency conditions.

VIRGINIA COMMUTER STUDY

Commuter Transportation Problems, Issues, and Policy/Program Response



SUMMARY

SUMMARY

The emphasis in this study has been upon the commuting problems of people working in central cities and living in outlying communities. For most of these commuters, the case study analyses have shown that ridesharing modes (car-, van-, and buspooling) and in certain cases in large urban areas--express bus--are the only feasible modal alternatives to driving alone. Thus, the focus in policy and program recommendations has been upon what can be done to expand and improve these modes.

Virginia has already made a good start in ridesharing promotion and support. The passage of House Bills 155 and 1091 in 1980 and 1981, respectively, clarified the legal status of carpool and vanpool vehicles and removed most of the legal and regulatory impediments to ridesharing. The recent transportation revenue package passed by the General Assembly recognized the need for a continuing state role in the financial support of local ridesharing programs. The recommendations of this study build upon this base of existing legislation and financial support.

The actions recommended by this study are modest in cost compared to current highway or transit expenditures, and they have been shown to be extremely cost-effective in terms of public costs per commuter benefitted. The study has also shown that the key to a successful ridesharing effort is heavy involvement of the private sector, primarily through a program focussed on major employers. While area-wide matching programs serve a useful purpose in a total ridesharing program, the greatest potential impacts can be made by promoting ridesharing and offering incentives where people work.

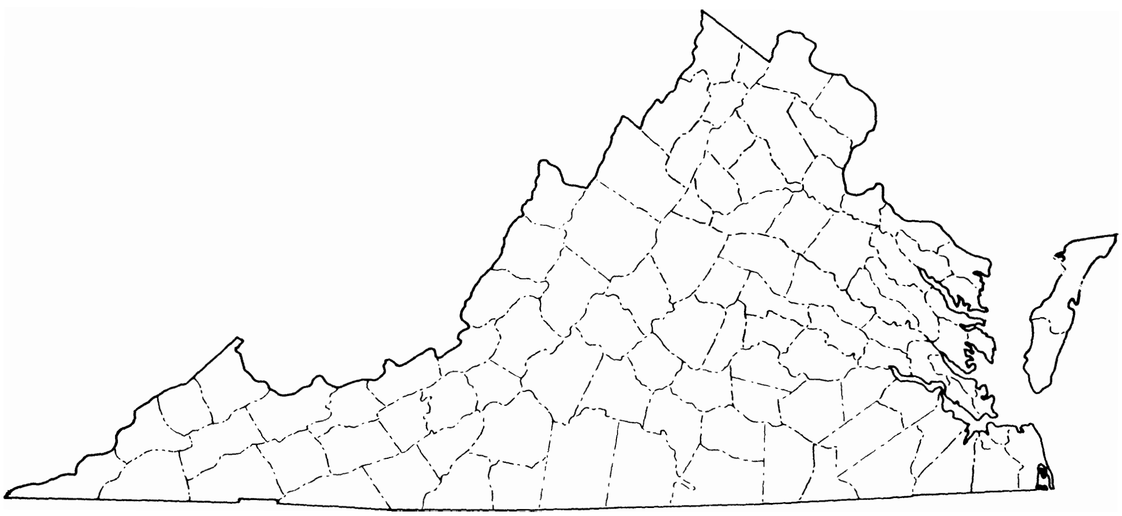
The state's basic policy in fostering ridesharing should be to create and enhance staff capability within local agencies by offering financial and technical assistance. Local governments must be involved, and indeed, primarly responsible for local ridesharing efforts, if such programs are to be successful. To provide the necessary encouragement and technical and financial assistance, VDH&T will need to expand its central office capabilities in this area.

Another key role for the state is in helping to make equipment available to both ridesharers and transit riders through a van lease guarantee program and expanded bus acquisition and lease arrangement for private transit operators--working through local governments. In both instances the state can leverage maximum public benefit with minimum public investment. The van lease guarantee program costs the state essentially nothing, except administrative costs. The bus acquisition/lease program keeps the private sector involved in the provision of transit service at little long-term cost to the state.

Finally, an important attribute of an expanded ridesharing program is that it not only provides a feasible, low cost modal alternative for present commuting, but it also offers the most feasible contingency for responding to a severe energy crisis in the future. Thus, it has both present and future viability in responding to the needs of Virginia's commuters.

VIRGINIA COMMUTER STUDY

A Methodology For Evaluating Commuter Travel Options In Virginia Cities



PREPARED FOR
THE VIRGINIA
DEPARTMENT OF HIGHWAYS
AND TRANSPORTATION
BY
BARTON-ASCHMAN ASSOCIATES, INC.

VIRGINIA COMMUTER STUDY

Phase 2 Report
A Methodology For Evaluating Commuter Travel Options In Virginia Cities

June 1982

Prepared for:
Virginia Department of Highways and Transportation

Prepared by:
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Washington, D.C.

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INTRODUCTION

This section of the Virginia Commuter Study describes a methodology to assess alternative transportation actions in urban/suburban commuting corridors. It is particularly concerned with the evaluation of modal alternatives and supportive transportation system improvements for commuters who work in urban areas and live in outlying jurisdictions.

The need for this methodology stems from several observations about the typical urban transportation planning process:

1. The geographic constraints of most urban transportation study areas do not provide for explicit analysis of the problems of longer-distance commuters (i.e., work trips in excess of 10 to 15 miles in length as typically generated by distant suburbs and the surrounding exurban area). Such trips are made primarily by auto, and there are usually no modal alternatives. These trips are particularly vulnerable to the exogenous effects of scarce or expensive gasoline, and on a per commute trip basis, they contribute a disproportionate share to regional air pollution because of their length.

2. Conventional urban transportation planning techniques cannot effectively evaluate certain ridesharing modal options applicable to longer-distance commuting. Travel demand models do not adequately estimate traveler response to non-time and cost ridesharing institutional actions.

3. The application of conventional urban transportation planning models is expensive, time-consuming, and requires extensive demographic, system, and travel data. Its cost effectiveness is questionable for many uses, in particular policy planning, which does not require precise accuracy in estimating travel demand for one alternative, but relative accuracy for all possible alternatives.

These observations suggest the need for a methodology that can:

(1) be used to test the viability of modal options for longer-distance commuters,
(2) be able to evaluate ridesharing (as well as other) modal options,

(3) be quick and relatively inexpensive to apply and useful under conditions of limited data availability.

The methodology described in this report addresses each of these needs. It emphasizes the use of manual analysis techniques (although a simple sketch planning computer model is included for more detailed analysis, if required, of major, capital alternatives). While the methodology is designed for application at the corridor level, regional implications can be gained through the accumulation of results from individual corridor analyses. Some elements can be applied directly at a regional level, such as estimates of ridesharing potential. The process is comprehensive in scope and includes:

(1) the indentification of candidate transportation actions for a corridor,
(2) the estimation of traveler or user response for the most promising actions,
(3) the evaluation of alternative actions (and associated direct and indirect impacts),
(4) the definition of implementation steps.

That part of the methodology which addresses travel demand estimation is based upon transferrence of experience in other areas to the area under investigation. National experience with various ridesharing options has been distilled to define estimated traveler response under varying socioeconomic and travel market conditions. To supplement these estimates, a sketch planning model can be applied to assess significant alternatives and modal shifts in major corridors.

The intent of this methodology is to permit the staff of the Virginia Department of Highways and Transportation (and/or local and regional transportation agencies) to assess the viability of different modal options and supportive actions in commuting corridors across the state. It could be particularly useful in assessing state-wide urban/suburban transportation needs because of its ease and speed of application, and yields results adequate for policy planning.

The methodology was applied in three case study areas: Northern Virginia, Roanoke, and Martinsville. These case study applications have two purposes:

(1) to develop recommendations which concern possible transportation improvements in the principal commuting corridors of these regions,
(2) to demonstrate the methodology in urban areas of different size and complexity.

This report reflects modifications to the preliminary methodology that were suggested by the case study demonstrations.

OVERVIEW OF METHODOLOGY

The overall methodology for the evaluation of commuter travel options can be broken into four principal parts:

- Part 1: Travel Options/Initial Screening
- Part 2: Demand Analysis/Traveler Response
- Part 3: Impact Analysis
- Part 4: Implementation Actions

These parts follow the basic systems analysis approach of defining alternatives, testing for user response, evaluating impacts, and defining implementation steps. Throughout the process, a pragmatic approach is taken toward the testing and evaluation of alternative actions. The methodology's focus begins with the full range of possible options, but through the use of screening criteria and warrants, progresses rapidly to those alternatives that appear most promising (for example, are there sufficient peak hour, peak direction person trips in a corridor to warrant further consideration of express bus service or other line-haul modes?). The surviving alternatives are then assessed to the degree necessary to determine their impact on the corridor travel market (i.e., modal share) and their general viability (for example, can express bus service attract a sufficient share of a corridor's travel market to make such service cost effective?).

Figure 1 divides the four parts of the methodology into a series of steps that form the structure for the application of the methodology. A brief overview of the methodology is given below, and a more detailed description of each of the major steps illustrated in Figure 1 is provided in the following chapters of this report.

Part 1: Travel Options/Initial Screening

In this part of the methodology, a list of candidate commuter options is defined, and initial warrants and threshold demand levels are developed to serve as preliminary screening criteria for these options. At the same time, information is assembled on demographic characteristics and travel volumes

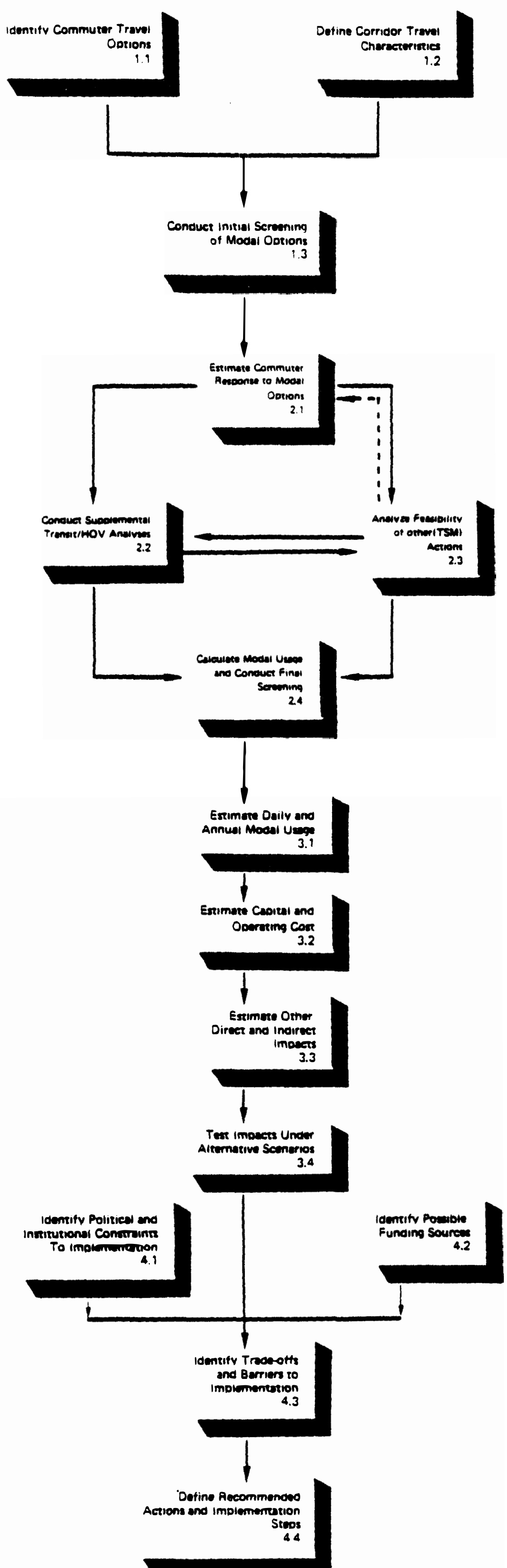

Figure 1
METHODOLOGY FOR EVALUATING COMMUTER TRAVEL OPTIONS

in the subject corridor for the time period to be analyzed. Data sources for travel volumes and patterns may include ongoing transportation study files, special studies performed for the area, employee travel data from major employers, and Census travel data. Initial screening of alternative actions is accomplished through comparison of preliminary warrants and screening criteria to demographic and travel characteristics of the corridor. Those alternatives that clearly do not meet the basic criteria are dropped, with the survivors carried forward to Part 2.

Part 2: Demand Analysis/Traveler Response

A key ingredient of Part 2 is a set of tables that has been developed in this study to estimate the market share achieved by six possible modal options under varying socioeconomic and travel market conditions.[1/] These modal summary tables are based on the concept of travel market segmentation and represent a distillation of national experience. The tables are used to estimate the potential market share in the subject corridor by modal options which survive the initial screening in Part 1. If one or more high-capital options (HOV Facility/Light Rail, Rapid Rail, or Commuter Rail) attract a significant modal share and warrant further analysis, a simple computerized sketch planning model is applied to estimate shifts in modal shares between alternatives and to provide a more detailed basis for their evaluation. The modal shares generated by all alternatives are related to a set of warrants for supportive transportation system management (TSM) actions to determine the viability of such actions (such as an HOV lane to serve or support an estimated strong modal response to ridesharing and/or express bus). The effect of such TSM actions in further stimulating related modal shares is estimated using logit sensitivity factors for time and cost effects.

Part 2 concludes with a final screening of the estimated traveler response against threshold demand levels for the modal options analyzed in Part 2. Thus, the products of Part 2 are those modal options that claimed a sufficient share of the corridor travel market to merit further evaluation, plus associated TSM actions.

Part 3: Impact Analysis

This section of the methodology involves a relatively straightforward calculation and display of direct and indirect impacts associated with the modal options and TSM actions from Part 2. There may be a need for an initial "packaging" step in some corridors in which compatible combinations of

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1/ The six options are: Carpool, Vanpool/Buspool, Express Bus, HOV Facility/Light Rail, Rapid Rail, Commuter Rail.

modal options and supportive actions are developed (although much of this function is likely to have been done in Part 2). Cost estimates are made for each travel option, using a life cycle cost model for the comparison of actions.

The key task in Part 3 is the calculation and display of impacts associated with each action. Where applicable, impacts are calculated in regard to cost, vehicle-miles of travel, fuel consumption, pollutant emissions and travel time savings.

The probable future viability of the actions is assessed by relating them to the descriptions of alternative future scenarios developed elsewhere in the study. This step identifies the actions' sensitivity to possible future changes in energy costs and availability, vehicle fuel efficiency, and transportation funding.

The products of Part 3 are impact and sensitivity analyses that further define the feasibility of the modal options and supportive TSM actions in each corridor.

Part 4: Implementation Actions

The final evaluation of corridor actions is done in this part of the methodology. Whereas the screenings and evaluations in the previous tasks have focused on physical or operational criteria related to travel demand, cost, time, and other related factors, this section injects political and institutional concerns and potential barriers to implementation. The positive and negative aspects of each action are defined, including problems that are likely to hinder implementation (such as possible adverse community reaction, lack of a reliable funding source, lack of agency staff to implement the action, local or state legal constraints.).

Priorities for actions within corridors are proposed and program elements described including personnel and materials (equipment) requirements. Suggestions on how to monitor proposed actions are also identified.

The products of Part 4 (and the overall methodology) are a set of commuter transportation actions for each corridor with impacts and implementation issues defined for use by local and state decision-makers.

Relation to Ongoing Transportation Planning

The proposed methodology is intended to supplement the planning techniques and analyses of the ongoing planning efforts in Virginia cities. The focus upon longer-distance commuting trips addresses a part of the urban transportation problem that has not been treated in many urban transportation studies. Moreover, this methodology is oriented primarily to the consideration of modal options in major corridors with a strong emphasis upon ridesharing (including transit and other forms). This, again, is an area in which the conventional urban transportation planning process has been relatively inactive. Transportation planning in such areas has usually focussed upon accommodation of the predominant travel mode--the low-occupancy automobile, a legitimate recognition of the dominance of auto travel in these areas. Contemporary concerns with energy costs and availability, the environment, and shrinking transportation revenues for new construction, however, require greater emphasis on seeking modal alternatives and maximizing use of existing facilities.

Proposals that evolve from application of this methodology should be blended with recommendations from ongoing local planning to produce transportation programs for urban regions. It may present alternatives to previously proposed actions that are more cost effective to the commuter and the tax-paying public, while at the same time broadening the range of transportation options available to commuters.

PART 1: TRAVEL OPTIONS/INITIAL SCREENING

Figure 2 illustrates the principal steps in this part of the planning methodology. In brief, they are:

1. Identify the full range of candidate modal options and supportive TSM actions that are available for consideration in corridor analysis.

2. Define the characteristics of the corridor commuter travel market.

3. Apply preliminary screening criteria to the corridor commuter travel market to eliminate those modal options that are clearly not appropriate, given demand levels in the corridor.

Step 1.1: Identify Commuter Travel Options

Six modal options and 16 supplemental TSM actions have been identified as possible candidate actions in corridor analyses.[1/] The initial screening in Part 1 and the subsequent estimation of commuter response to promising actions in Part 2 focuses first upon the modal options of carpooling, vanpooling/buspooling, express bus in mixed traffic, HOV facility/light rail, rapid rail and commuter rail. The supplemental TSM actions are then assessed as possible supporting elements--dependent upon the results of the modal share estimates.

The analyst may elect to test any or all of the six modal options. The initial screening of options in this part of the methodology is simple to execute and does not require extensive data. Thus, it may be desirable to screen a wide range of options in Part 1, even though the analyst may think that certain options will not prove feasible. A similar rationale may govern the further consideration of certain modal options in Part 2 that did not quite meet the initial screening warrants in Part 1. Local concerns may encourage a more substantive analysis of these options than is provided by the initial screening.

1/ The process used to select these modes and options is contained in an interim report which is not part of this final report.

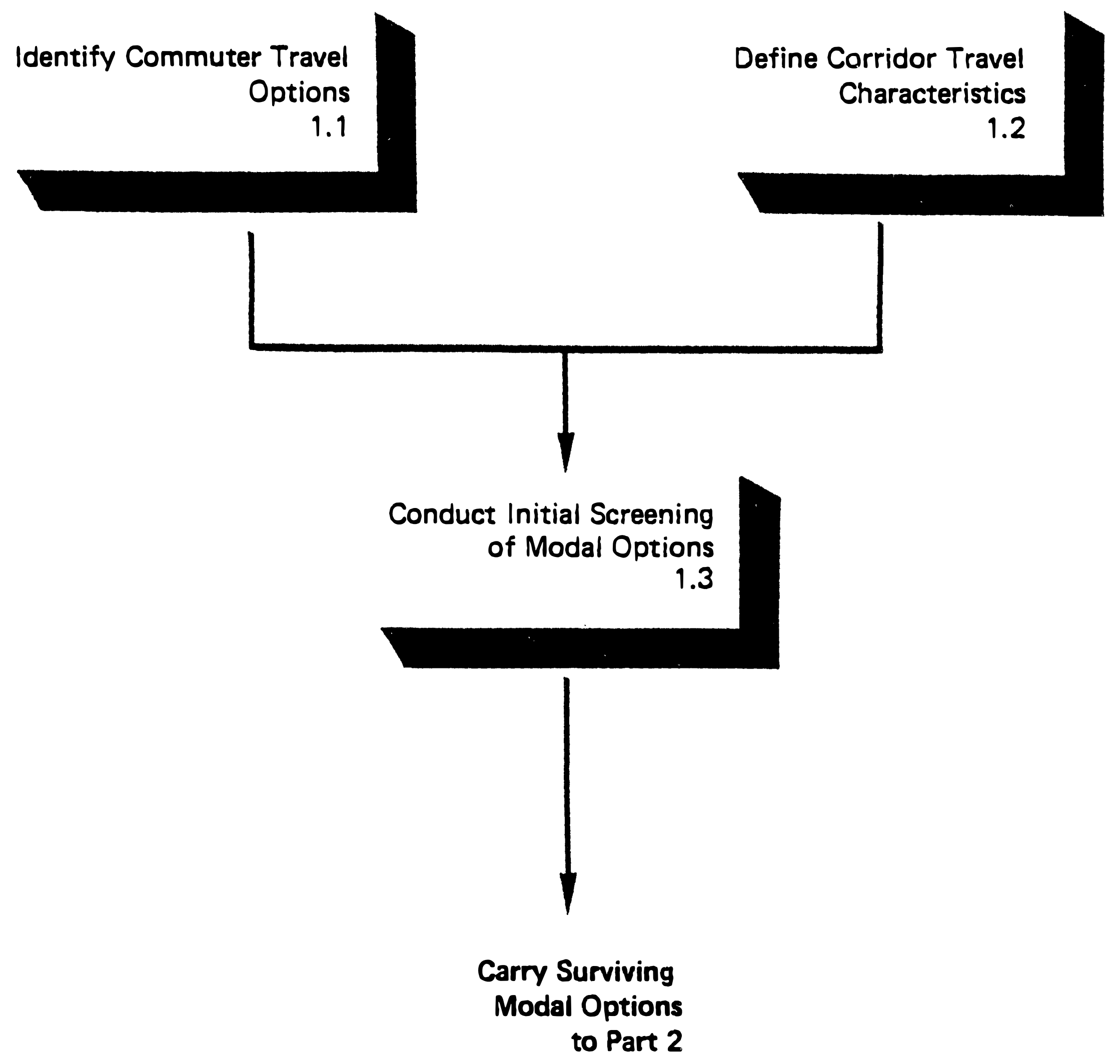


Figure 2
MAJOR STEPS IN PART ONE

Virginia Commuting Study

Step 1.2: Define Corridor Travel Characteristics

This step includes the critical task of assembling corridor demographic and travel data that will be used in all subsequent analyses. The types of data to be collected and their proposed use are summarized in Table 1. They include data both within and outside the urbanized area of the region being studied.

Determination of the volume and pattern of commuting trips in each corridor is the single most important element of data collection. These data form the basis for all subsequent analysis. The accuracy of this crucial, first step will determine the overall accuracy of the analysis techniques. Detailed information on long-distance commuting trips is often unavailable. The travel surveys and subsequent travel demand modeling and forecasting done in the comprehensive urban transportation studies of the 1960s and early 1970s did not identify the specific location of external trip ends (i.e., origins or destinations) for work trips crossing the study area boundary. Such trips were simply coded to the location on the major highway at which they crossed the study area boundary (i.e., the external station). The study boundaries generally extended only slightly beyond the Census-defined limits of the urbanized area.

Aside from possible special surveys (such as the 1980 roadside external survey in Northern Virginia), there are two other useful sources for data on long-distance commuting patterns. Major employers may be contacted to obtain employee residence locations by zip code or on a more detailed basis, if available. Employee trip lengths and approach routes can be manually determined from a plot of employee residence locations. This information can be used directly in assessing ridesharing potential for major employers. If enough employee residence data are available--5% to 10% of the area employment as a minimum--the external trip origin patterns from such data can be applied to the work trip ends at external stations to simulate a reasonably accurate estimate for all external trips destined to the areas in which these major employers are located.

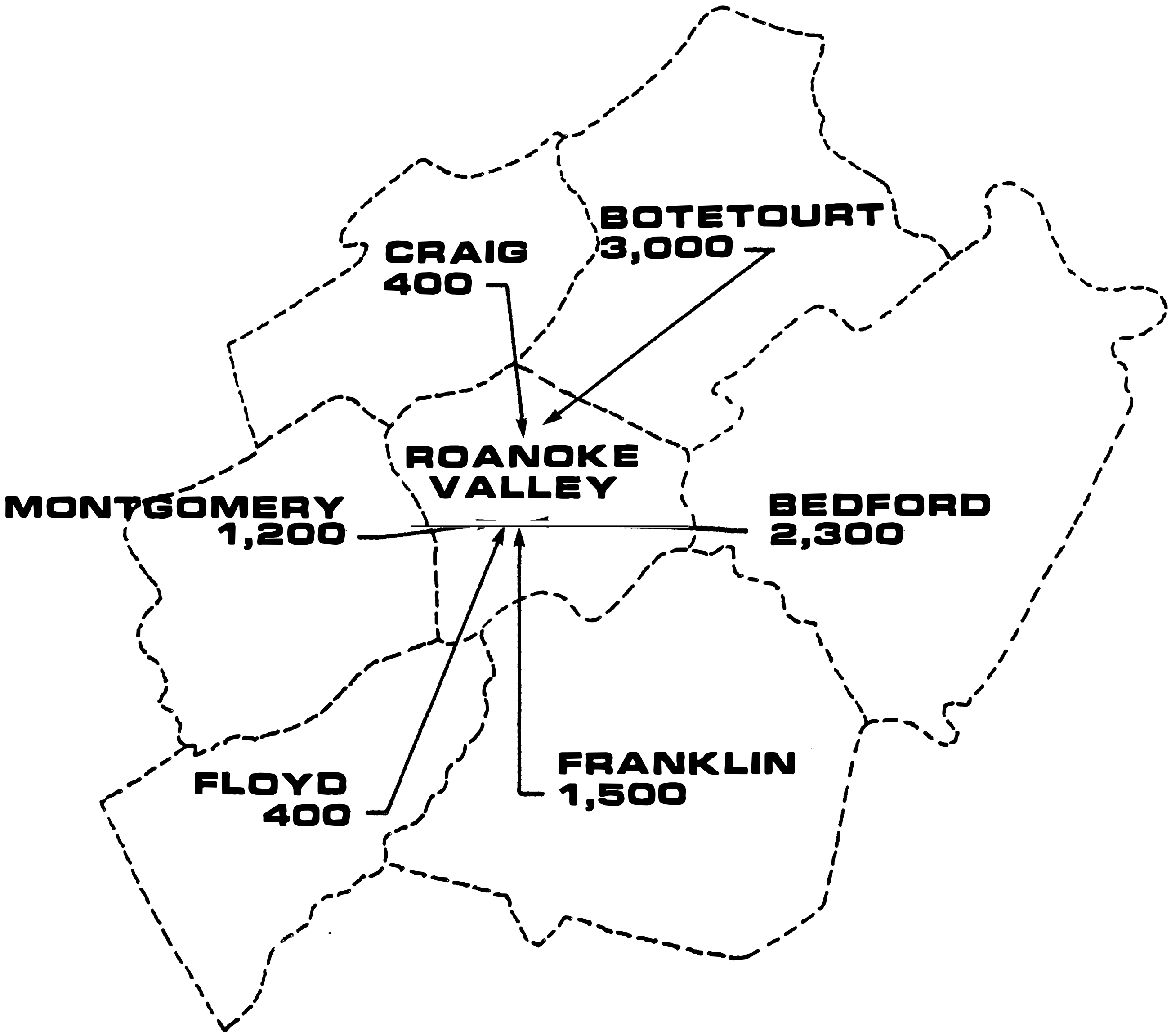
The second source of information on long-distance commuting is the 1970 U.S. Census. The Census provides data on commuting between counties, but its value is somewhat constrained by the gross level of geocoding (i.e. counties and principal incorporated areas). Figure 3 illustrates 1970 Census commuting data for Roanoke County, one of the three case study areas of this project.

The 1980 Census provides more transportation data, including travel time and vehicle occupancy to work, disability preventing use of public transportation, and perhaps most important, more detailed geocoding and reporting of place of work. A detailed description of 1980 Census data for transportation planning is contained in Appendix A. This data is expected to be available in 1982 or 1983.

Table 1
DATA REQUIREMENTS FOR COMMUTER TRANSPORTATION PLANNING METHODOLOGY

Type of Data	Proposed Use of Data
*A. Employment 1. Distribution by employer size, type, and amount (by traffic zone). 2. Name and location of major employers (over 100 employees in small and medium urban areas; over 500 in large urban areas.)	*A. To identify principal destinations of commuter traffic and candidate major employers from whom employee residence data might be sought.
*B. Residential Density 1. Dwelling units/residential acre (by traffic zone)	*B. To identify areas capable of supporting various modal options with sufficient trip generation
C. Traffic Volumes 1. Current and projected ADTs and peak hour volumes on arterial and freeway system. 2. Current and projected V/C ratios (peak hour) on arterial and freeway system.	C. To define location and significance of existing and future major traffic corridors and congestion/problem areas that impact commuters.
*D. Person or Vehicular Travel Patterns 1. Current and projected person or vehicular travel patterns and volumes between external stations and internal zones and between internal zones (work trips).	*D. To identify major long-haul commuting patterns and to define potential for combined long-haul and intra-urban transportation service improvements.
E. Transit Service and Usage. 1. Transit routes, headways, route volumes, and fare structure for local public transit and private bus service. 2. Location and number of spaces of park-ride facilities. 3. Location/characteristics of existing HOV or bus priority lanes, rail transit, or other special transit service (commuter). 4. Planned/proposed transit modifications.	E. To identify potential for existing/proposed transit service to serve (or be modified to serve) long distance commuters.
F. Other TSM Actions 1. Description of any organized ridesharing, staggered or variable work hours, or other TSM actions.	F. Possible source of data on employee residence location; to identify actions that could be expanded to serve longer distance commuters.
G. Residence location of people working within the Case Study urbanized area from: 1. Census County-to-County commuting data. 2. External "tail" of trips (work) crossing external cordon. 3. Private bus operator records. 4. Employee zip codes from major employers. 5. Records of local ridesharing coordinator. 6. Special studies that may have been done in the study area.	G. To define the magnitude/significance/location (corridors) of long distance commuting.
H. Population 1. Distribution (current and projected) by city, town, and other sub-county breakdown for at least the tier of counties surrounding the case study.	H. To define population concentrations to which transportation actions to improve long distance commuting might be directed.
*I. Highway System Characteristics 1. Location/number of lanes/ADT and peak hour volumes on arterials and principal highways. 2. Link capacities and speeds or travel time.	*I. To define travel corridors and system context for planning transportation improvements for long distance commuting and to identify problem areas.
J. Income 1. Distribution by city and county.	J. To determine propensity to use transit/ridesharing modes.

* Required for initial screening of modal options in Part I of methodology.



TOTAL INBOUND WORK TRIPS = 9,600
TRIPS FROM FIRST RING OF COUNTIES = 8,800
TRIPS FROM BEYOND FIRST RING OF COUNTIES = 800
1970 ROANOKE VALLEY JOBS = 77,500
EXTERNAL WORK TRIPS AS % OF JOBS IN THE VALLEY = 12%

NORTH

Figure 3
EXTERNAL COMMUTING TRAVEL
TO ROANOKE VALLEY (1970 CENSUS DATA)

Existing and projected travel volumes in major corridors within the urbanized areas are available from the regional transportation studies. This data is typically in the form of vehicle trips, but average car occupancy by type of trip is frequently available to factor vehicle trips into person trips. For those urban areas where total person trip data is not directly available, any transit ridership in major corridors should be added to auto person trips in the corridors. While it is particularly important to have volume data at peak load points, volumes at reasonable intervals (every two to five miles) are also needed throughout the corridor.

The methodology described in this work paper can be applied to any desired time frame for which population, employment and travel data are available. Both existing, and forecasts of future, population, employment, and travel are available from the regional transportation studies in each urbanized area of over 50,000 population. This information will generally be sufficient to use in applying the methodology. Although this study focusses upon the problems of long-distance commuters, the feasibility of many transportation actions (particularly capital-intensive actions) will depend upon the demand generated in the same corridor by shorter trips. These shorter trips within the urbanized areas have been estimated for present and future conditions as a part of the regional transportation studies.

Estimates of future travel patterns outside the reigonal study area boundaries may be needed to evaluate the future potential of modal options. If population forecasts are available for these outlying areas, rough estimates of future travel patterns can be made by using growth factors to adjust existing travel patterns as derived from employee residence location data or special surveys. A description of this procedure is given in Appendix B.

Finally, only certain key data are required for the initial screening of modal options in Step 1.3. They are identified in Table 1 by asterisks and are summarized below:

1. Central area total employment (CBD and environs).

2. Residential density (dwelling units per residential acre) by traffic zone (or by small communities outside the urbanized are boundary).

3. Person trip volumes at the maximum load point and other locations along the corridor.

The other data in Table 1 are needed for further analyses of surviving modes in Part 2 of the methodology. Collection of such data could be delayed until the initial screening in Step 1.3 identifies the potential for any high-capital modes (i.e., rail modes and HOV facilities). However, most of it will be useful in testing and designing the implementation of ridesharing modes, which are likely to have application in most commuting corridors.

Step 1.3: Conduct Initial Screening of Modal Options

The concept of successive screenings of corridor modal options is a key feature of the methodology. The initial screening compares basic corridor travel and demographic characteristics (assembled in Step 1.2) to broad warrants or conditions under which the various modal options have been implemented in other regions. Its purpose is to eliminate options that clearly are not commensurate with demand levels in the subject corridor(s).

Table 2 presents several criteria for use in the initial screening of corridor modal options. The criteria are stated as minimum or threshold conditions which should be met in a corridor before a modal option is accepted for further analysis.

Perhaps the most critical criterion in screening the higher capital cost options is the size of the corridor peak travel market (expressed in Table 2 as peak hour, peak direction person trips). For example, unless a corridor has (or is estimated to have for the assumed design year) at least 3,000 peak hour, peak direction person trips at its maximum load point, experience across the country suggests that express bus service is unlikely to attract a significant modal share to prove feasible. It is suggested that this corridor travel market criterion be the first to be applied to the subject corridors in a region. The other criteria--residential density in the trip production (outer) portion of the corridor, employment in the trip attraction or inner part of the corridor, and corridor length--should then be applied as further checks of viability.

Judgment must be used in applying these criteria. If a corridor meets the volume criterion for rapid rail, but residential density in its traffic-shed is very low or CBD employment is well under 70,000, it is probably a poor candidate for rapid rail. The high corridor volume may be the result of an unusual configuration of the regional arterial or freeway system or some other system or demographic anomaly.

Corridor length is another related consideration, particularly when linked with residential density and peak hour, peak direction volume. For example, a corridor may exhibit at its maximum load point near the CBD a peak volume near or above the 17,000 person trips noted in Table 2 as a threshold figure for rapid rail consideration. However, the central city may be relatively compact so that residential densities of 12 dwelling units per acre or more extend only about three miles out from the CBD or, the 17,000 person trip figure may result from the confluence of several highways a mile or two from the CBD, with much lower volumes another mile further out from the core. The experience reflected in Table 2 would suggest a corridor length of at least seven miles is required to generate a sufficient travel market at relatively high densities and volumes to support most rapid rail lines. Thus, although rapid rail might not immediately be dismissed in this corridor, it would appear to be questionable and stronger consideration might

Table 2

INITIAL SCREENING CRITERIA FOR MODAL OPTIONS

Mode	Corridor Volume (peak hour, peak direction person trips)[1/]	Employment	Residential Density (dwelling units/ residential acre)	Corridor Length (miles)
Express Bus	3,000	25,000[2/]	3	5[4/]
HOV Facility/Light Rail	8,000	50,000[2/]	9	5[4/]
Rapid Rail	17,000	70,000[2/]	12	7[4/]
Commuter Rail	17,000	100,000[2/]	1	10[4/]
Carpool	—	100[3/]	1	3[5/]
Vanpool/Buspool	—	300[3/]	1	7[5/]

[1/] At maximum load point in corridor for design year.

[2/] Central area total employment for design year.

[3/] Individual employers or contiguous employers with similar shift and employee characteristics.

[4/] Service or facility length

[5/] Trip length

Adapted from: <u>Public Transportation and Land Use Policy</u>, Zupan, J. and B. Pushkarev, 1976
<u>Urban Rail In America</u>, Zupan, J. and B. Pushkarev, November 1980
<u>Generic Alternatives Analyses</u>, Barton-Aschman Associates, Inc., June 1979.

be given to HOV facility/light rail or express bus which are feasible with lower supporting densities and volumes in shorter corridors. Clearly, there are inherent linkages between some criteria such as corridor length and residential density or person trip volume that should be kept in mind in using Table 2. Corridor length as a criterion is to a great extent a reflection of travel utility. For a mode such as express bus, it suggests that at distances under five miles, it is usually difficult to induce a mode change to bus (i.e., via park-ride or feeder bus). Moreover, the travel time savings of express bus versus local bus over such short distances may not merit express service.

Rail modes that survive the initial screening in one corridor may not merit further serious consideration, unless another corridor(s) in the region also appears promising for the same mode. In effect, the cost effectiveness of such modes improves as the opportunity increases to spread high fixed costs (i.e., for shops, maintenance facilities, yards, etc.) over a larger system base.

From Table 2 it is obvious that non-fixed route ridesharing modes (carpool, vanpool/buspool) will have the widest potential application because they have very minimal warrants or threshold requirements. Corridor volume is not a relevant criterion for these modes; the employment base or attraction is most important. The employment criteria for ridesharing modes is expressed in terms of individual employer size (or contiguous employers with similar shifts and employment characteristics). Furthermore, the most successful ridesharing programs have been oriented to individual employers, and this may prove the best basis for evaluating ridesharing potential.

In the case of ridesharing modes, corridor length is interpreted as the minimum trip length at which buspools, vanpools, and carpools have generally been most successful. If a review of the commuting characteristics of major employers in the central city suggests most employee work trips are shorter than the distances in Table 2, ridesharing potential for those employers is probably very limited.

Finally, the values in Table 2 are simply guidelines based on a review of current experience in the U.S. and should be applied with careful judgment. There will always be exceptions to them because they represent an amalgamation of many cases, and some study corridors may present a unique combination of factors that would yield contrary conclusions.

The surviving modal options from the initial screening in this step are carried forward into Part 2 for more detailed analysis.

PART 2: DEMAND ANALYSIS/TRAVELER RESPONSE

This section of the methodology estimates the share of the total corridor travel market claimed by the modal options surviving initial screening in Part 1. It also assesses the feasibility of TSM actions that may be supportive of the modal options. Figure 4 illustrates the principal steps in Part 2:

1. Estimate shares of the travel market achievable by modal options surviving Part 1 screening.
2. If warranted, further evaluate certain modal options (primarily capital-intensive) through the use of the corridor sketch planning model.
3. Evaluate feasibility of TSM actions to support modal options, then assess effects of such actions in stimulating larger modal shares.
4. Compare estimated commuter response for each modal option with threshold demand levels as a final feasibility check.

Step 2.1: Estimate Commuter Response to Modal Options

Travel demand estimation for conventional urban transportation planning is normally performed by developing a model which relates human behavior to various quantitative measures of the transportation system (such as travel time, distance, and cost) and to quantitative measures of the traveler (such as income and automobile availability). This model is then be used with estimates of the quantitative measures to estimate travel volumes by mode.

This procedure normally requires large amounts of detailed data and relies on a substantial calibration effort to insure that the model "shows" correct relationships. A well calibrated model with detailed estimates of the quantitative measures can forecast corridor volumes with an error of less than 20 percent, and if the quantitative measures of the traveler are correct, the error may be as low as 5 to 10 percent.

This methodology can be expensive, both in the calibration and application phases. The suitability of the procedure is questionable if demand estimates

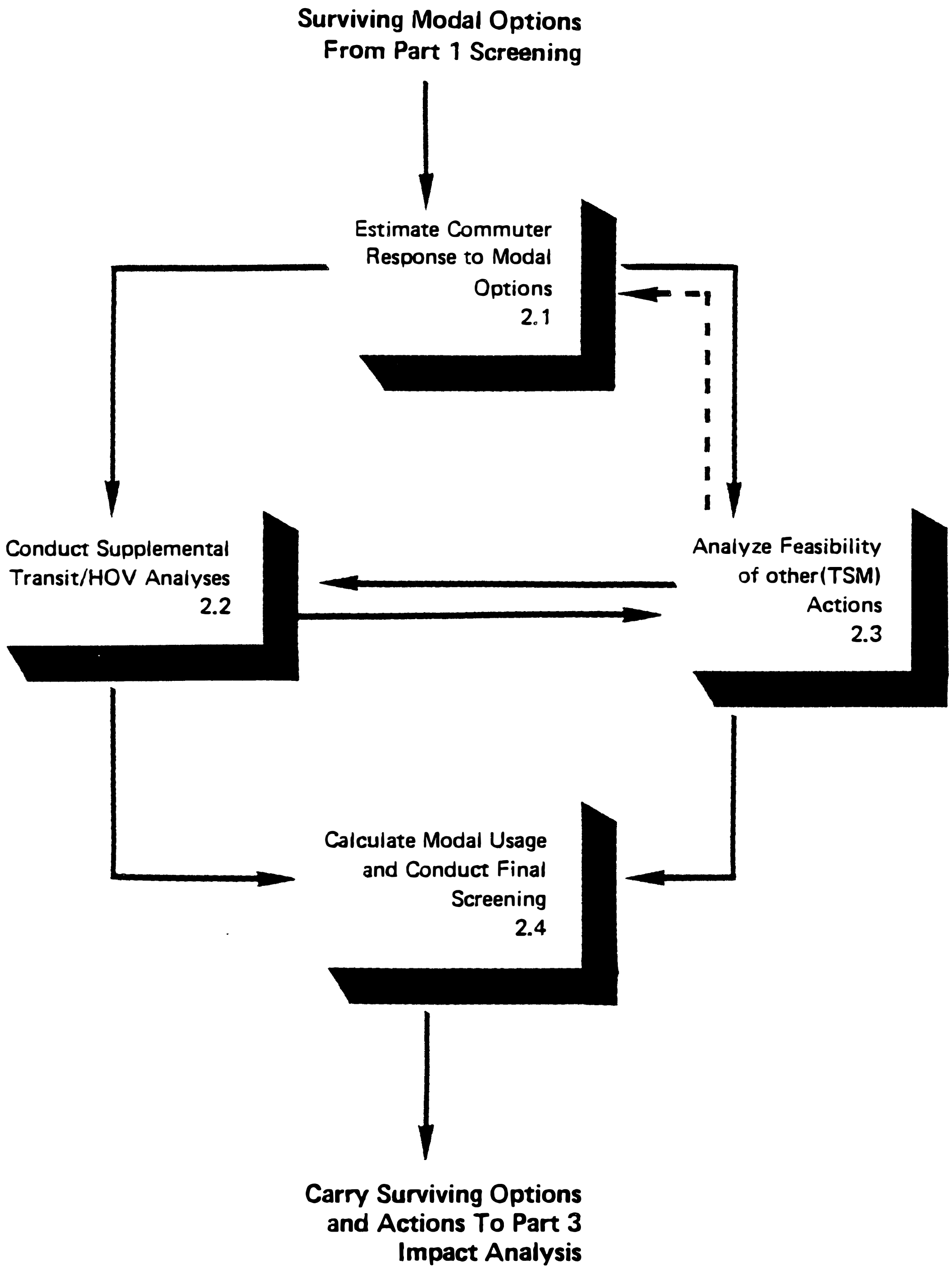


Figure 4
MAJOR STEPS IN PART TWO

Virginia Commuting Study

are to be used for policy planning, which does not require precise accuracy for one alternative, but relative accuracy for all possible alternatives. In addition, the procedure has the constraints of:

(1) the availability of data for calibration;
(2) the availability of, or resources to obtain, forecast data for future model applications;
(3) the availability of, and knowledge of how to use, a computer, which is normally required for these procedures;
(4) transportation system changes must be quantifiable within the structure of the model.

Many planning agencies have been faced with the problem of estimating travel demand when data availability, resources, and time are fairly limited. In addition, many of the more recent proposals to increase the efficiency of urban transportation systems have elements which are not quantifiable in terms normally associated with travel demand models: for example, the effects of carpool matching services and vanpool agencies.

As a part of this study, a manual analysis approach has been developed which may be used to estimate travel demand in lieu of the standard travel demand modeling procedure when data and resources are limited. This technique is called "Travel Demand Estimation by Analogy," and in essence consists of transferring the experience of other locations to the area under investigation.

The technique can be applied at a very gross level by using simple averages (i.e., for example, the national average modal share for all urban vanpools is 1.6 percent of a total urban travel market) or in considerably more detail by explicitly segmenting the travel market, (i.e. the national modal share average for vanpools which have a trip length of more than 15 miles and which are oriented to the central business district of a large urban area is 4.2 percent of that travel market). It is suggested that in applying the technique in this study, attention be paid to both levels of market segmentation.

This technique for manually estimating travel demand (or more appropriately, traveler or commuter response) employs a series of tables--called modal summary tables--that document the typical travel market share (in a range of low, normal, and high values) achieved by various modes in urban areas of different sizes. The tables also include a series of factors that can be applied to the basic modal share estimates to reflect the influence of varying socioeconomic conditions. The tables allow the use of actual socioeconomic characteristics for a particular study area (such as the proportion of employment classified as office, retail, or production), or a table of "default" values is provided for preliminary planning or where local data may be limited.

The tables were developed from summarization of national experience under a range of typical project conditions. This compilation of research results and project experience was possible within the constraints of this study due to recent work for the Federal Highway Administration in preparing the second edition of Traveler Response to Transportation System Changes. Appendix C describes data sources used in the development of the tables in greater detail.

Socioeconomic Distribution of Travel Market. Five different socioeconomic, land use, or urban form variables can be used to stratify urban travel markets. Experience with transit and ridesharing modes has shown that these market segmentations can significantly influence commuter travel behavior. The importance of these market stratifications has been found to vary by size of urban area. The five market stratifications for three sizes of urban areas are summarized in Table 3. Urban area size is defined as follows:

Small - under 100,000 population
Medium - 100,000-500,000
Large - over 500,000

The national market stratifications summarized in Table 3 have varying applicability to ridesharing and transit market potentials. Employment concentration and type are of particular concern in estimating ridesharing potential, because of the significant role which employer initiative and leadership can play in organizing and supporting carpools and vanpools. Ridesharing modes have a greater potential for successful implementation within larger employment concentrations. Experience has also shown that office workers exhibit a higher propensity for ridesharing, although this may reflect the high concentrations of such workers within Central Business Districts. Within Virginia, ridesharing by production workers has been very successful at major employers in the Newport News/Hampton/Norfolk area.

Residential density and household income are the more significant attributes that affect transit ridership. High-density residential areas typically exhibit a larger percentage of work trips by transit than lower-density areas, partly because of the shorter walking distances to transit and higher peak traffic congestion levels in such areas. Lower-income households, whether in high-density locations or not, also show greater propensity for transit ridership than higher-income households, due to lower automobile ownership and less money available to spend on transportation. These characteristics are assumed to be significant, not only on an intra-urban basis, but also for outlying residential areas from which longer-distance commuters are drawn.

The trip length stratifications of Table 3 indicate the relative size of the long-distance commuter market. A broad definition of long-distance travel as greater than 10 miles results in typical long-distance travel markets of between 25% and 35% of all commuters. Between 5% and 10% of all commuters fall within the longest trip length stratum of greater than 25

Table 3
SOCIOECONOMIC DISTRIBUTIONS OF COMMUTER TRAVEL MARKETS

Socioeconomic Market Characteristic	Typical Proportional Distribution of Travel Market Characteristic: Small Urban (under 100,000)	Medium Urban (100,000-500,000)	Large Urban (over 500,000)
Residential Density			
Low (under 3 d.u./residential acre	1/	1/	1/
Medium (3-6 d.u./residential acre)			
High (over 6 d.u./residential acre)			
Household Income (1978 dollars)			
Low (under $10,000)	.39	.32	.29
Medium ($10,000-$25,000)	.45	.45	.43
High (over $25,000)	.16	.23	.28
	1.00	1.00	1.00
Employment Concentration			
1-100 employees	.44	.50	.52
100-500 employees	.20	.24	.23
500-1,000 employees	.09	.10	.07
1,000 + employees	.27	.16	.18
	1.00	1.00	1.00
Type of Employment			
Office	.46	.54	.66
Retail	.14	.19	.20
Production	.40	.27	.14
	1.00	1.00	1.00
Work Trip Length (one-way)			
0-5 miles	.53	.51	.39
5-10 miles	.18	.25	.25
10-15 miles	.08	.09	.25
15-20 miles	.07	.07	.10
20-25 miles	.04	.03	.06
25 + miles	.10	.05	.07
	1.00	1.00	1.00

1/ Default values not available. Specific values or estimates should be obtained for the area under consideration.

See Appendix C for data sources.

miles. Those for whom long-distance commuter options will offer alternative travel means represent a significant minority of commuters. Those to whom the greatest benefits will accrue represent a small proportion of the total market, but one which contributes a large share of areawide vehicle-miles of travel.

If it is known or suspected that one or more of the socioeconomic distributions of Table 3 differs from the values in the table for any urban area under study, appropriate data for that area should be collected and the actual market stratification used. For example, areas with a high proportion of longer work trips, or a high proportion of production employment, may merit special data collection efforts before the methodology is applied. If, however, no such supplementary area-specific analyses are conducted, the "typical" distributions given in Table 3 may be used as default values in subsequent analyses.

Market Share Estimates. The top portions of Tables 4 through 9 summarize the "typical" market shares for ridesharing and transit modes that have been observed in urban areas of different size across the country. In applying these tables, the "normal" estimate of market share (within the appropriate city size category) should be used in developing preliminary estimates of modal response. This normal estimate implies that either very little is known about the characteristics of the study area, or that no extraordinary conditions apply. That is, no conditions exist which pose an abnormally large positive or negative influence on the use of these modes.

Typically, positive factors might include the combination of significant traffic congestion, park-and-ride lots, transit marketing efforts, high parking costs, and low parking availability. Negative factors include free or unlimited parking, little or no congestion, or perhaps a known unfavorable attitude towards alternative modes on the part of local officials and/or employers.

The "low" and "high" market share values for ridesharing modes are based upon site-specific studies, where local circumstances influenced participation in any of the ridesharing modes. They should be used only when an area has characteristics that affect commuter travel which are radically different from similar-sized areas. Thus, two mile back-ups and four-dollar-a-day parking charges would be unusual in a small urban area, but not a large one, triggering the use of "high" values in the former instance, but "normal" values in the latter.

The first step in the estimation of commuter response to modal options in any study area is the identification of the appropriate urban area size classification. Within the appropriate size class, and for each modal option being considered, the applicable market share from Tables 4 through 9 should be selected for the subject corridors. The modal shares can then be adjusted as desired by the factors in the middle and lower sections of the tables. These adjustments are described further in the following paragraphs.

Table 4a
MODAL SUMMARY TABLE: CARPOOL - Small Urban Area

Characteristic of Area or Travel Market	Typical Market Share Low	Normal	High
Employment Location			
Central Area/Suburbs	.171	.244	.267

	Proportional Adjustment Factors
Socioeconomic Section	
Residential Density	
Low (under 3 d.u./residential acre)	
Medium (3-6 d.u./residential acre)	NA
High (over 6 d.u./residential acre)	
Household Income (1978 dollars)	
Low (under $10,000)	1.223
Medium ($10,000-$25,000)	.815
High (over $25,000)	.977
Employment Concentration	
1-100 employees	.596
100-500 employees	.888
500-1,000 employees	.888
1,000 + employees	1.776
Type of Employment	
Office	1.106
Retail	1.106
Production	.841
Work Trip Length (one-way)	
0-5 miles	.635
5-10 miles	1.059
10-15 miles	1.106
15-20 miles	1.735
20-25 miles	1.800
25+ miles	1.912

Ridesharing Assistance Section

Carpool Encouragement 1/	Low	Normal	High
No action	1.00	1.00	1.00
Promotion/Information	1.00	1.00	1.00
Areawide matching	1.00	1.01	1.04
Employer matching 2/	1.01	1.05	1.18

1/ These factors represent total areawide carpooling mode share and are not site specific as are the vanpooling encouragement factors.

2/ Assumes participation by all employers of 100+ persons.

Table 4b
MODAL SUMMARY TABLE: CARPOOL - Medium Urban Area

Characteristic of Area or Travel Market	Typical Market Share Low	Normal	High
Employment Location			
Central Area/Suburbs	.128	.190	.208

	Proportional Adjustment Factors
Socioeconomic Section	
Residential Density	
Low (under 3 d.u./residential acre)	
Medium (3-6 d.u./residential acre)	NA
High (over 6 d.u./residential acre)	
Household Income (1978 dollars)	
Low (under $10,000)	1.244
Medium ($10,000-$25,000)	.829
High (over $25,000)	.993
Employment Concentration	
1-100 employees	.674
100-500 employees	1.004
500-1,000 employees	1.004
1,000 + employees	2.009
Type of Employment	
Office	1.069
Retail	1.069
Production	.813
Work Trip Length (one-way)	
0-5 miles	.662
5-10 miles	1.104
10-15 miles	1.153
15-20 miles	1.809
20-25 miles	1.877
25+ miles	1.993

Ridesharing Assistance Section

Carpool Encouragement 1/	Low	Normal	High
No action	1.00	1.00	1.00
Promotion/Information	1.00	1.00	1.00
Areawide matching	1.00	1.01	1.04
Employer matching 2/	1.01	1.05	1.18

1/ These factors represent total areawide carpooling mode share and are not site specific as are the vanpooling encouragement factors.

2/ Assumes participation by all employers of 100+ persons.

Table 4c
MODAL SUMMARY TABLE: CARPOOL - Large Urban Area

Characteristic of Area or Travel Market	Typical Market Share Low	Normal	High
Employment Location			
Central Area/Suburbs	.128	.191	.208

	Proportional Adjustment Factors
Socioeconomic Section	
Residential Density	
Low (under 3 d.u./residential acre)	
Medium (3-6 d.u./residential acre)	NA
High (over 6 d.u./residential acre)	
Household Income (1978 dollars)	
Low (under $10,000)	1.248
Medium ($10,000-$25,000)	.832
High (over $25,000)	.996
Employment Concentration	
1-100 employees	.665
100-500 employees	.991
500-1,000 employees	.991
1,000 + employees	1.982
Type of Employment	
Office	1.035
Retail	1.035
Production	.787
Work Trip Length (one-way)	
0-5 miles	.593
5-10 miles	.988
10-15 miles	1.032
15-20 miles	1.619
20-25 miles	1.680
25+ miles	1.784

Ridesharing Assistance Section

Carpool Encouragement 1/	Low	Normal	High
No action	1.00	1.00	1.00
Promotion/Information	1.00	1.00	1.00
Areawide matching	1.00	1.01	1.04
Employer matching 2/	1.01	1.05	1.18

1/ These factors represent total areawide carpooling mode share and are not site specific as are the vanpooling encouragement factors.

2/ Assumes participation by all employers of 100+ persons.

Table 5a
MODAL SUMMARY TABLE: VANPOOL/BUSPOOL - Small Urban Area

Characteristic of Area or Travel Market	Typical Market Share Low	Normal	High
Employment Location			
Central Area	.004	.019	.052
Suburbs	.004	.020	.054

	Proportional Adjustment Factors
Socioeconomic Section	
Residential Density	
Low (under 3 d.u./residential acre)	
Medium (3-6 d.u./residential acre)	NA
High (over 6 d.u./residential acre)	
Household Income (1978 dollars)	
Low (under $10,000)	
Medium ($10,000-$25,000)	NA
High (over $25,000)	
Employment Concentration	
1-100 employees	.398
100-500 employees	2.126
500-1,000 employees	2.049
1,000 + employees	.797
Type of Employment	
Office	1.216
Retail	1.216
Production	.676
Work Trip Length (one-way)	
0-5 miles	.178
5-10 miles	.700
10-15 miles	1.215
15-20 miles	1.262
20-25 miles	2.009
25+ miles	5.140

Ridesharing Assistance Section

Vanpool Encouragement[1/]	Low	Normal	High
Owner operated	1.00	1.00	1.00
Promotion/Information	1.00	2.10	3.55
Match/lease administration	1.00	3.16	5.33
Financial Assistance	1.58	5.61	5.72

1/ Factors represent effects at specific employment sites, not areawide effects. Note difference compared to Carpool Encouragement factors.

Table 5b
MODAL SUMMARY TABLE: VANPOOL/BUSPOOL - Medium Urban Area

Characteristic of Area or Travel Market	Typical Market Share Low	Normal	High
Employment Location			
Central Area	.003	.016	.043
Suburbs	.004	.020	.054

	Proportional Adjustment Factors
Socioeconomic Section	
Residential Density	
Low (under 3 d.u./residential acre)	
Medium (3-6 d.u./residential acre)	NA
High (over 6 d.u./residential acre)	
Household Income (1978 dollars)	
Low (under $10,000)	
Medium ($10,000-$25,000)	NA
High (over $25,000)	
Employment Concentration	
1-100 employees	.382
100-500 employees	2.041
500-1,000 employees	1.967
1,000 + employees	.765
Type of Employment	
Office	1.136
Retail	1.136
Production	.632
Work Trip Length (one-way)	
0-5 miles	.227
5-10 miles	.897
10-15 miles	1.556
15-20 miles	1.616
20-25 miles	2.574
25+ miles	6.585

Ridesharing Assistance Section

Vanpool Encouragement[1/]	Low	Normal	High
Owner operated	1.00	1.00	1.00
Promotion/information	1.00	2.10	3.55
Match/lease administration	1.00	3.16	5.33
Financial Assistance	1.58	5.61	5.72

1/ Factors represent effects at specific employment sites, not areawide effects. Note difference compared to Carpool Encouragement factors.

Table 5c
MODAL SUMMARY TABLE: VANPOOL/BUSPOOL - Large Urban Area

Characteristic of Area or Travel Market	Typical Market Share Low	Normal	High
Employment Location			
Central Area	.003	.016	.043
Suburbs	.004	.020	.054

	Proportional Adjustment Factors
Socioeconomic Section	
Residential Density	
Low (under 3 d.u./residential acre)	
Medium (3-6 d.u./residential acre)	NA
High (over 6 d.u./residential acre)	
Household Income (1978 dollars)	
Low (under $10,000)	
Medium ($10,000-$25,000)	NA
High (over $25,000)	
Employment Concentration	
1-100 employees	.405
100-500 employees	2.164
500-1,000 employees	2.085
1,000 + employees	.811
Type of Employment	
Office	1.066
Retail	1.066
Production	.593
Work Trip Length (one-way)	
0-5 miles	.176
5-10 miles	.694
10-15 miles	1.204
15-20 miles	1.251
20-25 miles	1.992
25+ miles	5.095

Ridesharing Assistance Section

Vanpool Encouragement	Low	Normal	High
Owner operated[1/]	1.00	1.00	1.00
Promotion/information[1/]	1.00	2.10	3.55
Match/lease administration[1/]	1.00	3.16	5.33
Financial assistance[1/]	1.58	5.61	5.72
Vanpool coordinator program[2/]	1.25	1.25	1.25

1/ Factors represent effects at specific employment sites, not areawide effects. Note difference compared to Carpool Encouragement factors.

2/ Applicable to large urban areas only. Factor is applied to areawide vanpooling, not site-specific as are other factors.

Table 6a
MODAL SUMMARY TABLE: EXPRESS BUS (MIXED TRAFFIC) - Small Urban Area

Characteristic of Area or Travel Market	Typical Market Share[1/] Low	Normal	High
Employment Location			
Central Area	.11	.12	.13
Suburbs	.01	.02	.02

	Proportional Adjustment Factors
Socioeconomic Section	
Residential Density	
Low (under 3 d.u./residential acre)	
Medium (3-6 d.u./residential acre)	NA
High (over 6 d.u./residential acre)	
Household Income (1978 dollars)	
Low (under $10,000)	.875
Medium ($10,000-$25,000)	1.076
High (over $25,000)	1.086
Employment Concentration	
1-100 employees	
100-500 employees	NA
500-1,000 employees	
1,000 + employees	
Type of Employment	
Office	1.187
Retail	1.187
Production	.719
Work Trip Length (one-way)	
0-5 miles	.582
5-10 miles	1.580
10-15 miles	1.404
15-20 miles	1.404
20-25 miles	1.404
25+ miles	1.404

1/ Market share pertains to percentage of total work person trips in a corridor that are destined to the central area. Typically, express bus mode share represents .02 to .04 of total areawide work trips in cities with moderate express service. Express transit averages .33 to .67 of total corridor transit ridership.

Table 6b
MODAL SUMMARY TABLE: EXPRESS BUS (MIXED TRAFFIC) - Medium Urban Area

Characteristic of Area or Travel Market	Typical Market Share 1/ Low	Normal	High
Employment Location			
Central Area	.08	.12	.14
Suburbs	.01	.02	.02

	Proportional Adjustment Factors
Socioeconomic Section	
Residential Density	
Low (under 3 d.u./residential acre)	
Medium (3-6 d.u./residential acre)	NA
High (over 6 d.u./residential acre)	
Household Income (1978 dollars)	
Low (under $10,000)	.863
Medium ($10,000-$25,000)	1.062
High (over $25,000)	1.072
Employment Concentration	
1-100 employees	
100-500 employees	NA
500-1,000 employees	
1,000 + employees	
Type of Employment	
Office	1.119
Retail	1.119
Production	.678
Work Trip Length (one-way)	
0-5 miles	.566
5-10 miles	1.535
10-15 miles	1.364
15-20 miles	1.364
20-25 miles	1.364
25+ miles	1.364

1/ Market share pertains to percentage of total work person trips in a corridor that are destined to the central area. Typically, express bus mode share represents .02 to .04 of total areawide work trips in cities with moderate express service. Express transit averages .33 to .67 of total corridor transit ridership.

Table 6c
MODAL SUMMARY TABLE: EXPRESS BUS (MIXED TRAFFIC) - Large Urban Area

Characteristic of Area or Travel Market	Typical Market Share[1/] Low	Normal	High
Employment Location			
Central Area	.08	.12	.14
Suburbs	.01	.02	.02

	Proportional Adjustment Factors
Socioeconomic Section	
Residential Density	
Low (under 3 d.u./residential acre)	
Medium (3-6 d.u./residential acre)	NA
High (over 6 d.u./residential acre)	
Household Income (1978 dollars)	
Low (under $10,000)	.858
Medium ($10,000-$25,000)	1.055
High (over $25,000)	1.065
Employment Concentration	
1-100 employees	
100-500 employees	NA
500-1,000 employees	
1,000 + employees	
Type of Employment	
Office	1.058
Retail	1.058
Production	.641
Work Trip Length (one-way)	
0-5 miles	.516
5-10 miles	1.401
10-15 miles	1.246
15-20 miles	1.246
20-25 miles	1.246
25+ miles	1.246

1/ Market share pertains to percentage of total work person trips in a corridor that are destined to the central area. Typically, express bus mode share represents .02 to .04 of total areawide work trips in cities with moderate express service. Express transit averages .33 to .67 of total corridor transit ridership.

Table 7
MODAL SUMMARY TABLE: EXPRESS BUS ON HOV FACILITY/LIGHT RAIL

Characteristic of Area or Travel Market	Typical Market Share 1/ Low	Normal	High
Employment Location			
Central Area	NA	.25	.33
Suburbs	NA	.03	.04

	Proportional Adjustment Factors
Socioeconomic Section	
Residential Density	
Low (under 3 d.u./residential acre)	
Medium (3-6 d.u./residential acre)	NA
High (over 6 d.u./residential acre)	
Household Income (1978 dollars)	
Low (under $10,000)	.968
Medium ($10,000-$25,000)	1.224
High (over $25,000)	.688
Employment Concentration	
1-100 employees	
100-500 employees	NA
500-1,000 employees	
1,000 + employees	
Type of Employment	
Office	1.082
Retail	1.082
Production	.498
Work Trip Length (one-way)	
0-5 miles	.646
5-10 miles	1.754
10-15 miles	1.559
15-20 miles	1.559
20-25 miles	1.559
25+ miles	1.559

1/ Market share pertains to percentage of total work person trips in a corridor that are destined to the central area.

Table 8
MODAL SUMMARY TABLE: RAPID RAIL - Large Urban Area

Characteristic of Area or Travel Market	Typical Market Share Low	Normal	High
Employment Location			
Central Area	NA	.25	.33
Suburbs	NA	.03	.04

	Proportional Adjustment Factors
Socioeconomic Section	
Residential Density	
Low (under 3 d.u./residential acre)	0.91
Medium (3-6 d.u./residential acre)	0.94
High (over 6 d.u./residential acre)	1.00
Household Income (1978 dollars)	
Low (under $10,000)	1.144
Medium ($10,000-$25,000)	1.062
High (over $25,000)	0.754
Employment Concentration	
1-100 employees	
100-500 employees	
500-1,000 employees	NA
1,000 + employees	
Type of Employment	
Office	
Retail	NA
Production	
Work Trip Length (one-way)	
0-5 miles	1.393
5-10 miles	1.065
10-15 miles	0.836
15-20 miles	0.544
20-25 miles	0.368
25+ miles	0.079

Table 9a
MODAL SUMMARY TABLE: COMMUTER RAIL - Medium Urban Area

Characteristic of Area or Travel Market	Typical Market Share[1/] Low	Normal	High
Employment Location			
Central Area	NA	.046	NA
Suburbs	NA	.006	NA

	Proportional Adjustment Factors
Socioeconomic Section	
Residential Density	
Low (under 3 d.u./residential acre)	0.85
Medium (3-6 d.u./residential acre)	0.94
High (over 6 d.u./residential acre)	1.00
Household Income (1978 dollars)	
Low (under $10,000)	0.468
Medium ($10,000-$25,000)	1.034
High (over $25,000)	1.692
Employment Concentration	
1-100 employees	
100-500 employees	NA
500-1,000 employees	
1,000 + employees	
Type of Employment	
Office	
Retail	NA
Production	
Work Trip Length (one-way)	
0-5 miles	0.040
5-10 miles	0.226
10-15 miles	1.365
15-20 miles	1.405
20-25 miles	5.579
25+ miles	10.693

1/ Market share pertains to percentage of total work person trips in a corridor that are destined to the central area.

Table 9b
MODAL SUMMARY TABLE: COMMUTER RAIL - Large Urban Area

Characteristic of Area or Travel Market	Typical Market Share[1/] Low	Normal	High
Employment Location			
Central Area	NA	.068	NA
Suburbs	NA	.009	NA

	Proportional Adjustment Factors
Socioeconomic Section	
Residential Density	
Low (under 3 d.u./residential acre)	0.85
Medium (3-6 d.u./residential acre)	0.94
High (over 6 d.u./residential acre)	1.00
Household Income	
Low (under $10,000)	0.446
Medium ($10,000-$25,000)	0.984
High (over $25,000)	1.610
Employment Concentration	
1-100 employees	
100-500 employees	NA
500-1,000 employees	
1,000 + employees	
Type of Employment	
Office	
Retail	NA
Production	
Work Trip Length (one-way)	
0-5 miles	0.027
5-10 miles	0.153
10-15 miles	0.926
15-20 miles	0.954
20-25 miles	3.787
25+ miles	7.258

1/ Market share pertains to percentage of total work person trips in a corridor that are destined to the central area.

Market Share Adjustment Factors. Based largely upon site-specific studies for both ridesharing and transit modes, adjustment factors have been developed to reflect the different propensities that various groups have for using ridesharing and transit modes. These factors correspond to the five socioeconomic characteristics that were discussed earlier and displayed in Table 3. The middle portions of Tables 4 through 9 contain socioeconomic adjustment factors for each combination of mode and urban area size. For example, Table 4a contains the information needed to estimate the carpooling mode share in small urban areas and make appropriate socioeconomic adjustments.

After a market share from the top section of the appropriate modal summary table (as identified by mode and urban area size) has been chosen, relevant socioeconomic factors for the area being analyzed are selected from the center section of the table and applied to produce an adjusted market share. This figure must then be further adjusted by the proportion of total employees or work trips that fall within the particular socioeconomic stratum using the default values in Table 3 or actual data from the area being analyzed, if available.

To illustrate, if an estimate of the number of potential vanpoolers/buspoolers among employment concentrations of 500 to 1,000 employees in a typical large urban area CBD is desired, the "normal" market share (from Table 5c) of 0.016 is multiplied by the adjustment factor for that employment size class (also from Table 5c) of 2.085 and then by the proportion of urban area employees typically working in concentrations of 500 to 1,000 employees in large urban areas (from Table 3) of 0.07. The resulting factor, multiplied by the total employment in the CBD will yield the desired estimate of vanpoolers /buspoolers.

In the above example the "default" distribution of regional employment concentrations from Table 3 was used because the analyst presumably knew only total regional employment. A better estimate could be made if the analyst knew the distribution of employment concentrations for the central area. The best estimate would apply the factors from Table 5c to the actual number of employees working in concentrations of 500 to 1,000 employment in the central area (i.e., avoiding the use of any default values).

In addition to the socioeconomic factors in Tables 4 through 9, there are additional factors at the bottom of the ridesharing modal summary tables. This is called the "Ridesharing Assistance Section" and includes factors relating to the presence or absence of certain actions to encourage ridesharing. These are generally non-time and cost related supplemental TSM actions, whose effects on ridesharing have been estimated from national experience. These factors are to be applied when:

(1) one or more of the conditions exists in the urban area under study,
(2) the conditions do not exist, but the TSM action warrants (to be discussed in a subsequent section) indicate that they may be justified, or
(3) the analyst wishes to estimate the mode choice response to such actions.

These factors may be used on the first application of the ridesharing modal summary tables, or perhaps on a "second pass" through the tables, or both (although the factor for the same action should be applied only once).

The Ridesharing Assistance Section factors have high, normal, and low values. The choice of factor is based on the assumed effectiveness and thoroughness of the action, neither of which can be truly quantified. Tables 10 and 11 give additional examples of the application of market share adjustment factors.

Finally, it should be noted that missing values for certain factors in these tables do not necessarily mean that the factors have no effect. It may mean that data on these relationships were unavailable to establish appropriate relationships.

Step 2.2: Supplemental Transit/HOV Analysis

If the preceding analysis indicates that substantial use of one or more fixed guideway modes is possible, or if more detailed estimates of transit modal share are desired, a more thorough patronage estimation technique is provided. This technique consists of the Corridor Sketch Planning Program, applied using the UTPS program UMODEL. It represents a level of effort and results between that of the modal summary tables and a full-scale regional travel analysis.

The program is intended for use in a corridor setting, where a "shed" of analysis zones on either side of a transportation facility can be defined, with the focus on trips having a primary destination at one end of the corridor. The main program input consists of person trips, transit level of service (average walk and wait time per zone, by service type), highway times and distances, distribution of VMT by district, and other zonal data, such as parking cost, highway terminal times, and households by income level. The output is a set of trip-end summaries by mode, reports on VMT by district, and a set of zone-to-zone UTPS trip tables by mode. This output can be used directly, or can be input to other UTPS programs for summarization and tabulation.

The program has a wide range of flexibility in analyzing local transit (both radial and circumferential), express bus in mixed traffic, bus on busway, or other fixed guideway line-haul modes. Feeder bus and auto access to line-haul service are modelled explicitly. The model calculates the relative

Table 10
EXAMPLE IN ESTIMATING TRAVEL DEMAND

Problem:

Estimate potential express bus (in mixed traffic) usage between an exurban county and the CBD of a medium sized urban area.

Available planning data:

(1) All trips are over 15 miles.
(2) Approximately 2,000 work trips are made from the county to the CBD.
(3) CBD has 25 percent retail, 5 percent production workers, and 70 percent office employment.
(4) Service will serve park/ride lots on reasonable headways during peak periods.

General Equation:

$$\text{Express Bus Trips} = \text{Trips}_{ijk} * MS * HI_i * TE_j * TL_k$$

For each market segment where:

Trips_{ijk} = no. of one-way person work trips with income i, employment type j and trip length k.

MS = applicable express bus mode share

HI_i = Household Income adjustment factor for income i

TE_j = Type of Employment adjustment factor for employment type j

TL_k = Work Trip Length adjustment factor for trip length k

Calculations:

Normal mode share = .12 (from Table 6b)

High mode share = .14 (CBD parking is expensive, analyst proposes transit marketing program and wants to see the effect of using a high value)

		Normal	High
Adjusted modal share (Office)	= .12 * 1.119 * 1.364 =	.183	.214
Adjusted modal share (Retail)	= .12 * 1.119 * 1.364 =	.183	.214
Adjusted modal share (Production)	= .12 * .678 * 1.364 =	.111	.129

Normal Estimated Trips = (.183 * .05 * 2000) + (.183 * .25 * 2000) + (.111 * .70 * 2000) = 265.2 = 265

High Estimated Trips = 309

Table 11
EXAMPLE IN ESTIMATING TRAVEL DEMAND

Problem:

Estimate potential vanpool/buspool demand for a central area employer in a small urban area.

Available Planning Data

(1) 1,500 employees on-site
(2) 90% blue collar; 10% office
(3) Break-down of work trip length (from an analysis of employee residence location):

0-5 miles = 500 employees
5-10 miles = 300 employees
10-15 miles = 250 employees
15-20 miles = 150 employees
20-25 miles = 100 employees
25+ miles = 200 employees

General Equation:

$$\text{Vanpool/Buspool Trips} = \text{Trips}_{ijk} * MS * EC_i * TE_j * TL_k * ENC$$

For each market segment where:

Trips_{ijk} = no. of one-way person work trips at employment concentration i, employment type j and trip length k.

MS = applicable vanpool/buspool mode share

EC_i = Employment Concentration adjustment factor for site of size i

TE_j = Type of Employment adjustment factor for employment type j

TL_k = Work Trip Length adjustment factor for trip length k

ENC= Vanpool Encouragement adjustment factor (if applicable)

Calculations:

Normal modal share = .019 (from Table 5a)

Adjusted modal share (office) = .019 * .797 * 1.216 * .10 = .0018
Adjusted modal share (blue collar) = .019 * .797 * .676 * (0.90) = .0092

Office person trips (no incentives = (.0018 * .178 * 500) +
(.0018 * .700 * 300) + (.0018 * 1.215 * 250) +
(.0018 * 1.262 * 150) + (.0018 * 2.009 * 100) +
(.0018 * 5.140 * 200) = 3.638 or 4 trips in one direction

Blue Collar person trips (no incentives) = (.0092 * .178 * 500) +
(.0092 * .700 * 300) + (.0092 * 1.215 * 250) +
(.0092 * 1.262 * 150) + (.0092 * 2.009 * 100) +
(.0092 * 5.140 * 200) = 18.6 = 19 trips in one direction

Total estimated person trips by vanpool (no incentives) = 19 + 4 = 23 trips each way.

If employer will guarantee leasing:
Trips = 23 * 3.16 = 72.7 = 73 trips each way

traveller "disutility" for each of five modes: transit, autos with one person, two person autos, three person autos, and four or more person autos. A multinomial logit formula is then used to determine mode shares based on the disutilities.

Although the program requires a moderate level of effort to assemble the data for one application, subsequent applications are much easier, since most of the data will remain the same. In fact, the program's main feature is that changes in transit service level (either feeder, line haul, or both), are fairly easy to represent. The program can be used to test the effects of several different actions that directly affect the time and/or cost of travel. These include HOV exclusive lanes or facilities, HOV priority facilities, parking cost incentives, reduced tolls, and feeder service level or fare. However, changes not related to travel time or cost cannot be estimated using this process.

This technique should be used when the modal summary tables indicate probable high usage of any capital-intensive option, if more than one capital-intensive option is to be studied, or if additional detail is required regarding HOV mode usage at any point in the demand analysis process. Appendix D describes the Corridor Sketch Planning Program in greater detail.

Step 2.3: Feasibility Analysis of Other Commuter Travel Actions

In addition to the modal options that have been discussed in the preceding sections, there are other actions that may be implemented to ease the problems of commuter travel. Most are transportation system management actions aimed at the more efficient use of existing facilities. These actions are labeled "Supplemental TSM Actions", because they are generally implemented in support of a particular mode or modes. As indicated in Table 12, three different types of improvements are involved --improvement in user time or cost, institutional actions to facilitate usage of a mode, and miscellaneous actions. Table 12 indicates how the supplemental TSM actions are categorized.

These actions are treated as factors that modify the basic mode choice percentages determined in Steps 2.1, and 2.2. The time and cost-related actions create a measurable improvement for HOVs (both transit and rideshare modes), sometimes at the expense of single-occupancy autos. The time or cost savings can be translated into a percentage shift in the mode share of the mode which benefits. This shift is estimated using sensitivity tables based on coefficients from previously calibrated logit models. The shift can also be explicitly modelled using the Corridor Sketch Planning Program. The insititutional actions have a less direct, but still discernable, effect on mode usage. The changes attributable to these actions have been estimated from the experience of actual projects as reported in recent literature. The other actions include some (such as variable work hours and traffic engineering improvements) which can improve peak traffic flow conditions for all commuter traffic. Two of these actions (park-ride

Table 12
SUPPLEMENTAL TSM ACTIONS

Category	TSM Action	Commuter Modes Affected
Institutional Actions	Promotion/marketing/ information	Rideshare
	Matching assistance (areawide or employer-specific)/brokerage	Rideshare
	Lease administration and assistance	Vanpool/Buspool
	User subsidy (3)	Vanpool/Buspool
Time and Cost Actions	Freeway HOV lanes (1)	Express Bus, Rideshare (2)
	Arterial HOV lanes (1)	Express Bus
	Reversible traffic lanes	Express Bus
	Priority entry for HOVs	Express Bus, Rideshare
	Bus signal priority systems	Express Bus
	HOV parking cost incentives	Rideshare
	Transit fare changes	Transit (4)
Other Actions	Ramp metering	(5)
	Preferential parking location for HOVs	Rideshare (8)
	Pool staging lots	Rideshare (8)
	Park and ride parking facilities for transit	Transit (7)
	Feeder bus services	Transit (7)
	Variable work hours	(5)
	High-capacity buses	Express Bus, HOV Facility/Light Rail (6)
	Traffic engineering improvements	(5)

Notes:

(1) Includes both with-flow and contraflow lanes.

(2) Rideshare = Carpool and Vanpool/Buspool.

(3) Strictly speaking, this is a user cost measure, but not enough is known about the effect of user subsidies on ridesharing to be able to consider this in the "Time and Cost" category.

(4) Transit = Express Bus, Commuter Rail, Rapid Rail, and HOV Facility/Light Rail

(5) These actions generally improve the flow of all peak hour traffic. As such, they can affect many commuters, but they usually cannot be related specifically to shifts to high-occupancy modes.

(6) This action does not affect usage of transit, but does affect transit capital and operating costs.

(7) The effects of these actions can only be estimated in this study via use of the Express Corridor Transit Planning Program.

(8) Research for this study could not find ways of quantifying the effects of these actions on modal use. The presence or absence of such actions could be among the things considered in deciding whether to use the "low" or "high" factors in the modal summary tables.

facilities for transit and feeder bus service) can only be analyzed using the Corridor Sketch Planning Program. The effects of the others, if any, can be estimated only approximately.

In cases where the analyst is uncertain whether or not any of the candidate TSM actions is justified, warrants for such actions are supplied. These warrants, shown in Table 13, indicate the lowest usage for which some of the more cost-intensive actions should be considered. The mode usage estimates needed to use this table come from the modal summary tables (Step 2.1), the Corridor Sketch Planning Program (Step 2.2), or observed data.

The warrants relate only to those supplemental TSM actions which involve relatively major construction. Other TSM strategies, generally the institutional actions, have historically not been implemented or justified based on any particular level of usage. Since these institutional actions are not capital-intensive, do not require long lead times, and can be readily rescinded, their implementation does not require the same level of supporting analysis as the other actions.

If the warrants indicate that supplemental TSM strategies appear justified based on initial mode share estimates, or if the analyst wishes to investigate such actions for other reasons, the next part of Step 2.3 may be applied. The particular approach employed is based on the type of TSM action involved: institutional or time/cost related.

For institutional actions, the analyst merely re-applies the ridesharing modal summary tables, using the Ridesharing Assistance Options factors as appropriate. These factors apply only to the ridesharing modes and only within the context of the modal summary tables.

For time/cost related actions, the analysis is more complex. First, the analyst must estimate the absolute time and/or cost savings per person trip associated with the TSM action. In the case of HOV parking cost incentives, this is simply half the difference between the daily average parking cost for HOVs and non-HOVs. Note that this is based on average cost and not maximum cost. For transit fare changes, the difference is the change in round trip fare divided by two.

For the other actions, the calculations are more involved, since they relate to increases in speed for HOV modes. Speed increases must be applied over a fixed distance in order to develop an absolute change in travel time. Table 14 indicates some typical increases in speed and some typical project lengths for these TSM actions. The values in this table are broadly representative of a variety of existing projects. If more information about a proposed TSM action is known, it can be substituted for the typical values shown in the table.

Once the absolute change in time or cost is known, the only other information needed is the mode share without the improvement. This value may come

Table 13
WARRANTS FOR SUPPLEMENTAL TSM ACTIONS

TSM Action	Minimum Vehicular Volumes[3/] Buses[1/]	Carpools[2/]	Minimum Person Trips[3/]	Comments
Arterial With-flow HOV lanes	20	--	800	For bus use only. Must be at least 2 more lanes for other traffic.[1/]
Arterial Contraflow HOV Lanes	15	--	600	
Priority entry for HOVs	10	150	400	Priority entry allows HOVs to bypass metered ramps or other restrictions.
Bus signal priority systems	10	--	400	
Ramp metering	--	--	750 vehicles	Total volume of ramp and near lane must be less than 1800 vehicles.[4/]
Pool staging lots	--	30[5/]	50	Assumes auto occupancy of 3.0 leaving the lot.
Transit park and ride lots	6	--	240	Fewer buses acceptable if service is of sufficiently high quality to attract riders.[1/]

Notes

1/ Source: Bus Use of Highways, NCHRP Report 155, Wilbur Smith and Associates, 1975.

2/ Includes vanpools.

3/ Peak hour, peak direction volumes, in HOV modes.

4/ Source: Evaluation of Freeway High Occupancy Vehicle Lanes and Ramp Metering. Vol. I-II, D. Baugh and Associates, Inc., for USDOT, August, 1980.

5/ Minimum number of carpools formed.

able 14
YPICAL RESULTS OF APPLYING TIME-RELATED SUPPLEMENTAL TSM ACTIONS

SM Action		Speed (mph) Before	After	Projects Length (miles)	Resulting Time Reduction (minutes)
ırterial with-flow HOV lanes	RS:2/	20.0	27.0	4	3.1
	T:2/	10.0	13.0	4	5.5
ırterial Contraflow lanes	RS:	18.0	25.0	1.7	1.6
	T:	9.0	11.0	1.7	2.1
'riority entry for HOVs	RS:	1/	1/	1/	3.1
	T:	1/	1/	1/	3.1
ius signal priority system	RS:	1/	1/	1/	1/
	T:	9.0	10.5	6	5.7

1/ Does not apply.

2/ RS = rideshare modes, T = transit (express bus). Since each of these modes has a different initial speed, a similar percentage increase results in different absolute travel time savings.

ıources:

A Manual for Planning and Implementing Priority Techniques for High Occupancy Vehicles, prepared for USDOT by Public Technology, Inc., July, 1977.

Bus Use of Highways: State of the Art, NCHRP Report 143, prepared for the Transportation Research Board by Wilbur Smith and Associates, 1973.

Bus Use of Highways: Planning and Design Guidelines, NCHRP Report 155, prepared for the Transportation Research Board by Wilbur Smith and Associates, 1975.

from the modal summary tables, the Corridor Sketch Planning Program, or from observed data. The analyst may then use the elasticity tables, shown in Tables 15 through 18, to determine the new transit or carpool modal share. Tables 15 and 16 concern changes in transit running time and fare, while Tables 17 and 18 concern changes in high-occupancy automobile parking cost and running time.

Step 2.4: Calculation of Modal Usage and Final Screening

This is the final step in the demand analysis process. It consists of combining the various modal shares in a rational manner, in recognition of the cross-effects changes to one mode have on other modes. This step pulls together the mode choice estimates of the previous steps and provides another screen with which to judge the viability of the potential commuter options.

By this time, the analyst may have developed market shares for two ridesharing modes and up to four transit modes for each corridor. These percentages are obviously not all independent of each other and may, in extreme cases, total more than 100 percent.

To aid in rationalizing and balancing the modal shares within a corridor, a new method of classifying modes is introduced in Table 19, due to varying definitions of what constitutes a carpool and because of the need to distinguish auto person trips from vehicle trips. The carpool modal summary tables (Tables 4a, 4b, and 4c) reflect a carpool definition of autos with two or more persons. Depending upon the situation, the analyst may choose to use more restrictive definitions, such as three or more persons per auto or even four or more persons per auto. Vanpools are generally described as vehicles with seven or more persons. Table 19 identifies these ridesharing modes as sub-sets of a more basic "group" auto mode to facilitate rationalizing modal shares.

First, the transit share is calculated as the single largest value for the transit modes, if more than one is considered in a single corridor. The underlying assumption is that two or more competing transit modes in a corridor do not tap separate markets.

The same assumption does not apply for ridesharing modes as both modes may very well coexist in the same corridor. If carpool and vanpool/buspool are both considered, then the ridesharing mode share is the sum of these two percentages. The sum of these percentages is the same as the percentage of "Group" mode usage. The remaining share is "Drive Alone". Table 20 illustrates this calculation.

By setting the Group share equal to the Ridesharing share, the example in Table 20 assumes that carpools are defined as autos with two or more persons. If the analyst wishes to use a different definition, the mode shares

Table 15
NEW TRANSIT MODAL SHARE RESULTING FROM A DECREASE IN TRANSIT RUN TIME

	Decrease in Run Time			
	2 Minutes	5 Minutes	10 Minutes	15 Minutes
Modal Share	New Share	New Share	New Share	New Share
.01	0.011	0.012	0.014	0.016
.05	0.053	0.058	0.067	0.077
.10	0.106	0.115	0.132	0.150
.20	0.210	0.226	0.254	0.285
.30	0.313	0.334	0.369	0.406
.40	0.415	0.438	0.476	0.515
.50	0.515	0.539	0.577	0.614
.75	0.761	0.778	0.804	0.827
.90	0.905	0.913	0.925	0.935

Logit Coefficient = 0.031

Table 16
NEW TRANSIT MODAL SHARE RESULTING FROM A DECREASE IN USER COST

	Decrease in User Cost[1/]			
	5 Cents	10 Cents	15 Cents	25 Cents
Modal Share	New Share	New Share	New Share	New Share
.01	0.011	0.011	0.012	0.013
.05	0.052	0.055	0.058	0.063
.10	0.105	0.109	0.114	0.125
.20	0.208	0.216	0.225	0.243
.30	0.311	0.321	0.332	0.355
.40	0.412	0.424	0.436	0.461
.50	0.512	0.525	0.537	0.562
.75	0.759	0.768	0.777	0.794
.90	0.904	0.909	0.913	0.920

Logit Coefficient = 0.010
[1/] Values represent change in one-way fare

Table 17
NEW RIDESHARING MODAL SHARE RESULTING FROM A DECREASE IN TRIP TIME

	Decrease in Trip Time			
	2 Minutes	5 Minutes	10 Minutes	15 Minutes
Modal Share	New Share	New Share	New Share	New Share
.01	0.011	0.012	0.014	0.016
.05	0.053	0.058	0.067	0.077
.10	0.106	0.115	0.132	0.150
.20	0.210	0.226	0.254	0.285
.30	0.313	0.334	0.369	0.406
.40	0.415	0.438	0.476	0.515
.50	0.515	0.539	0.577	0.614
.75	0.761	0.778	0.804	0.827
.90	0.905	0.913	0.925	0.935

Logit Coefficient = 0.031

Table 18
NEW RIDESHARING MODAL SHARE RESULTING FROM A DECREASE IN RIDESHARING PARKING COST

	Decrease in Ridesharing Parking Costs[1/]			
	25 Cents	50 Cents	100 Cents	200 Cents
Modal Share	New Share	New Share	New Share	New Share
.01	0.011	0.012	0.015	0.022
.05	0.055	0.060	0.073	0.105
.10	0.109	0.119	0.142	0.198
.20	0.216	0.234	0.272	0.357
.30	0.321	0.344	0.390	0.488
.40	0.424	0.449	0.499	0.597
.50	0.525	0.550	0.599	0.690
.75	0.768	0.786	0.817	0.870
.90	0.909	0.917	0.931	0.952

Logit Coefficient = 0.010

[1/] One-half the daily parking cost

Table 19
REVISED COMMUTER MODE CLASSIFICATION

I. Transit
   1. Express Bus in Mixed Traffic
   2. HOV Facility/Light Rail
   3. Rapid Rail
   4. Commuter Rail

II. Auto
   1. Drive Alone (one person per auto)
   2. "Group" Auto Mode
      a. Carpool
         i. Two Persons per Auto
         ii. Three Persons per Auto
         iii. Four Through Six Persons per Auto
      b. Vanpool/Buspool (seven or more persons per vehicle)

Table 20
SAMPLE RATIONALIZATION OF ALL MODE SHARES

	proportion of person trips
Transit share	0.14
Carpool share	0.39
Vanpool/Buspool share	0.07
subtotal[1/]	0.46

Total Transit and Ridesharing share = 0.14 + 0.46 = 0.60

Therefore, Drive Alone share = 1.00 - 0.60 = 0.40

Notes

1/ Assumed to be equal to the "Group" auto mode.

will be different. Research indicates that a typical split between two persons per auto, three per auto, and four through six per auto modes is 69.9, 18.4 and 11.7 percent, respectively (i.e., as a percentage of total person trips in the carpool sub-mode)[1/]. Therefore, if the definition of a carpool is three or more persons, the initial carpool estimates would be factored by .301 (.184 plus .117). As noted earlier, the modal summary tables assume that a carpool is two through six persons.

Another necessary adjustment is the effect shifts to or from one mode have on other modes. At the level of detail of this methodology, the effects of alternative travel choices cannot be estimated precisely, but a reasonable approximation can be made. If there are three modes A, B, and C, whose initial shares are known, and the share of mode A increases for any reason, the shares of the other two modes decrease in the same proportions they originally held. This is illustrated in Table 21, continuing the example in Table 20.

Once the mode shares are adjusted and normalized, they are applied to the total market of work person trips developed previously. The shares must match their respective market definitions. For example, the modal summary tables often allow calculation of mode shares for trips oriented to either a central area, suburban area, or both. In order to use this level of detail, person trips for each of these destinations must be estimated. When the analyst is confident that the mode share and person trip market are sufficiently consistent, they can be multiplied to yield person trips by mode.

If the market is specified in terms of employees, a factor of 1.7 can be used to convert to one-way work person trips[2/]. This can then be converted to peak hour, peak direction person trips using a factor of 0.18. The result is peak hour, peak direction person trips by mode, a major product of this step.

The analyst may need to answer one more basic question at this point: Does the estimated demand, including any supplemental actions which may have been applied, justify further consideration of various modes? This is the same question posed earlier in the initial Part I screening. A second screen, shown in Table 22, provides a more detailed method and acts as an additional test of each mode's feasibility. The person trip estimates calculated above may be converted to vehicle trips using the following vehicle occupancy factors: Transit (Bus = 40, Rapid Rail = 70 per car, Light Rail = 60 per car, Commuter Rail = 120 per car), Drive Alone = 1, Carpool = 2.5, Vanpool = 12, and Buspool = 40. This yields the number of vehicles--transit, pool vehicles, and single person autos--in the peak hour and peak direction. The resulting values may be compared with the warrants shown in Table 22 to determine if continued analysis of a mode is justified on the basis of usage.

1/ 1977 Nationwide Personal Transportation Study.

2/ An example of a one-way work person trip is a trip from home to work. Every commuter makes two work person trips on days that (s)he works. The 1.7 figure accounts for absenteeism.

Table 21
EFFECTS OF SHIFTS IN MODAL SHARE

Given the following mode shares:

Transit	0.14
Carpool	0.39
Vanpool/Buspool	0.07
Drive Alone	0.40

Say that transit service improves so that the Transit mode share changes to 0.20 (20%). The other modes can be estimated to change as follows:

Transit	0.200
Carpool	0.363 = .80 * .39/.86
Vanpool/Buspool	0.066 = .80 * .07/.86
Drive Alone	0.372 = .80 * .40/.86

Table 22
MODAL USAGE WARRANTS

Mode	Minimum Vehicular Trips 1/	Minimum Person Trips 1/
Express Bus in Mixed Traffic	10	400
HOV Facility	60	2,400
Light Rail	80 2/	4,800
Rapid Rail	120 2/	8,400
Commuter Rail	18 2/	2,160
Carpool 3/	200	500
Vanpool/Buspool 3/	10	120

Note:

1/ Peak hour peak direction. By corridor for transit modes. Areawide, exclusive of central area, for ridesharing modes.

2/ Minimum number of rail cars.

3/ Warrants for these ridesharing modes relate to justification of some organized assistance effort.

Adapted from: "Optimizing Bus Use of Highways," Levinson H.S. and W.F. Hoey; ASCE Proceedings Paper 10558; May, 1974
Urban Rail in America, Zupan, J. and B. Pushkarev; November, 1980
Traveler Response to Transportation System Changes, Second Edition, Pratt, R.H. and J.N. Copple; July, 1981.

Table 23 illustrates a complete example of these calculations. The end result is additional justification for continued consideration and feasibility of the various modes as well as an indication of the expected usage.

The modal options surviving this screening are carried forward to Part 3 of the methodology, where costs and other impacts of each option are calculated and arrayed.

Table 23
EXAMPLE OF FINAL MODAL OPTION SCREENING

From Table 20 assume the following values:

Mode	Mode Share
Transit	0.14
Carpool	0.39
Vanpool/Buspool	0.07
Drive Alone	0.40
	1.00

Employees living in the corridor and working in the central area = 12,000

Daily work trips = 12,000 * 1.7 = 20,400

Mode	Person Trips	Vehicle Trips	Meets Warrant?
Transit	2,860	1/	1/
Carpool	7,960	3,460	yes
Vanpool/Buspool	1,430	95	yes
Drive Alone	8,150	8,150	--

Notes:

1/ Assume that only one major transit mode will be considered, and that transit person trips = 2,860

Transit Sub-Mode	Vehicle Trips	Meets Warrant?
Express Bus in Mixed Traffic	72	yes
Express Bus on HOV Facility	72	yes
Light Rail	48	no
Rapid Rail	41	no
Commuter Rail	24	yes

PART 3: IMPACT ANALYSIS

This part of the methodology estimates the impacts associated with the modal options and related TSM actions that survive the screening at the end of Part 2. The objective of the impact analysis is to estimate and array the major implications of these actions so that officials can make informed decisions regarding implementation.

The principal steps in Part 3 are illustrated in Figure 5 and listed below:

1. Convert peak hour estimates of modal usage from Part 2 into a data set that is useful in impact analysis.

2. Estimate capital and operating costs for modal options and supportive TSM actions.

3. Estimate other direct and indirect impacts and array the results.

4. Assess impacts in terms of future conditions under alternative scenarios.

Step 3.1: Estimate Daily and Annual Modal Usage

The peak-hour modal share estimates produced in Part 2 must be expanded to daily and annual ridership or patronage estimates. Peak hour to daily relationships can be drawn from data/records of the regional transportation study for the local commuting study area or from the factors described in the previous section. Expansion to annual data should assume an average of 250 commuting days per year.

Trip length frequency distributions drawn from actual knowledge of employee travel characteristics or from the default values in Table 3 may be used to estimate vehicle-miles of travel (VMT). If the Corridor Sketch Planning Program has been used in Step 2.3 to test certain transit and HOV options, output from that program can be used to produce related estimates of VMT by mode.

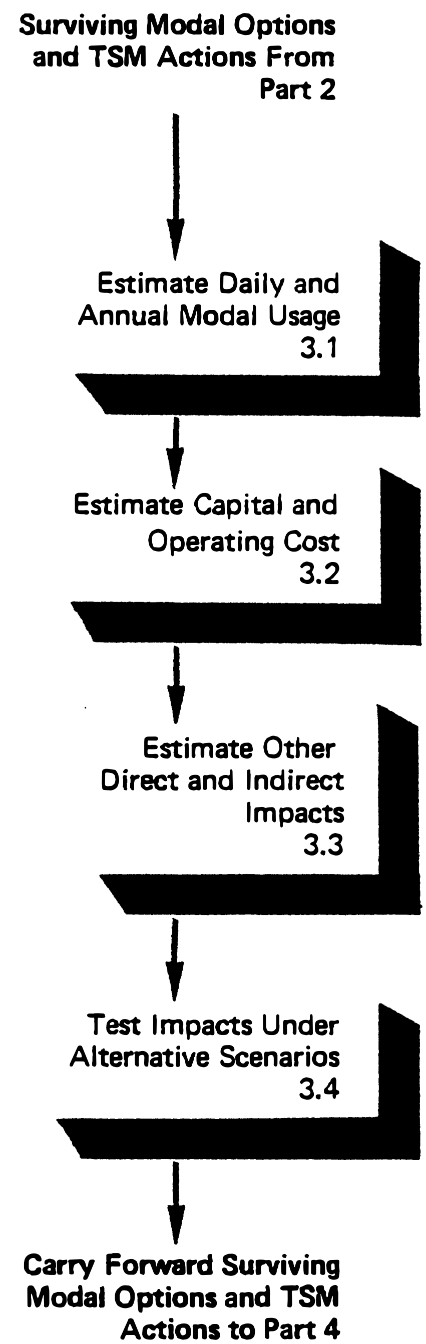


Figure 5
MAJOR STEPS IN PART THREE

Virginia Commuting Study

For transit modal options (rail and bus), estimates of central area passenger volumes (on an annual basis) from previous studies or from ongoing regional transportation planning efforts are used to supplement corridor estimates from the Corridor Corridor Sketch Planning Program. This is needed to ensure a total patronage estimate against which cost per passenger can be calculated. Moreover, in Step 3.3 it will be useful to be able to calculate cost per passenger for longer-distance commuters separately so that the marginal cost of extending corridor transit to serve these potential users can be derived.

This step also includes the estimation of vehicle-miles of service for the transit modal options. It will be necessary for the analyst to define general service limits and route characteristics, although much of this will already have been done in Part 2 as various modal options and supportive TSM actions were initially defined. Step 3.2 discusses the types of information needed to estimate capital and operating costs for modal options.

The products of Step 3.1 are estimates of peak hour, daily, and annual patronage or usage for the modal options and VMT for all options (and related TSM actions).

Step 3.2: Estimate Capital and Operating Costs

While much effort is typically devoted in transportation analyses to the estimation of travel demand and modal shares, the development of capital and operating cost components may be more important in being able to identify feasible alternatives. This methodology includes a procedure for estimating such costs, including the development of annualized costs to facilitate comparison of capital and non-capital intensive options.

Operating Costs. For most transit systems, operating costs will be greater than system capital costs when these costs are calculated on an annual basis or when the total costs are estimated over 15 to 25 years. It is therefore important that sufficient detail be used in estimating annual operating costs to allow a fair comparison of modal options.

For a full feasibility study, operating costs are normally estimated by performing a detailed analysis of the transit operations to ascertain the required transit resources, such as vehicle-miles, vehicle-hours, vehicles required, and personnel required. The suggested approach in this methodology is to use operating cost equations which relate annual operating cost to basic transit resources, such as vehicle-miles of service provided. These types of cost models are normally called "allocation models", and Table 24 defines equations for estimating annual operating costs for major transit modes. Two equations for estimating bus costs are given--one for use in large urban areas (such as northern Virginia) and the other for use in smaller areas. The latter reflects 1979 bus operating cost experience for Virginia transit operators (excluding WMATA). The rapid rail and light rail operating costs were

Table 24
COST EQUATIONS FOR THREE MAJOR TRANSIT TECHNOLOGIES

BUS OPERATING COST EQUATION (Large Metropolitan Area)[1/]

ANNUAL OPERATING COST = $12.973 * Annual Bus Hours + $0.45 * Annual Vehicle Miles
+ $21,691 * Buses Required in Peak Hour + $0.018 * Annual Number of Passengers
+ $7,700 * Guideway Miles (two way) + $8,800 * Normal Stations (no attendant)
+ $180,000 * Terminal Stations + $100 * Parking Spaces

BUS OPERATING COST EQUATION (Medium and Small Metropolitan Areas)[2/]

ANNUAL OPERATING COST = $8.955 * Annual Bus Hours + $0.382 * Annual Vehicle Miles
+ $9,626 * Buses Required in Peak Hour + $7,700 * Guideway Miles (two way)
+ $8,800 * Normal Stations (no attendant) + $180,000 * Terminal Stations
+ $100 * Parking Spaces

CONVENTIONAL TRANSIT RAIL OPERATING COST EQUATION[3/]

ANNUAL OPERATING COST = $28.90 * Annual Train Hours + $0.83 * Annual Car Miles
+ $11,000 * Cars Required in Peak Hour + $380,000 * Stations
+ $180,000 * One Way Track Miles + $100 * Parking Spaces

LIGHT RAIL OPERATING COST EQUATION[3/]

ANNUAL OPERATING COST = $28,90 * Annual Train Hours + $0.90 * Annual Car Miles
+ $340,000 * Stations + $180,000 * One Way Track Miles + $100 * Parking Spaces

COMMUTER RAIL OPERATING COST EQUATIONS[4/] [5/]

ANNUAL OPERATING COST = $110 * Annual Train Hours + $0.55 * Annual Car Miles
+ $5,000 * Cars in the Fleet + $1,000 * Stations + $4,000 * One Way Track Miles

1/ Source: Houston (Texas) Transit Alternatives Analysis Study, 1981.

2/ Source: Modification of Houston equation using Virginia Statewide transit costs (excluding WMATA) for 1979.

3/ Source: Houston Alternatives Analysis, 1981

4/ Source: Guadalupe Corridor Study, Santa Clara, California, 1981.

5/ Add 15% of estimated operating cost to refl[illegible]ase payment to host railroad.

developed using information from the Houston Alternatives Analysis study.[1/] The commuter rail operating cost was adopted from the recent Guadalupe Corridor (Santa Clara, California) Alternatives Analysis Study.

It should be noted that a substantial portion of the operating cost for a rail system is composed of maintenance and continuing costs associated with the right-of-way (ROW) and the stations. The allocation of rail costs by individual cost components is shown in Table 25.

The rapid rail operating cost model and associated unit cost assumptions in Tables 24 and 25 reflect predominately at-grade/above-grade operation. This assumption results in lower track and station maintenance costs than WMATA's Metrorail, which includes substantial below-grade operation. The assumption of predominate at-grade/above-grade operation is consistent with the expectation that future rail transit facilities are likely to be considered only as extensions to Metrorail in Northern Virginia and possibly in the more distant future, in Tidewater and Richmond. Additionally, the light rail and rapid rail cost models assume labor rates that are generally lower than those of WMATA, and more comparable with labor rates in Tidewater and Richmond. (Note: The specific assumptions in the example come from the Houston, Texas alternatives analysis). WMATA costs should be used in analyzing rail transit options in Northern Virginia.

For high-capital transit modes (primarily the rail alternatives), a major part of estimating operating costs relates to the guideway component. This estimation can be performed at a fairly detailed level, once the level of transit demand is estimated. A hypothetical example of this costing technique is shown in Table 26. This example shows the specific steps taken to estimate transit system requirements and costs using the equations from Table 24. Since the example was designed to illustrate the mathematical steps required, the assumptions used were designed to simplify the calculations, and secondarily, to be representative of a typical urban corridor. The same basic methodology can be applied in estimating operating costs for specific route alternatives which do not involve the use of an exclusive guideway.

The example shown in Table 26 deals only with the operating cost of the guideway portion of a transit facility. There is obviously a considerable operating cost associated with the feeder bus system and with the local bus system not associated with any specific guideway. The operating costs for these in-traffic flow bus routes can be estimated by determining the transit resources on a route by route basis. This technique, of course, would mean that a fairly detailed transit route map would have to be developed for the corridor. A simpler method of estimating transit resources for feeder routes is to use a sketch planning technique, which estimates the average walking

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1/ The guideway portions of the bus operating cost equations were also developed from the Houston study.

Table 25
RAIL COST ALLOCATION BY COST COMPONENT

COST COMPONENT	BASIS OF ALLOCATION	COST PER UNIT OF ALLOCATION FOR: CONVENTIONAL RAIL	LIGHT RAIL
Vehicle Operating Labor	Train Hours	$28.90/Hour	$28.90/Hour
Station Operating Labor	Stations	$110,000/Station	$90,000/Station
ROW and Systems Maintenance Labor	One Way Track Miles	$160,000/Track Mile	$160,000/Track Mile
ROW and Systems Maintenance Labor	Stations	$65,000/Station	$60,000/Station
Vehicle Maintenance Materials and Supplies	Car Miles	0.150/Car Mile	$0.06/Car Mile
R.O.W. and Systems Maintenance Materials and Supplies	One Way Track Miles	$20,000/Track Mile	$20,000/Track Mile
Station Maintenance Materials and Supplies	Stations	$45,000/Station	$40,000/Station
Parking Lot Maintenance, Labor and Supplies	Parking Spaces	$100.00/Space	$100.00/Space
Propulsion	Car Miles	$0.33/Car Mile	$0.285/Car Mile
Station Energy	Stations	$40,000/Station	$35,000/Station
Claims	Car Miles	$0.065/Car Mile	$0.065/Car Mile
Revenue Collection Labor	Stations	$85,000/Station	$80,000/Station
Security Labor	Stations	$35,000/Station	$35,000/Station
Vehicle Maintenance Labor	Car Miles	$0.285/Car Mile	$0.49/Car Mile
	Cars Required in Peak Hours	$11,000/Car	---

Table 26
SAMPLE ESTIMATION OF OPERATING COSTS FOR A GUIDEWAY

Estimated Data and Assumptions

Peak Hour, peak direction volume at maximum load point = 12,000 trips

Daily transit trips = 90.000

Annualization factor for transit trips = 295

Annualization factor for transit miles and hours = 300

Number of hours in peak service = 5 hours

Number of hours in off-peak service = 18 hours

Average peak transit service to off-peak transit service ratio = 2.5
transit service is defined as number of transit vehicle miles/hour)+

Average number of passengers per peak hour vehicle at maximum load point:+

- Conventional rail = 160 passengers per car
- Light rail = 135 passengers per car
- Express Bus = 55 passengers per bus

Maximum number of cars per train+

- Conventional rail = 5
- Light rail = 3

Guideway data (same for all alternatives)

- Length (one-way) = 9.5 miles
- Round trip running time (including layovers) = 30 minutes
- Route trip average speed = 38 mph
- Number of stations = 10
  - Busway has 1 station designed as a terminal station
- No parking spaces estimated

Conventional Rail Calculations

Calculate headways and consists

- Peak hour vehicles through maximum load point = 12,000/160 = 75
- Peak hour trains through maximum load point = 75/5 = 15
- Peak hour headway = 4.0 minutes
- Off-peak cars/hour through maximum load point = 75/2.5 = 30

- Off-peak trains per hour:
  - 6 trains with a 5 car consist, or
  - 10 trains with a 3 car consist, or
  - 15 trains with a 2 car consist
  - Use 10 trains per hour with a 3 car consist for a six minute headway+

Calculate vehicles required (no spares)

- Peak hour trains required = round trip time/headway = 30/4 = 7.5; round up to 8
- Peak hour cars required = 8 * 5 = 40
- Off-peak hour trains required = 30/6 = 5.0
- Off-peak hour cars required - 5 * 3 = 15

Calculate train hours and car miles

- Daily train hours = hours * required trains = 5 * 8 + 13 * 5 = 105
- Daily car miles = MPH * cars required * hours = 38 * 40 * 5 + 38 + 15 * 13 = 15,000
- Annual train hours = 105 * 300 = 31,500
- Annual car miles = 15,010 * 300 = 4,503,000

Calculate annual operating cost for conventional rail:

Annual cost = 28.90 * 31,500 + 0.83 * 4,503,000 + 11,000 * 40 + 380,000 * 10 + 180,000 * 9.5 * 2
= $12,307,840

Table 26 (Continued)

Light Rail Calculations

Calculate headways and consists

- Peak hour vehicles through maximum load point = 12,000/135 = 88.9
- Peak hour trains through maximum load point = 88.9/3 = 29.6; round to 30
- Peak hour headway = 2 minutes
- Off-peak cars per hour through maximum load point = 88.9/2.5 = 35.6
- Off-peak trains per hour
  - 12 trains with 3 car consist, or
  - 18 trains with 2 car consist, or
  - 36 trains with 1 car consist
  - Use 12 trains per hour with a 3 car consist for a 5 min. headway+

Calculate vehicles required (no spares)

- Peak hour trains required = 30/2 = 15
- Peak hour cars required = 15 * 3 = 45
- Off-peak trains required = 30/5 = 6
- Off-peak cars required = 6.0 * 3 = 18

Calculate train hours and car miles

- Daily train hours = 5 * 15 + 13 * 6 = 153
- Daily Car Miles = 38 * 45 * 5 + 38 * 18 * 13 = 17,442
- Annual train hours = 153 * 300 = 45,900
- Annual car miles = 17,442 * 300 = 5,232,600

Calculate annual operating cost for light rail

- Annual Cost = 28.90 * 45,900 + 0.90 * 5,232,600 + 340,000 * 10 + 180,000 * 9.5 * 2 = $12,855,850

Busway Calculations

Calculate headways

- Peak hour buses through maximum load points = 12,000/55 = 218.2 = 219
- Peak hour headway = 60/219 = 0.274
- Off peak hours bases through maximum load point = 218.1/2.5 = 87.3 = 88

Calculate vehicles required (no spares)

- Peak hour buses required = 30/0.274 = 109.5 = 110
- Off-peak hour buses required = 30/.682 = 44

Calculate bus hours and miles

- Daily bus hours = 5 * 110 + 13 * 44 = 1122
- Daily bus miles = 38 * 44 * 13 = 42,636
- Annual bus hours = 1122 * 300 = 336,600
- Annual bus miles = 42,636 * 300 = 12,790,800

Calculate Annual Operating Cost for Busway

- Annual Cost = 12.973 * 336,600 + 0.45 * 12,790,800 + 21,691 * 110
  +0.018 * (90,000 * 295) + 7,700 * 9.5 + 8,800 * 9 + 180,000 * 1
  = $13,318,832

+Values based upon regional policy and experience

Summary

Technology	Annual Cost	Cost Per Vehicle Mile	Cost Per Vehicle Hour	Cost Per Vehicle	Passengers Per Vehicle Mile
Conventional Rail	$12,307,840	$2.73	$103.86	$307,696	5.896
Light Rail	12,855,850	$2.46	93.36	285,685	5.074
Busway	13,318,832	$1.04	39.57	121,080	2.076

time to the bus system and the average time spent waiting[1/] for the bus, for small analysis areas (such as traffic zones or districts). These values can then be used to estimate bus miles per hour by using the following equation:

$$BM = 150/(Wait * Walk)$$

Where:

BM is bus miles per hour (one-way)
Wait is the average waiting time (minutes)
Walk is the average walking time (minutes)

Total bus miles in the peak hour are then estimated by multiplying the one-way bus miles by two. Daily bus miles are estimated in the same manner as daily guideway vehicle miles. Bus hours are estimated by using an average speed for the local buses, including layovers; a possible default value is 13.6 miles per hour. The peak period buses required can be estimated as being equal to the peak hour bus hours. This type of estimating technique should be performed for feeder service supporting guideway transit options. An example of using this operating cost model is shown in Table 27, which defines one feeder bus scenario for the guideway transit options described in Table 26. As with the guideway cost estimating example, some of the assumptions used in the feeder bus example were chosen to minimize the calculations. This method of estimating bus miles is the same methodology as is used in the UTPS sketch planning program RIDE.

In summary, to estimate transit operating costs, it is necessary to estimate the basic transit system requirements. This estimation can be performed quickly, in sufficient detail, for guideway systems and for modifications to local bus systems. However, the analyst should make every attempt to estimate realistic system requirements. A most appropriate methodology is to relate these requirements to the estimated patronage; especially the maximum load point patronage for guideways. Summary statistics should always be prepared as a check on the reasonableness of the estimates. Possible "check" statistics are: cost per vehicle mile, cost per vehicle hour, cost per peak hour vehicle, and passengers per vehicle mile.

Capital Costs. While operating cost will be a recurring cost element for modal options, the capital costs are normally concentrated in a short time span; usually between 5 and 10 years. This concentration can impose some constraints upon development of the mode, especially if financial techniques for "stretching" the payments, such as bonds, are not available.

A set of capital cost estimates for each major cost component of principal transit modes is shown in Table 28. These costs have been derived by reviewing the cost estimates of other transit systems, especially the recent cost estimates for the Houston Alternatives Analysis study, and representative capital costs in 1980 dollars for a "normal" set of construction specifications.

1/ Usually calculated as half the headway of the bus route.

Table 27

SAMPLE ESTIMATION OF OPERATING COSTS FOR A FEEDER BUS SYSTEM

Estimated Data and Assumptions

Estimate cost of providing feeder bus service to guideways specified in Table 26

Average walk time = 5 minutes

Average wait time = 3 minutes

Note: average person in corridor must walk approximately 1,320 feet to a feeder bus stop and the average bus route has a six minute headway

Last two miles of corridor (i.e., from the CBD) does not require feeder bus service

Average feeder bus "water-shed" is two miles on either side of guideway.

Total area served by feeder bus is therefore:

4 miles wide (2 miles from guideway)

9.5 miles long (guideway length less inner 2 miles plus 2 miles from end of guideway)

Feeder-bus area is 38 square miles

Average bus speed is 10.5 miles per hour, including layovers

Calculate Bus Miles

Peak Hour One Way Bus Miles = (150/5*3) * 38 = 380

Two Way Peak Hour Bus Miles = 760

Off-peak Hour Bus Miles = 760/2.5 = 304

Daily Bus Miles = 5 * 760 + 13 *304 = 7752
(use same peak to off-peak ratio and time periods as guideway)

Annual Bus Miles = 7,752 * 300 = 2,325,600

Calculate Bus Hours and Peak Hour Buses Required

Peak Hour Bus Hours = 760/10.5 = 72.38⁺

Off-peak Hour Bus Hours = 304/10.5 = 28.95

Daily Bus Hours = 72.38 * 5 + 28.95 * 13 + 738.25

Annual Bus Hours = 300 * 738.25 = 221,475

Peak Hour Buses Required = Peak Hour Bus Hours = 72.38

Calculate Annual Operating Cost for Feeder Buses

Annual Cost = 12.973 * 221,475 + 0.45 * 2,325,600 + 21,691 * 72.38 = $5,489,710

Note: Passengers were not included in equation since these costs were already included in the busway costs

⁺No rounding to whole numbers is performed because of the level of aggregation of the analysis.

Summary

Technology	Annual Cost	Cost Per Vehicle Mile	Cost Per Vehicle Hour	Cost Per Vehicle
Feeder Bus	$5,489,710	$2.36	$24.79	$75,846

Table 28

CAPITAL COST ESTIMATES BY COST COMPONENTS FOR PRINCIPAL TRANSIT MODES

Cost Components	Mode				
	Busway	Light Rail Transit	Conventional Rapid Transit	Commuter Rail Transit	Unit
Guideway Costs:					
Surface	$ 5,500,000	$ 9,500,000	$ 11,000,000	$ 250,000	Per Mile of Guideway
Subway	57,500,000	56,000,000	62,000,000	--	
Elevated	15,000,000	23,500,000	24,500,000	--	
Station Costs:					
Surface	$ 1,500,000	$ 1,000,000	$ 3,000,000	$ 500,000	Per Station
Subway	--	10,500,000	13,000,000	--	
Elevated	3,000,000	2,000,000	5,000,000	--	
Right of Way Costs:					
Surface	3,500,000	$ 3,500,000	$ 3,500,000	1/	Per Mile of Guideway
Subway	500,000	500,000	500,000		
Elevated	3,500,000	3,500,000	3,500,000		
Cost of Support Facilities:					
Bus Garages	$ 20,000,000	--	--		One Garage/250 Buses
Rail Yards	--	$ 60,000,000	$ 60,000,000	1/	One Yard/200 Cars
Command and Control Facilites	--	20,000,000	20,000,000		Only One Required Per System
Cost of Vehicles	$ 120,000	$ 1,000,000	$ 1,200,000	$1,000,000	Per Vehicle

1/ Assumes commuter rail will use existing railroad tracks and facilities.

Obviously, special geographical characteristics cannot be considered in these estimates, nor can special construction techniques be included. Right-of-way cost is also subject to many special considerations, with the cost increasing in very dense areas and decreasing if some present public right-of-way can be used.

Commuter rail costs assume use of existing tracks and maintenance facilities. The guideway cost of $250,000 per track mile in Table 28 is a contingency for signal upgrading and possible track work, if needed. Compensation to the host railroad for use of tracks and facilities is reflected in the earlier operating cost estimate.

A hypothetical example of estimating capital costs is given in Table 29. This example uses the basic information shown in the previous two operating cost examples, Tables 26 and 27, and the calculations are fairly simple. The calculation of vehicle costs assumes that only one set of rail vehicle costs are required (rail vehicles have an effective life of between 20 and 40 years), while buses are assumed to have a life of 400,000 vehicle miles. This standard was chosen, instead of the normal twelve-year life span, because the example relates to high-speed operations on busways.

Annualized Costs. A direct comparison of operating cost and capital cost is difficult, since these costs occur in different time periods. One method of making this type of comparison is to "annualize" the capital cost. This technique is simply to "spread" the capital cost over the estimated life of the project, using an assumed interest rate for the capital costs. In most cases for Federally-financed transit projects, an interest rate of ten percent and a life span of 36 years is used. The mathematical technique to calculate the annual capital cost is to determine a capital recovery factor as shown below:

$$CRF = i\,(1+i)^n/(1+i)^n - 1$$

Where:

CRF is the capital recovery factor
i is the interest rate, expressed as a fraction of 1.0
n is the life of the project in years.

This capital recovery factor is then multiplied by the total cost of the project to determine the annual capital cost. A selected number of capital recovery factors are shown in Table 30.

While the annualized capital cost, calculated using a capital recovery factor, cannot be considered as the actual flow of dollars associated with building a transit facility, it can be combined with annual operating cost for purposes of comparing alternatives. For example, Table 31 shows the annualized capital cost for the guideways previously described. Three different interest rates are shown in this table: a ten percent interest rate, which is essentially the Federal Government recommended rate; a seven percent interest rate, which is perhaps more "in-line" with most local governments' policies; and a four percent interest rate, which is probably the lowest rate which should be considered. The annualized capital cost can then be added to the annual operating cost to produce a total annual cost for the transit system, as shown

Table 29
SAMPLE ESTIMATION OF CAPITAL COST FOR A GUIDEWAY

Estimated Data and Assumptions

Estimate Capital cost for the guideways specified in Tables 26
All guideways have:
4 mile of elevated guideway
5.5. miles of surface guideway
4 stations with an elevated portion
6 stations on surface portion
Conventional Rail will require one yard:
40 cars plus 12 percent spares = 45 cars
Light rail will require one yard:
45 cars plus 12 percent spares = 51 cars
Busway may require one extra garage:
110 buses plus 12 percent spares = 124 buses

Conventional Rail Calculations

Guideway Costs = 4 * 24,500,000 + 5.5 * 11,000,000 =	$158,500,000
Station Costs = 4 * 5,000,000 + 6 * 3,000,000 =	38,000,000
ROW Costs = 4 * 3,500,000 + 5.5 + 3,500,000 =	33,250,000
Support Costs = 60,000,000 * 1 + 20,000,000 =	80,000,000
Total Costs =	$309,750,000
Vehicle Costs:	
45 cars at $1,200,000	54,000,000
Total Costs (including one set of vehicles)	$363,750,000

Light Rail Calculations

Guideway Costs = 4 * 23,500,000 + 5.5 * 9,500,000 =	$146,250,000
Station Costs = 4* 2,000,000 + 6 * 1,000,000 =	14,000,000
ROW Costs = 4 * 3,500,000 + 5.5 * 3,500,000 =	33,250,000
Support Costs = 60,000,000 + 20,000,000 =	80,000,000
Total Costs =	$273,500,000
Vehicle Costs	
51 cars at $1,000,000 each	51,000,000
Total Costs (including one set of vehicles)	$324,500,000

Busway Calculations

Guideway Costs = 4 * 15,000,000 + 5.5 * 5,500,000 =	90,250,000
Station Costs = 4 * 3,000,000 + 6 * 1,500,000 +	21,000,000
ROW Costs + 4 * 3,500,000 + 5.5 * 3,500,000 =	33,250,000
Support Costs = 20,000,000	20,000,000
Total Costs =	164,500,000
Vehicle Costs	
Annual Bus Miles * 15 years = 12,790,800 * 15 = 191,862,000	
Use 400,000 miles per bus = 191,862,000/400,000 = 480 buses	
480 buses at $120,000 each =	57,600,000
Total Cost (including vehicles for 15 years) =	$222,100,000

Summary

Technology	Capital Cost Per: Mile of Guideway	Capital Cost Per: Daily Passenger
Conventional Rail	$ 38,210,526	$4033
Light Rail	34,157,894	3605
Busway	23,378,947	2468

Table 30
SELECTED CAPITAL RECOVERY FACTORS

Number of Years for Life of Project	Interest Rate			
	4 Percent	7 Percent	10 Percent	12 Percent
	Capital Recovery Factor (CRF)			
10	.1233	.1424	.1627	.1770
12	.1066	.1259	.1468	.1614
15	.0899	.1098	.1315	.1468
20	.0736	.0944	.1175	.1339
25	.0640	.0858	.1102	.1275
30	.0578	.0806	.1061	.1241
35	.0536	.0772	.1037	.1223
36	.0529	.0767	.1033	.1221
40	.0505	.0750	.1023	.1213
50	.0466	.0725	.1009	.1204

Table 31
EXAMPLE OF ANNUALIZED CAPITAL COST CALCULATIONS

Cost Component	Total 1/ Cost	Life of Component	4 Percent CRF	4 Percent Cost	7 Percent CRF	7 Percent Cost	10 Percent CRF	10 Percent Cost
			Annual Cost with an Interest Rate of:					
ANNUALIZED COST FOR CONVENTIONAL RAIL RAPID TRANSIT								
Guideway	$158,500,000	35	.0536	$ 8,495,600	.0772	$12,236,200	.1037	$16,436,450
Station	38,000,000	35	.0536	2,036,800	.0772	2,933,600	.1037	3,940,600
ROW	33,250,000	50	.0466	1,549,450	.0725	2,410,625	.1009	3,354,925
Support	80,000,000	35	.0536	4,288,000	.0772	6,176,000	.1037	8,296,000
Vehicles	54,000,000	30	.0578	3,121,200	.0806	4,352,400	.1061	5,729,400
TOTAL	$363,750,000	--	--	$19,491,050	--	$28,108,825	--	$37,757,375
ANNUALIZED COST FOR LIGHT RAIL TRANSIT								
Guideway	$146,250,000	35	.0536	$ 7,839,000	.0772	$11,290,500	.1037	$15,166,125
Station	14,000,000	35	.0536	750,400	.0772	1,080,800	.1037	1,451,800
ROW	33,250,000	50	.0466	1,549,450	.0775	2,410,625	.1009	3,354,925
Support	80,000,000	35	.0536	4,288,000	.0772	6,176,000	.1037	8,296,000
Vehicles	51,000,000	30	.0578	2,947,800	.0806	4,110,600	.1061	5,411,100
TOTAL	$324,500,000	--	--	$17,374,650		$25,068,525		$33,679,950
ANNUAL CAPITAL COST FOR BUSWAY								
Guideway	$ 90,250,000	35	.0536	$ 4,837,400	.0772	$ 6,967,300	.1037	$ 9,358,925
Station	21,000,000	35	.0536	1,125,600	.0772	1,621,200	.1037	2,177,700
ROW	33,250,000	50	.0466	1,549,450	.0725	2,410,625	.1009	3,354,925
Support	20,000,000	35	.0536	1,072,000	.0772	1,544,000	.1037	2,074,000
Vehicles	57,600,000	15 2/	.0899	5,178,240	.1098	6,324,480	.1315	7,574,400
TOTAL	$222,100,000	--	--	$13,762,690	--	$18,867,605	--	$24,539,950

1/ See Table 29, for total capital cost calculation

2/ Life span used same as length of time used to calculate bus requirements, see Table 29.

in Table 32. Again, it should be noted that this annual cost is not the actual cost of the system, but an average figure and should be used only for comparative purposes.

TSM Project Costs. Typical costs for implementing TSM actions are difficult to ascertain, because local conditions can create significant cost variations between similar projects in different areas. Table 33 illustrates costs associated with specific projects (i.e., not average costs for several projects) whose documentation appeared to provide the most reasonable costs for certain types of improvements. They should be used with caution and checked, if possible, with local cost experience. Also, the costs in Table 33 do not include right-of-way costs or enforcement and publicity costs for HOV actions. HOV enforcement can usually be accomplished without expansion of the police work force, but may involve added expense, particularly associated with heavy enforcement during project initiation.

Ridesharing Program Costs. Ridesharing options present difficulties in estimating public implementation costs that are not encountered with conventional transit modes. Some ridesharing programs may require significant public capital expenditures (as in vanpooling programs where state or local governments purchase vans, then lease them to private operators). However, ridesharing typically involves the use of privately-obtained and/or operated vehicles, with the public role limited to encouraging or facilitating the shared use of these vehicles. This is done primarily by providing staff and funding for ridesharing promotion, coordination, and technical assistance. The estima tion of public costs for ridesharing implementation involves defining the level of staff and promotional assistance required to achieve a desired level of commuter response.

The national experience with ridesharing programs does not make possible a discrete linkage between the number of staff positions provided and the number of carpools, vanpools, or buspools that such staff help to generate. However, it is possible to relate at least minimum staffing and promotional efforts to the different functions that are embodied in various types of ridesharing programs. Tables 34 and 35 describe four different program levels in terms of program elements, staffing, computer costs, and promotion costs. These program levels make several assumptions that should be considered carefully in assessing local implementation:

1. The program is an adjunct to an existing organization, such as a Planning District Commission or a Transit Authority. Thus, the costs cited are incremental costs and do not include broad administrative and support services.

2. Computer time is purchased from private sources at commercial rates.

Because of the variety of institutional structures for accommodating the ridesharing encouragement function, the costs in Table 35 should not be used directly to evaluate the adequacy of existing ridesharing programs. Such programs may have been set up with varying cost sharing arrangements which could distort comparisons with the Table 35 costs.

Table 32
EXAMPLE OF COMPARING ANNUALIZED COSTS

Technology	Annual[1/] Operating Cost	Annualized[2/] Capital Cost	Total Annualized Cost	Annual Passengers	Cost Per Passenger
COSTS WITH 4 PERCENT INTEREST					
Conventional Rail	$12,307,840	$19,491,050	$31,798,890	26,730,000	$1.19
Light Rail	12,855,850	17,374,650	30,230,500	26,730,000	1.13
Busway	13,318,832	13,762,690	27,081,522	26,730,000	1.01
COSTS WITH 7 PERCENT INTEREST					
Conventional Rail	$12,307,840	$28,108,825	$40,416,665	26,730,000	$1.51
Light Rail	12,855,850	25,068,525	37,924,375	26,730,000	1.42
Busway	13,318,832	18,867,605	32,186,437	26,730,000	1.20
COSTS WITH 10 PERCENT INTEREST					
Conventional Rail	$12,307,840	$37,757,375	$50,065,215	26,730,000	$1.87
Light Rail	12,855,850	33,679,950	46,535,800	26,730,000	1.74
Busway	13,318,832	24,539,950	37,858,782	26,730,000	1.42

1/ See Table 26 for operating cost calculations

2/ See Table 31 for annualized capital cost calculations

Table 33
TSM CAPITAL AND OPERATING COSTS ($000)[1/]

	Capital Cost	Annual Operating Cost	Assumptions
Freeway HOV Lane			
o add-a-lane	$450/mi		at-grade, no structures
o contra-flow	$50/mi	$16/mi	using removable posts
o concurrent flow	$5/mi	$16/mi	using removable posts
Arterial HOV Lane			
o add-a-lane	$350/mi		
o contra-flow	$4/mi		signing and lane delineation
o concurrent-flow	$3/mi		signing and lane delineation
Reversible Traffic Lanes	$55/mi		overhead lane signals and signing
Ramp Metering	$18/ramp	$1/ramp	not linked to freeway surveillance
HOV By Pass and Ramp Metering	$36/ramp	$1.2/ramp	including ramp widening
Bus Signal Preemption	$0.5/bus plus $1.5/signal		
Parking Spaces			
o surface	$1.5/space	$0.1/space	fenced, lighted
o structure	$4.5/space	$0.1/space	

1/ Note: these costs are for planning estimates only. Land costs are reflected only in the cost for parking. Enforcement costs for HOV priority strategies are not included. All per mile costs assume one lane for HOV operation.

Table 34
FOUR TYPICAL RIDESHARING PROGRAMS

Level One:	Program emphasis is on information dissemination to employers and individual commuters. Program aspects include media and roadside advertisements encouraging ridesharing and urging employer involvement in ridesharing efforts. Information requests are handled by existing staff on a part-time basis, who send ridesharing kits describing the steps necessary to form ridesharing arrangements or employer ridesharing programs to interested persons and employers. No direct staff involvement or matching services are provided.
Level Two:	In addition to Level One activities, manual or computer matching is provided to those individuals and employers so requesting. Survey forms are provided to employers to ensure necessary data are collected. Level two activities may be handled by existing personnel or additional staff may be required, according to area size and program response.
Level Three:	Program emphasis shifts from response to incoming requests to active promotion of ridesharing, especially in regard to major employers. Full time professional staff contact individual employers and business groups to set up ridesharing presentations to both management and employee groups. All steps in ridesharing formation are monitored by program staff, working closely with major employers. Services include technical assistance in vanpool and buspool formation, including identifying costs and steps involved in leasing, organization, insurance. Program staff assist in licensing and other regulatory requirements.
Level Four:	In addition to Level Three activities, Level Four includes ridesharing incentives such as lease guarantees to minimize vanpool risk, close-in carpool/vanpool parking, establishment of park/ride lots and financial assistance such as free or reduced cost parking, subsidized vanpool operation, etc.

Table 35

TYPICAL COSTS AND STAFFING ASSOCIATED WITH RIDESHARING PROGRAMS

	Total Cost	Personnel	Promotion	Computer	Other	Full Time Staff	Part Time Staff
<u>LEVEL ONE</u>							
Small Urban Area	$ 10,000	$ 6,000	$ 2,000	$ 0	$ 2,000	0	1
Medium Urban Area	12,000	8,000	2,000	$ 0	2,000	0	1
Large Urban Area	15,000	10,000	3,000	$ 0	2,000	0	1
<u>LEVEL TWO</u>							
Small Urban Area	$ 25,000	$ 16,000	$ 4,000	$ 0	$ 5,000	1	0
Medium Urban Area	35,000	20,000	6,000	3,000	6,000	1	0
Large Urban Area	50,000	32,000	7,000	4,000	7,000	1	1
<u>LEVEL THREE</u>							
Small Urban Area	$ 50,000	$ 27,000	$ 8,000	$ 8,000	$ 7,000	1	1
Medium Urban Area	60,000	33,000	10,000	9,000	8,000	1	1
Large Urban Area	90,000	60,000	11,000	10,000	9,000	2	1
<u>LEVEL FOUR</u>							
Small Urban Area	$ 80,000	$ 50,000	$ 10,000	$ 10,000	$ 10,000	2	1
Medium Urban Area	100,000	65,000	13,000	12,000	10,000	3	0
Large Urban Area	150,000	95,000	20,000	20,000	15,000	3	2

Table 36 relates the four levels of ridesharing programs discussed above to the ridesharing assistance factors that are used to adjust the market share estimates from Tables 4 and 5. Depending upon the assumptions made in estimating a ridesharing modal share from these tables (and the adjustment factors used from the bottoms of the tables), a corresponding program level for costing purposes can be selected from Table 36. For example, if an estimate of vanpool usage has been made assuming normal market conditions and match/lease administration services (i.e., from Table 5c), a Level Three program (from Table 36) can be used in estimating public costs for ridesharing implementation.

Finally, the use of the program cost estimates must be tempered by a reasonable implementation strategy. Although an area may exhibit significant ridesharing potential as a result of analyses using Tables 4 and 5, state and local agencies may not wish to leap immediately into a Level 4 financial commitment, particularly if there has been no prior ridesharing program in the area. In such cases the four levels may be considered as implementation stages. One level might be implemented the first year with subsequent levels following in successive years.

Step 3.3: Estimate Other Direct and Indirect Impacts

The objective of this step is to incorporate the preliminary cost estimates from Step 3.2 with other impact considerations to produce an overall impact assessment of the modal options and related TSM actions from Part 2. For each modal option (or package of modal options and TSM actions) for a corridor, the following impact measures are estimated:

1. Annual modal usage or patronage. This is simply an indication of the number of trips served by each modal option. It provides one measure of the project's value (i.e., the sheer volume of trips served by the option).

2. Peak hour person trips served and percent share of total corridor travel market. This is another indication of the benefits accruing from an action, particularly the significance of its impact upon peak travel conditions (such as a busway project which could serve 25 percent of total peak period traffic in a corridor, as compared to buses in mixed traffic that might serve 15 percent).

3. Potential travel time savings. For applicable options, this measure is calculated for average work trips in the study corridor (for example, under a proposed modal option and/or TSM action, commuters with 10-mile work trips may have five minutes cut from their trip time). If the trip length frequency distribution for work trips in the corridor is known, total travel time savings for all corridor work trips can be estimated.

ıble 36

ELATION OF RIDESHARING PROGRAM COST LEVELS
) DEGREE OF ASSISTANCE PROVIDED

Degree of Ridesharing ssistance Provided	Ridesharing Market Share and Corresponding Program Level		
	CARPOOL -- all areas		
	Low	Normal	High
omotion/Information	Level 1	Level 1	Level 1
reawide Matching	Level 2	Level 2	Level 2
nployer Matching	Level 3	Level 3	Levels 3&4
	VANPOOL/BUSPOOL -- all areas		
	Low	Normal	High
omotion/Information	Level 1	Level 2	Level 2
atch/Lease Administration	Level 3	Level 3	Level 3
inancial Assistance	Level 4	Level 4	Level 4

4. Project costs and cost per trip. To permit comparison between capital intensive and non-capital intensive options, three cost estimates are calculated in Step 3.2: capital costs, operating/maintenance costs, and total annualized costs. For comparative purposes in this impact analyses, these costs are expressed in absolute totals and in cost per trip served. These costs also relate to what would be considered public capital and operating costs that must be borne by some governmental entity under the present transportation funding framework.

5. Reduction in vehicle-miles of travel (VMT). To the extent that transit and ridesharing modal options attract commuters from low occupancy autos, associated reductions in VMT can be achieved. Reduced VMT can be estimated by applying the weighted average trip length of divert ed commuting trips to the number of diverted trips (i.e., the modal shift).

6. Energy savings. Fuel savings resulting from modal shifts and reduced VMT are estimated, taking into consideration vehicle fuel efficiencies for the modes involved.

7. Air pollutant reduction. Reductions in VMT are translated into reduced pollutant emissions (i.e., kilograms of pollutants).

8. Change in work mode choice. Modal shifts that will occur in the corridor as a result of implementing a modal option are drawn from the Part 2 analysis. Of particular importance is the estimated modal shift from "drive alone" or low-occupancy auto to ridesharing and transit options.

9. User costs. This impact variable seeks to measure the change in costs to the commuter under the different modal options being considered (i.e., does the commuter's travel cost increase, decrease, or stay the same for comparable trips?). Only reasonably direct costs are considered, such as transit fares, auto operating costs parking costs, and ridesharing fee assessments. These costs will be calculated for average trips within the study corridor.

Step 3.4: Assess Impacts Under Alternative Scenarios

The Commuter Transportation Problems Issues and Policy/Program volume of the final report includes descriptions of three scenarios which represent potential future effects of external factors on commuter transportation in the state. The scenarios are structured around variations in three factors:

(1) vehicle fuel efficiency coupled with fuel cost and availability

(2) highway funding support

(3) transit funding support

The scenarios are designed to cover the spectrum of future conditions, ranging from a constrained transportation future, to an expected future, to an unconstrained future. The analyst should be familiar with the scenario descriptions before proceeding to the impact assessment.

The scenario impact assessment differs from the base case impact assessment previously described, in that the focus of the scenario assessment is on the tendency of future conditions to enhance or detract from the alternatives which appear most promising given base case conditions.

The method used to analyze the scenarios involves translating the three factors listed above into time and cost related changes for commuting via transit and auto modes, then calculating mode shifts based on the changes. The calculations are performed for representative trips, which permits not only the evaluation of scenario impacts on the use of different modes, but also the relative impacts on shorter versus longer commute trips. The mode shift calculations are determined through the use of a logit model. Appendix E describes the logit model formulation.

The final task in the assessment of scenario impacts is the determination of scenario effects on the modal options analyzed in steps 3.1 through 3.3. Although this task is largely subjective, general effects which should be considered are:

(1) Will the scenario tend to dampen any estimated shifts to transit or ridesharing, thereby lessening program impacts and driving up costs on a per user basis?

(2) Will the scenario enhance program impacts, so that cumulative benefits are greater than under the base condition?

(3) Will the scenario render any options ineffective, unnecessary or infeasible.

An example of the first case, where a scenario tends to lessen program impacts, would occur if improved vehicle fuel efficiencies were to combine with a decrease in fuel cost to cause a sharp drop in the cost of auto commuting. A ridesharing assistance program may flourish under existing conditions, but have a minor impact under this example.

Alternatively, a scenario involving no change in auto commuting characteristics, but a large increase in transit funding support, would tend to enhance any transit options under consideration, as fares stabilized or declined in constant dollars, service expanded and became more reliable, and capital equipment was maintained or replaced on schedule.

Under specific conditions, the scenarios may determine the future applicability of certain options. For example, an area planning to implement a ridesharing assistance program in order to meet environmental warrants may find the program unnecessary for that purpose given improved vehicle fleet pollutant control in the future. Similarly, a capital-intensive transit mode may be feasible under current Federal/state/local funding shares, but beyond the means of localities should their burden increase.

The fourth, and final, part of the methodology report addresses issues associated with implementation of alternatives which have passed successfully through the first three parts of the Virginia Commuter Study Methodology.

PART 4: IMPLEMENTATION ACTIONS

The final part of the Virginia Commuter Study Methodology considers the financial, institutional and political issues which must be addressed in order to translate the general modal options of the previous three parts into workable local transportation programs. The four steps in this process are:

1. Identify Political and Institutional Constraints To Implementation

2. Identify Possible Funding Sources

3. Identify Trade-offs and Barriers To Implementation

4. Define Recommended Actions and Implementation Steps

The relationship among these four steps is depicted in Figure 6.

Step 4.1: Identify Political and Institutional Constraints to Implementation

Although one or more of the modal options may be suitable for an urban area on technical grounds, the particular institutional and political environment in which actions are to be implemented must be considered in order to assess the viability of their application. Possible political and institutional constraints tend to be represented by one of two questions:

(1) Is there both public and political support for the type of action under consideration?

(2) Is there an institutional entity, or can one be created, that can assume local responsibility for the actions' implementation and operation?

Implicit in both these questions is whether they can be answered in the affirmative given necessary levels of local funding to implement the actions.

The first of these concerns--public and political support--indicates a perception on the part of the local government and population that there is a

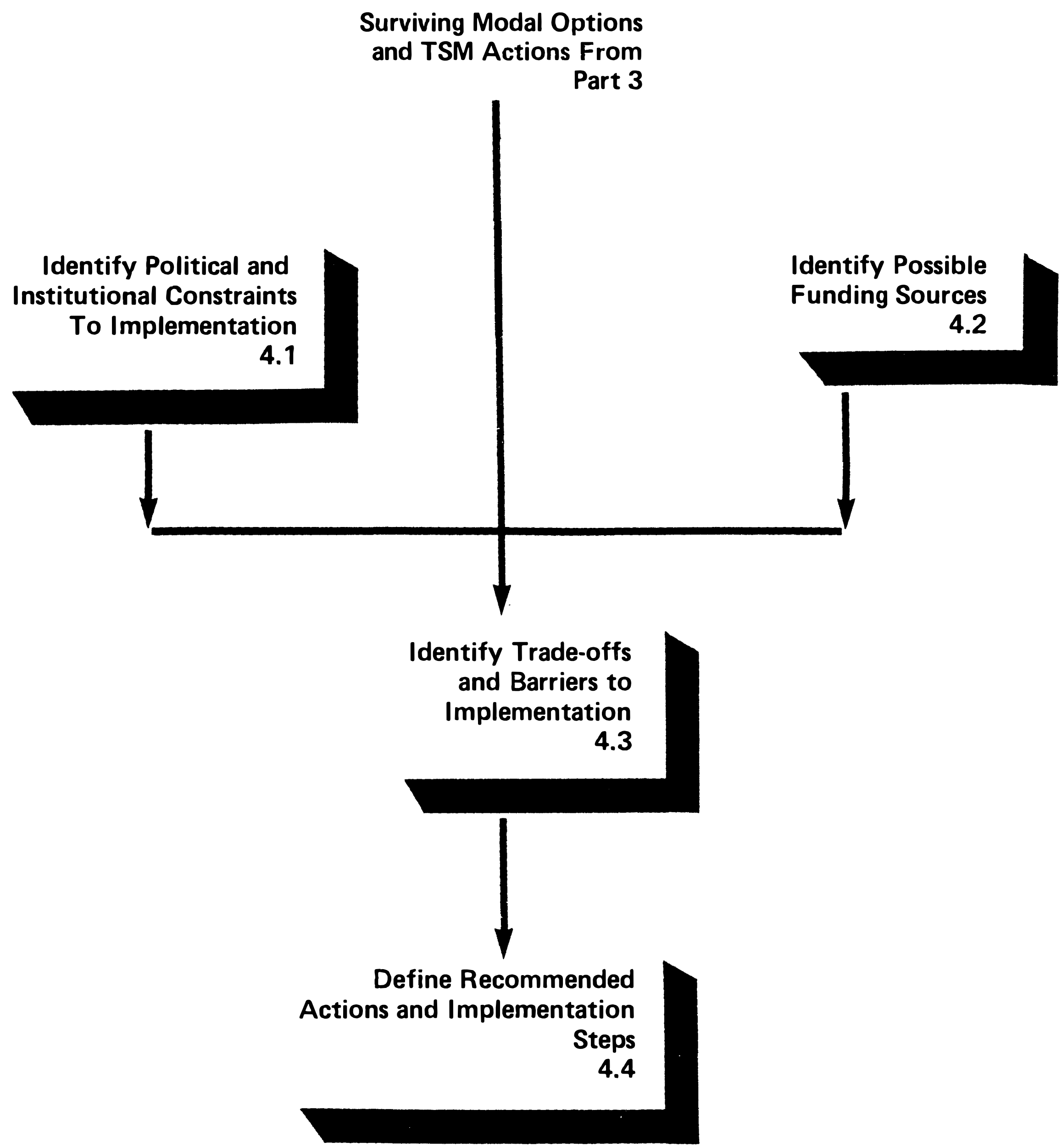

Figure 6
MAJOR STEPS IN PART FOUR

Virginia Commuting Study

transportation problem, that it is appropriate that government action help to solve it, and that particular transportation alternatives are reasonable responses. If there is adamant disagreement with any of these successive points, then it is unlikely that the candidate actions would, or should, be implemented.

For example, the application of the methodology may have indicated that expanded commuter (express) bus operation to exurban areas will provide the best alternative to auto travel for long-distance commuters in a particular city. If implementation of safe, reliable, expanded service requires capital assistance to private operators, but the affected local government has historically been opposed to public assistance to transit operators, then the degree to which this political constraint will determine the ultimate feasibility of the option must be weighed. Similarly, if an urban area contemplating an employer-based ridesharing program anticipates a lack of cooperation on the part of several major employers, this institutional constraint may limit the program's effectiveness and perhaps doom the effort entirely.

The second concern, that of an organization or organizations willing and able to assume responsibility for the proposed actions, is similar to the first in that it is an indication of local committment to solve transportation problems. Many local governments, particularly in times of budgetary uncertainties, are hesitant to expand existing agencies or create new ones to assume the responsibilities associated with new transportation programs, even if these programs are technically sound. The relative abilities of existing organizations which may be able to assume new transportation roles--Planning District Commissions, Transit Authorities, county governments, local governments, private operators, and non-profit agencies--and the potential for creating new organizations must be included in the analysis of program feasibility.

Step 4.2: Identify Possible Funding Sources

Funding for virtually all commuter transportation alternatives will involve a combination of Federal, state and/or local funds. Possible funding sources available at each of these government levels are discussed below.

There are a number of categories of federal assistance to local transportation agencies. The categories and their extent have changed frequently over the 18 years during which federal public transportation assistance has been available.

The current major categories, and the associated funding rates for federal assistance programs, are:

(1) For urbanized areas of over 50,000 population:
  a. Capital Assistance
     (Sections 3 and 5)
     80% of project cost
  b. Operating Assistance
     (Section 5)
     50% of net operating loss

(2) For areas under 50,000 population (and rural areas):
  a. Capital Assistance
     (Section 18)
     80% of project cost
  b. Operating Assistance
     (Section 18)
     50% of net operating loss
  c. Administrative Assistance
     (Section 18)
     80% of administrative costs

(3) Unrestricted by size of area
  a. Demonstration Grants
     (Section 6)
     varying percentages
  b. Planning Assistance
     (Section 8)
     varying percentages, usually 80%

Three broad categories of financial assistance are provided by the state of Virginia:

(1) Financial Assistance For Mass Transit
  -- 95% of the local share of capital cost (i.e.: if federal assistance is obtained at 80%, then 95% of the 20% local share, or 19% state assistance; if no federal assistance is involved, then 95% of cost)
  -- 50% of the local share of administrative costs

(2) Experimental Public Transportation Projects
  -- 95% of development, implementation and promotional costs
  -- 95% of operating costs (for 12 months)

(3) Public Transportation Promotion, Operations Studies and Ride-sharing Support
  -- 100% of VDH&T promotion program
  -- 80% of the local share of development, implementation and continuation of ridesharing programs
  -- 50% of the local share of operations planning and technical studies

The Experimental Public Transportation Projects program is the only one offering operating assistance.

Actual funding for each of the categories is specified for each of the major urbanized areas, and for the experimental and ridesharing support programs. Table 37 shows the amount for each category for the 1982-84 biennial budget.

Federal assistance is oriented primarily to urban-centered transit operations, but does affect long-distance commuter transportation within, or near, the boundaries of the urban area receiving the assistance (particularly in the larger areas such as northern Virginia, Richmond, Tidewater, Peninsula, and Roanoke). Section 18 funds may be used for rural commuter travel, but the limitation of 50% federal participation in operating assistance has caused financial problems for potential operators (i.e., finding the local 50%), and there is some confusion between the rural-to-rural or rural-to-small-urban intent of Section 18 and commuting, which may be rural-to-large-urban or small-urban to large-urban.

VDH&T (Public Transportation Division) and the Energy Division of the State Office of Emergency and Energy Services have cooperated in a program to administer incentives funds from the State, in combination with other federal and state funds, to promote ridesharing programs. While not aimed specifically at the long-distance commuter, they have obvious relevance. Table 38 shows FY81 funding by area with funding sources. Note that "Demo" (the State "incentives" program) and State Energy Conservation Plan funds appear in almost every project.

At the local level, a variety of funding mechanisms have been developed to finance transit and ridesharing programs. It is particularly important to consider existing local funding bases and public support or opposition to specific revenue sources. In most instances, it is administratively and politically easier and less costly to increase revenue from an existing source than to institute a new mechanism.

The Institute of Public Administration, under DOT contract, examined eleven possible categories of local funding sources by six criteria:

(1) Yield potential
(2) Administration problems
(3) Economic effects
(4) Equity
(5) Relation to benefits
(6) Political acceptability

Each of these criteria may differ in value for different areas. Table 39 lists the eleven most common local funding sources for public transportation programs and rates each source based on the above criteria for a typical situation. High ratings in Table 39 connote revenue sources with strong potential for use in supporting transit.

Table 37
'''RGINIA FINANCIAL ASSISTANCE FOR PUBLIC TRANSPORTATION FOR THE 1982-84 BIENNIAL

Budget Element	Year 1	Year 2	Total
TOTAL	31,907,835	32,617,855	64,525,690
WMATC	112,500	112,500	225,000
NVTC (northern Virginia)	20,634,400	21,106,000	41,740,000
Tidewater	2,914,790	3,023,790	5,938,580
Richmond	2,876,710	2,526,710	5,403,420
Peninsula	1,753,210	2,578,210	4,231,420
Roanoke	521,615	333,615	855,230
Lynchburg	357,790	357,790	715,580
Tri Cities	113,750	111,750	225,500
Bristol	30,650	29,650	60,300
harlottesville	259,300	389,300	638,600
Danville	255,900	180,900	436,800
All areas	1,567,620	1,367,620	2,935,240
Experimental Public Transportation Projects	420,000	350,000	770,000
Public Transportation Promotion, Operations Studies, & Ridesharing Support	200,000	150,000	350,000

Table 38
VIRGINIA RIDESHARING PROGRAM FUNDING FOR FY81

Program	Total Project Budget	Funding Source(s)
Alexandria	$ 15,000	SECP, local
Commuter Club	160,000 [1/]	HPR, SECP
Commuter Express	54,000	Demo
COMPOOL	111,512	Demo, SECP, PL
Easyride	96,028	UMTA Sec. 6
JAUNT	31,250	Demo
Loudoun County	38,000	Demo
New River Valley	48,855	Demo, SECP, local
Prince William County	65,637	Demo
RADCO	15,000	SECP, local
RideX	65,900	SECP, internal
Rooftop	20,809	SECP, STEP
TRT	50,000 (estimate)	UMTA Sec. 5, local
VANGO	10,000	
TOTAL	$ 781,991	

Funding Abbreviations -- Explanation/Administered by:

Demo -- State Aid to Experimental Mass Transit and Ridesharing Projects/VDH&T
HPR -- Highway Planning and Research/VDH&T
Internal -- Internally generated funds
Local -- Local government funds
PL -- Planning funds/VDH&T
SECP -- State Energy Conservation Plan/OEES
STEP -- Small Town Emphasis Program
UMTA sec. 5 -- Federal Operating Assistance/UMTA
UMTA Sec. 6 -- Services and Method Demonstration (Section 6)/UMTA

[1/] Include funding support from Maryland and the District of Columbia.

Table 39
RATING OF LOCAL REVENUE RESOURCES WHICH MIGHT BE USED FOR TRANSIT ASSISTANCE

Criterion (Weight in Parenthesis)	Benefit-Related Taxes and Charges: Real Estate Value Increments	Motor Fuel; Vehicles	Commercial Parking	All Parking	Tolls	Employer Payroll	Broad-Base Taxes: Property	Sales	General Income	Employee Payroll	Other Sources: Excise (Electricity)
Yield Potential . . .	1*	2*	1*	2*	1*	3*	3*	3*	3*	3*	1-2*
(4)	4	8	4	8	4	12	12	12	12	12	4-8
Administrative Problems	2*	2*	3*	1*	2*	3*	3*	2*	2*	2*	3*
(1)	2	2	3	1	2	3	3	2	2	2	2
Economic Effects . .	3*	3*	2*	2*	3*	1*	2*	2*	2*	2*	2*
(2)	6	6	4	4	6	2	4	4	4	4	4
Equity	3*	1-2*	1*	1*	2*	1*	2*	1-2*	3*	1*	
(3)	9	3-6	3	3	6	3	6	3-6	9	3	3-6
Relation to Benefits	3*	1-2*	1*	2*	2-3*	1-2*	1-2*	0*	0*	0*	0*
(3)	9	3-6	3	6	6-9	3-6	3-6	0	0	0	0
Political Acceptability . . .	0*	1*	2*	0*	1*	1*	3*	3*	1-2*	1-2*	1-2*
(4)	0	4	8	0	4	4	12	12	4-8	4-8	4-8
TOTAL	12*	7-8*	10*	8*	11*	9-11*	14-15*	11-12*	11-12*	9-10*	8-11*
	30	26-32	25	22	28-31	27-30	32-35	31-34	31-35	25-29	18-29

*Unweighted scores. Weighted scores are the unweighted scores multiplied by the weights listed under the criteria in the first column.

Source: Institute of Public Administration, Financing Transit: Alternatives for Local Government. U.S. DOT. 1979.

Step 4.3: Identify Trade-offs and Barriers to Implementation

This third step is an exercise in compromise between the technical evaluations of the first three parts of the methodology and the political, institutional and funding concerns examined in the previous two steps.

The financial strength of local funding sources, the abilities of existing or potential agencies and staff, the particular political climate in the study area, the transportation infrastructure, and the benefits associated with various levels of transportation options are balanced against one another to determine the combination of actions which will yield the best implementable package for the area. Although no rigorous formula exists which describes the process of examining trade-offs and barriers to implementation, the context in which this analysis is made focusses on the results of Parts 1, 2, and 3 of the methodology as they relate to the first two steps of Part 4. In summary, the question which guides this step is:

> What combination of benefits which accrue from specific commuter transportation options are worth the financial, institutional and political effort necessary to achieve these benefits?

The answer to this question determines the recommended actions and implementation phases of the next step.

Step 4.4: Define Recommended Actions and Implementation Steps

The final task in the application of the Virginia Commuter Methodology is to define the transportation actions which are most appropriate for the area under consideration, and staffing, cost, and institutional concerns associated with their implementation. The purpose of this step is not to provide detailed routing, scheduling or vehicle requirements as would be done in a full transportation development program, but instead to clarify the costs and effort necessary to achieve program benefits.

There are seven separate concerns which should be addressed in this step. They are:

(1) Recommended options or packages of options, and program elements

(2) Priority among the options

(3) Supportive TSM actions to accompany the options

(4) Implementation responsibility

(5) Costs and staffing

(6) Funding sources

(7) Monitoring of results

Each of these seven concerns is described in more detail in the following paragraphs.

Recommended options or packages of options, and program elements. Based on the technical and policy analyses conducted to this point, recommended transit and ridesharing programs and the program elements are described. Included are reasons for the options chosen and the specific level of program effort recommended.

Priority among the options. Options are prioritized for implementation based on cost, likely benefits, length of time to implement, and local institutional and political concerns associated with each option in comparison to others. The result is a blueprint for transportation development in the area under consideration.

Supportive TSM actions to accompany the options. The degree to which park/ride lots, priority entry or parking schemes, or other TSM actions will benefit the recommended options is identified and locations and levels of recommended supportive actions are described.

Implementation responsibility. Agencies and departments targeted to implement and operate the options are identified. Responsibilities recommended for each organization, and the reasons for choosing the organization, as opposed to others, are given.

Costs and staffing. Costs associated with each recommended option and approximate staffing level changes necessary to implement each option are summarized. Where appropriate, primarily in the case of non-capital-intensive options, types and locations of additional staff will be described.

Funding sources. For each option, recommended Federal, state and local funding sources, and the amount of funds available, are defined. Emphasis is placed on the feasibility of various local funding mechanisms.

Monitoring of results. The way in which each option should be monitored is described, as are the organizations responsible for monitoring programs and the types of data necessary to accurately determine results of implementing the transportation options.

APPENDIX A

1980 CENSUS DATA FOR TRANSPORTATION PLANNING

INTRODUCTION

The 1980 Census provides one of the most complete and thorough data bases available for transportation planning. Numerous questions asked in the Census relate generally to individual and household travel patterns. The 1970 Census, for example, provides data on descriptive characteristics such as household size and income, number of autos owned, place of work, and means of travel to work. The 1980 Census includes those questions and adds these: travel time to work, auto occupancy to work, and disability preventing use of public transportation. Also, the 1980 Census provides for more detailed geocoding and reporting of the place of work question. Figures 1-3 illustrate the relevant portions of the 1980 Census questionnaire.

This section is divided into two parts. The first part describes the basic types of Census data available for transportation planning. The second part discusses how this information can be used in the screening and analysis of alternatives.

AVAILABLE TRANSPORTATION DATA

The Census questionnaire is in two parts. Some items were asked of every household (so-called "100-Percent Items"), while others were asked of only every 1 in 6 households (or 3 of 6 in smaller areas) (so-called "Sample Items"). These two levels of subject matter detail must be kept in mind when specifying geographic detail. Due to budget limitations, however, the place of work question is being coded for only 50% of the sample households, or about 1 in 12. Still, this is a higher sampling rate (8.33%) than in many urban area origin-destination home interview surveys.

Census data will be available in two basic forms: reports (printed and microfiche) and summary tape files. Figure 4 is a copy of a Census Bureau announcement listing the products and their approximate date of availability. Since that brochure was published, the availability dates have in most cases been pushed back a few months from the dates shown. Also, decisions are still being made about publishing some reports in microfiche only (no printed copies), reducing subject matter detail in some reports, and not publishing certain reports altogether. The final page of Figure 4 illustrates the subject items included in the 100% survey and the sample survey.

For transportation planning purposes, the most useful printed data will probably come from Series PC(1)-D (Detailed Population Characteristics, also called PHC80-1-D and Series PC(2) (Population Subject Reports, also called PC80-2). As of February, 1982, these are both due to be released sometime in 1983. The former report will cover most of the sample subjects, shown for states and large SMSA's. The latter will provide more detail on individual subjects. The more useful of these will be reports on employment and income.

Summary Tape File 4, corresponding to the 1970 Fourth Count Tape, is the most useful machine readable product for transportation planners. This contains considerable subject matter detail down to the Census tract level.

Figure 1

Census Sample Household Questionnaire

13. Which best describes this building?
Include all apartments, flats, etc., even if vacant.

- A mobile home or trailer
- A one-family house detached from any other house
- A one-family house attached to one or more houses
- A building for 2 families
- A building for 3 or 4 families
- A building for 5 to 9 families
- A building for 10 to 19 families
- A building for 20 to 49 families
- A building for 50 or more families
- A boat, tent, van, etc.

14a. How many stories (floors) are in this building?
Count an attic or basement as a story if it has any finished rooms for living purposes.

- 1 to 3 — *Skip to H15*
- 4 to 6
- 7 to 12
- 13 or more stories

b. Is there a passenger elevator in this building?

- Yes
- No

15a. Is this building —

- On a city or suburban lot, or on a place of less than 1 acre? — *Skip to H16*
- On a place of 1 to 9 acres?
- On a place of 10 or more acres?

b. Last year, 1979, did sales of crops, livestock, and other farm products from this place amount to —

- Less than $50 (or None)
- $50 to $249
- $250 to $599
- $600 to $999
- $1,000 to $2,499
- $2,500 or more

ou get water from —

- A public system *(city water department, etc.)* or private company?
- An individual drilled well?
- An individual dug well?
- Some other source *(a spring, creek, river, cistern, etc.)*?

17. Is this building connected to a public sewer?

- Yes, connected to public sewer
- No, connected to septic tank or cesspool
- No, use other means

18. About when was this building originally built? *Mark when the building was first constructed, not when it was remodeled, added to, or converted.*

- 1979 or 1980
- 1975 to 1978
- 1970 to 1974
- 1960 to 1969
- 1950 to 1959
- 1940 to 1949
- 1939 or earlier

19. When did the person listed in column 1 move into this house (or apartment)?

- 1979 or 1980
- 1975 to 1978
- 1970 to 1974
- 1960 to 1969
- 1950 to 1959
- 1949 or earlier
- Always lived here

20. How are your living quarters heated?
Fill one circle for the kind of heat used most.

- Steam or hot water system
- Central warm-air furnace with ducts to the individual rooms *(Do not count electric heat pumps here)*
- Electric heat pump
- Other built-in electric units *(permanently installed in wall, ceiling, or baseboard)*
- Floor, wall, or pipeless furnace
- Room heaters with flue or vent, burning gas, oil, or kerosene
- Room heaters without flue or vent, burning gas, oil, or kerosene *(not portable)*
- Fireplaces, stoves, or portable room heaters of any kind
- No heating equipment

H21a. Which fuel is used most for house heating?

- Gas: from underground pipes serving the neighborhood
- Gas: bottled, tank, or LP
- Electricity
- Fuel oil, kerosene, etc.
- Coal or coke
- Wood
- Other fuel
- No fuel used

b. Which fuel is used most for water heating?

- Gas: from underground pipes serving the neighborhood
- Gas: bottled, tank, or LP
- Electricity
- Fuel oil, kerosene, etc.
- Coal or coke
- Wood
- Other fuel
- No fuel used

c. Which fuel is used most for cooking?

- Gas: from underground pipes serving the neighborhood
- Gas: bottled, tank, or LP
- Electricity
- Fuel oil, kerosene, etc.
- Coal or coke
- Wood
- Other fuel
- No fuel used

H22. What are the costs of utilities and fuels for your living quarters?

a. Electricity
$ ______ .00 *Average monthly cost* OR
- Included in rent or no charge
- Electricity not used

b. Gas
$ ______ .00 *Average monthly cost* OR
- Included in rent or no charge
- Gas not used

c. Water
$ ______ .00 *Yearly cost* OR
- Included in rent or no charge

d. Oil, coal, kerosene, wood, etc.
$ ______ .00 *Yearly cost* OR
- Included in rent or no charge
- These fuels not used

H23. Do you have complete kitchen facilities? *Complete kitchen facilities are a sink with piped water, a range or cookstove, and a refrigerator.*

- Yes
- No

H24. How many bedrooms do you have?
Count rooms used mainly for sleeping even if used also for other purposes.

- No bedroom
- 1 bedroom
- 2 bedrooms
- 3 bedrooms
- 4 bedrooms
- 5 or more bedrooms

H25. How many bathrooms do you have?
A complete bathroom is a room with flush toilet, bathtub or shower, and wash basin with piped water.
A half bathroom has at least a flush toilet or bathtub or shower, but does not have all the facilities for a complete bathroom.

- No bathroom, or only a half bathroom
- 1 complete bathroom
- 1 complete bathroom, plus half bath(s)
- 2 or more complete bathrooms

H26. Do you have a telephone in your living quarters?

- Yes
- No

H27. Do you have air conditioning?

- Yes, a central air-conditioning system
- Yes, 1 individual room unit
- Yes, 2 or more individual room units
- No

H28. How many automobiles are kept at home for use by members of your household?

- None
- 1 automobile
- 2 automobiles
- 3 or more automobiles

H29. How many vans or trucks of one-ton capacity or less are kept at home for use by members of your household?

- None
- 1 van or truck
- 2 vans or trucks
- 3 or more vans or trucks

Figure 2

Census Sample Person Questionnaire

ANSWER THESE QUESTIONS FOR

Name of Person 1 on page 2:

Last name First name Middle initial

11. In what State or foreign country was this person born?
Print the State where this person's mother was living when this person was born. Do not give the location of the hospital unless the mother's home and the hospital were in the same State.

Name of State or foreign country; or Puerto Rico, Guam, etc.

12. *If this person was born in a foreign country —*
a. Is this person a naturalized citizen of the United States?
- Yes, a naturalized citizen
- No, not a citizen
- Born abroad of American parents

b. When did this person come to the United States to stay?
- 1975 to 1980
- 1965 to 1969
- 1950 to 1959
- 1970 to 1974
- 1960 to 1964
- Before 1950

13a. Does this person speak a language other than English at home?
- Yes
- No, only speaks English — *Skip to 14*

b. What is this language?

(For example — Chinese, Italian, Spanish, etc.)

c. How well does this person speak English?
- Very well
- Not well
- Well
- Not at all

14. What is this person's ancestry? *If uncertain about how to report ancestry, see instruction guide.*

(For example: Afro-Amer., English, French, German, Honduran, Hungarian, Irish, Italian, Jamaican, Korean, Lebanese, Mexican, Nigerian, Polish, Ukrainian, Venezuelan, etc.)

15a. Did this person live in this house five years ago (April 1, 1975)?
If in college or Armed Forces in April 1975, report place of residence there.
- Born April 1975 or later — *Turn to next page for next person*
- Yes, this house — *Skip to 16*
- No, different house

b. Where did this person live five years ago (April 1, 1975)?

(1) State, foreign country, Puerto Rico, Guam, etc.: ______

(2) County: ______

(3) City, town, village, etc.: ______

(4) Inside the incorporated (legal) limits of that city, town, village, etc.?
- Yes
- No, in unincorporated area

16. When was this person born?
- Born before April 1965 — *Please go on with questions 17-33*
- Born April 1965 or later — *Turn to next page for next person*

17. In April 1975 *(five years ago)* was this person —
a. On active duty in the Armed Forces?
- Yes
- No

b. Attending college?
- Yes
- No

c. Working at a job or business?
- Yes, full time
- No
- Yes, part time

18a. Is this person a veteran of active-duty military service in the Armed Forces of the United States?
If service was in National Guard or Reserves only, see instruction guide.
- Yes
- No — *Skip to 19*

b. Was active-duty military service during —
Fill a circle for each period in which this person served.
- May 1975 or later
- Vietnam era *(August 1964—April 1975)*
- February 1955—July 1964
- Korean conflict *(June 1950—January 1955)*
- World War II *(September 1940—July 1947)*
- World War I *(April 1917—November 1918)*
- Any other time

19. Does this person have a physical, mental, or other health condition which has lasted for 6 or more months and which . . .

	Yes	No
a. Limits the kind or amount of work this person can do at a job?		
b. Prevents this person from working at a job?		
c. Limits or prevents this person from using public transportation?		

20. *If this person is a female —*
How many babies has she ever had, not counting stillbirths?
Do not count her stepchildren or children she has adopted.
None 1 2 3 4 5 6 7 8 9 10 11 12 or more

21. *If this person has ever been married —*
a. Has this person been married more than once?
- Once
- More than once

b. Month and year of marriage? — Month and year of first marriage?
(Month) (Year) (Month) (Year)

c. *If married more than once —* Did the first marriage end because of the death of the husband (or wife)?
- Yes
- No

22a. Did this person work at any time last week?
- Yes — *Fill this circle if this person worked full time or part time. (Count part-time work such as delivering papers, or helping without pay in a family business or farm. Also count active duty in the Armed Forces.)*
- No — *Fill this circle if this person did not work, or did only own housework, school work, or volunteer work.* — *Skip to 25*

b. How many hours did this person work last week (at all jobs)?
Subtract any time off; add overtime or extra hours worked.

Hours

23. At what location did this person work last week?
If this person worked at more than one location, print where he or she worked most last week.
If one location cannot be specified, see instruction guide.

a. Address *(Number and street)* ______

If street address is not known, enter the building name, shopping center, or other physical location description.

b. Name of city, town, village, borough, etc.

c. Is the place of work inside the incorporated (legal) limits of that city, town, village, borough, etc.?
- Yes
- No, in unincorporated area

d. County ______

e. State ______ f. ZIP Code ______

24a. Last week, how long did it usually take this person to get from home to work (one way)?

Minutes

b. How did this person usually get to work last week?
If this person used more than one method, give the one usually used for most of the distance.
- Car
- Truck
- Van
- Bus or streetcar
- Railroad
- Subway or elevated
- Taxicab
- Motorcycle
- Bicycle
- Walked only
- Worked at home
- Other — *Specify*

If car, truck, or van in 24b, go to 24c. Otherwise, skip to 28.

FOR CENSUS USE ONLY

Per. No.	11.	13b.	14.	15b.	23.	VL	24a.

Figure 3

Census Sample Person Questionnaire

c. When going to work **last week**, did this person usually —
- Drive alone — *Skip to 28*
- Share driving
- Drive others only
- Ride as passenger only

d. How many people, including this person, usually rode to work in the car, truck, or van **last week**?
- 2
- 3
- 4
- 5
- 6
- 7 or more

After answering 24d, skip to 28.

25. Was this person **temporarily** absent or on layoff from a job or business **last week**?
- Yes, on layoff
- Yes, on vacation, temporary illness, labor dispute, etc.
- No

26a. Has this person been looking for work during the last 4 weeks?
- Yes
- No — *Skip to 27*

b. Could this person have taken a job **last week**?
- No, already has a job
- No, temporarily ill
- No, other reasons *(in school, etc.)*
- Yes, could have taken a job

27. When did this person last work, even for a few days?
- 1980
- 1979
- 1978
- 1975 to 1977
- 1970 to 1974
- 1969 or earlier
- Never worked

Skip to 31d

28–30. Current or most recent job activity
Describe clearly this person's chief job activity or business last week. If this person had more than one job, describe the one at which this person worked the most hours. If this person had no job or business last week, give information for last job or business since 1975.

28. Industry

a. For whom did this person work? *If now on active duty in the Armed Forces, print "AF" and skip to question 31.*

(Name of company, business, organization, or other employer)

b. What kind of business or industry was this?
Describe the activity at location where employed.

(For example: Hospital, newspaper publishing, mail order house, auto engine manufacturing, breakfast cereal manufacturing)

c. Is this mainly — *(Fill one circle)*
- Manufacturing
- Wholesale trade
- Retail trade
- Other — *(agriculture, construction, service, government, etc.)*

29. Occupation

a. What kind of work was this person doing?

(For example: Registered nurse, personnel manager, supervisor of order department, gasoline engine assembler, grinder operator)

b. What were this person's most important activities or duties?

(For example: Patient care, directing hiring policies, supervising order clerks, assembling engines, operating grinding mill)

30. Was this person — *(Fill one circle)*
- Employee of private company, business, or individual, for wages, salary, or commissions
- Federal government employee
- State government employee
- Local government employee *(city, county, etc.)*
- Self-employed in own business, professional practice, or farm —
  - Own business not incorporated
  - Own business incorporated
- Working without pay in family business or farm

CENSUS USE: 21b. I II III IV; 22b.; 28. A B C D E F G H J K L M; AF NW; 29. N P Q R S T U V W X Y Z

31a. Last year (1979), did this person work, even for a few days, at a paid job or in a business or farm?
- Yes
- No — *Skip to 31d*

b. How many weeks did this person work in 1979?
Count paid vacation, paid sick leave, and military service.

---------- Weeks

c. During the weeks **worked** in 1979, how many hours did this person usually work each week?

---------- Hours

d. Of the weeks **not worked** in 1979 (if any), how many weeks was this person looking for work or on layoff from a job?

---------- Weeks

32. Income in 1979 —
Fill circles and print dollar amounts.
If net income was a loss, write "Loss" above the dollar amount.
If exact amount is not known, give best estimate. For income received jointly by household members, see instruction guide.

During 1979 did this person receive any income from the following sources?

If "Yes" to any of the sources below — How much did this person receive for the entire year?

a. Wages, salary, commissions, bonuses, or tips from all jobs. *Report amount before deductions for taxes, bonds, dues, or other items.*
- Yes → $ ______ .00 *(Annual amount — Dollars)*
- No

b. Own nonfarm business, partnership, or professional practice. *Report net income after business expenses.*
- Yes → $ ______ .00 *(Annual amount — Dollars)*
- No

c. Own farm. *Report net income after operating expenses. Include earnings as a tenant farmer or sharecropper.*
- Yes → $ ______ .00 *(Annual amount — Dollars)*
- No

d. Interest, dividends, royalties, or net rental income. *Report even small amounts credited to an account.*
- Yes → $ ______ .00 *(Annual amount — Dollars)*
- No

e. Social Security or Railroad Retirement
- Yes → $ ______ .00 *(Annual amount — Dollars)*
- No

f. Supplemental Security (SSI), Aid to Families with Dependent Children (AFDC), or other public assistance or public welfare payments
- Yes → $ ______ .00 *(Annual amount — Dollars)*
- No

g. Unemployment compensation, veterans' payments, pensions, alimony or child support, or any other sources of income received regularly. *Exclude lump-sum payments such as money from an inheritance or the sale of a home.*
- Yes → $ ______ .00 *(Annual amount — Dollars)*
- No

33. What was this person's total income in 1979?
Add entries in questions 32a through g; subtract any losses.
$ ______ .00 *(Annual amount — Dollars)*
If total amount was a loss, write "Loss" above amount.
OR None

CENSUS USE ONLY: 31b. 31c. 31d. 32a. 32b. 32c. 32d. 32e. 32f. 32g. 33.

→ *Please turn to the next page and answer the questions for Person 2 on page 2*

Supplement to Data User News

1980 Census of Population and Housing

Revised February 1982

Tentative Publication and Computer Tape Program

The results of the 1980 census will be released as soon as they are tabulated and assembled. In this data dissemination program three major media will be utilized: printed reports, computer tapes, and microfiche.

The publications of the 1980 census are released under three subject titles, *1980 Census of Population and Housing, 1980 Census of Population,* and *1980 Census of Housing.* The description of the publication program below is organized in sections, by census title, followed by the reports under each title. It should be noted that a number of the population census reports contain some housing data and a number of the housing census reports contain some population data.

Following the description of the publication program are sections on computer tapes, maps, and microfiche, and a section listing the subject items included in the 1980 census.

The data product descriptions include listings of geographic areas for which data are summarized in that product. Note that the term "place" refers to incorporated places and census designated (or unincorporated) places, as well as towns and townships in 11 States (the 6 New England States, the 3 mid-Atlantic States, Michigan, and Wisconsin).

Order forms for these materials are available in most cases, subject to availability of the data product, from Data User Services Division, Customer Services, Bureau of the Census, Washington, D.C. 20233; Census Bureau Regional Offices; U.S. Department of Commerce District Offices; and State Data Centers. Inquiries concerning any phase of the data dissemination program may be addressed to Data User Services Division, Customer Services, Bureau of the Census, Washington, D.C. 20233. After publication, census reports are on file in libraries and are available for examination at any Department of Commerce District Office or Census Bureau Regional Office.

The Bureau is continually reviewing its 1980 census publication and computer tape program. Changes may occur to content, schedules, and media as described in this leaflet. When dates are not shown below, schedules are in review. Revisions showing more complete scheduling will be issued as necessary.

REPORTS

1980 Census of Population and Housing

Preliminary Reports

Series PHC80-P **Preliminary Population and Housing Unit Counts**

Issued: 10/80–2/81

These reports present preliminary population and housing unit counts as compiled in the census district offices. Counts are shown for the following areas or their equivalents: States, counties, county subdivisions, incorporated places, standard metropolitan statistical areas (SMSA's) as designated prior to the census, and congressional districts as delineated for the 96th Congress. There is one report for each State, the District of Columbia, Puerto Rico, Guam, Virgin Islands of the United States, and American Samoa, and a U.S. Summary report showing counts for the United States, regions, divisions, and States.

Advance Reports

Series PHC80-V **Final Population and Housing Unit Counts**

To be Issued: 2/81—early 1982

These reports present provisional population counts classified by race and Spanish origin and also final housing unit counts prior to their publication in the final reports. These figures supersede the preliminary counts published in the PHC80-P series. Final counts are shown for the following areas or their equivalents: States, counties, county subdivisions, incorporated places, and congressional districts as delineated for the 96th Congress. There is one report for each State, the District of Columbia, Puerto Rico, Guam, Virgin Islands of the United States, and American Samoa, and a U.S. Summary report showing counts for the United States, regions, divisions, States, and congressional districts.

Final Reports

Series PHC80-1 BLOCK STATISTICS

To be issued: early 1982—mid-1982

These reports present population and housing unit totals and statistics on selected characteristics which are based on complete-count data. Statistics are shown for individual blocks in urbanized areas, for selected blocks adjacent to urbanized areas, for blocks in places of 10,000 or more inhabitants, and for blocks in areas which contracted with the Census Bureau to provide block statistics. The set of reports consists of 375 sets of microfiche (no printed reports), and includes a report for each SMSA, showing blocked areas within the SMSA, and a report for each State and for Puerto Rico, showing blocked areas outside SMSA's, and a U.S. Summary which is an index to the set. In addition to microfiche, printed detailed maps showing the blocks covered by the particular report are available.

Series PHC80-2 CENSUS TRACTS

To be issued: late 1982—mid-1983

Statistics for most of the population and housing subjects included in the 1980 census are presented for census tracts in SMSA's and in other tracted areas. Some tables show complete-count data and others, sample-estimate data. Most statistics are presented by race and Spanish origin for areas with at least a specified number of persons in the relevant population groups. There is one report for each SMSA, as well as one for most States and Puerto Rico covering the tracted areas outside SMSA's (designated selected areas).

Copies of tables containing complete-count data may be purchased at the cost of reproduction as each set of tables is completed. Completion dates range from early 1982 through mid-1982.

Series PHC80-3 SUMMARY CHARACTERISTICS FOR GOVERNMENTAL UNITS AND STANDARD METROPOLITAN STATISTICAL AREAS

To be issued: Spring 1982—Fall 1982

Statistics are presented on total population and on complete-count and sample population characteristics such as age, race, education, disability, ability to speak English, labor force, and income, and on total housing units and housing characteristics such as value, age of structure, and rent. These are shown for the following areas or their equivalents: States, SMSA's, counties, county subdivisions (those which are functioning general-purpose local governments), and incorporated places. There is one report for each State, the District of Columbia, and Puerto Rico. This series does not include a U.S. Summary.

Copies of tables containing complete-count data may be purchased at the cost of reproduction as each set of tables is completed. Completion dates range from September 1981 through early 1982.

Series PHC80-4 CONGRESSIONAL DISTRICTS OF THE 98th CONGRESS

To be issued: Spring 1982—late 1982

This report presents complete-count and sample data for congressional districts of the 98th Congress. The report reflects redistricting now underway in anticipation of the 1982 elections and the special needs of the congressional audience. One report will be issued for each of the 50 States and the District of Columbia.

Copies of tables containing complete-count data may be purchased at the cost of reproduction as each set of tables is completed. Completion dates range from early 1982 through mid-1982.

Series PHC80-S1-1 PROVISIONAL ESTIMATES OF SOCIAL, ECONOMIC, AND HOUSING CHARACTERISTICS

To be issued: early 1982

This report presents provisional estimates based on sample data collected in the 1980 census. Data on social, economic, and housing characteristics are shown for the United States as a whole, each State, the District of Columbia, and SMSA's of 1,000,000 or more inhabitants. These data are based on a special subsample of the full census sample. The sample, which represents about 1.6 percent of the total population, was developed to provide users with early data on characteristics of the population and housing units.

1980 Census of Population·

Final Reports

Volume 1.

CHARACTERISTICS OF THE POPULATION

This volume presents final population counts and statistics on population characteristics. It consis of reports for the following 57 areas: the United States, each of the 50 States, the District (Columbia, Puerto Rico, and the outlying areas of Guam, Virgin Islands of the United States, American Samoa, and the Trust Territory of the Pacific Islands. The volume consists of four chapters for each area, chapters A, B, C, and D. Chapters A and B present data collected on a complete count basis, and chapters C and D present estimates based on sample information, except for outlying areas where all data are collected on a complete-count basis. In the complete-count data presented there are some differences from the counts presented earlier in the PHC80-V reports because corrections were made for errors found after the PHC80-V reports were issued. Chapters B, C, and D present most statistics by race and Spanish origin for areas with at least a specified number of the relevant population groups.

The U.S. Summary reports present statistics for the United States, regions, divisions, States, and selected areas below the State level. The State or equivalent area reports (which include the District of Columbia, Puerto Rico, and outlying areas) present statistics for the State or equivalent area and its subdivisions.

Statistics for each of the 57 areas are issued in separate paperbound editions of chapters A, B, and C. Chapter D is to be issued on microfiche only.

Series PC80-1-A Chapter A

NUMBER OF INHABITANTS

To be issued: 10/81—early 1982

Final population counts are shown for the following areas or their equivalents: States, counties, county subdivisions, incorporated places and census designated places (and towns and tow ships in selected States), standard consolidated statistical areas (SCSA's), SMSA's, and urbanize areas. Selected tables contain population counts by urban and rural residence. Many tables cont historical statistics from previous censuses.

Series PC80-1-B Chapter B

GENERAL POPULATION CHARACTERISTICS

To be issued: early 1982—mid-1982

Statistics on household relationship, age, race, Spanish origin, sex, and marital status are shown for the following areas or their equivalents: States, counties (by rural residence), county subdivisions, places (and towns and townships in selected States) of 1,000 or more inhabitants, SCSA's, SMSA's, urbanized areas, American Indian reservations, and Alaska Native villages.

Series PC80-1-C Chapter C

GENERAL SOCIAL AND ECONOMIC CHARACTERISTICS

To be issued: Fall 1982—early 1983

Data for subjects shown in the PC80-1-B reports are presented in more detail in PC80-1-C. Also shown are statistics on nativity, State or country of birth, citizenship and year of immigration for the foreign-born population, language spoken at home and ability to speak English, ancestry, fertility, family composition, type of group quarters, marital history, residence in 1975, journey to work, school enrollment, years of school completed, disability, verteran status, labor-force status, occupation, industry, class of worker, labor-force status in 1979, income in 1979, and poverty status in 1979. Each subject is shown for some or all of the following areas or their equivalents: States, counties (by rural and rural-farm residence), places (and towns and townships in selected States) of 2,500 or more inhabitants, SCSA's, SMSA's, urbanized areas, American Indian reservations, and Alaska Native villages.

Series PC80-1-D Chapter D

DETAILED POPULATION CHARACTERISTICS

To be issued: mid to late 1983

Statistics on population characteristics are presented in considerable detail and cross-classified t age, race, Spanish origin, and other characteristics. Each subject is shown for the State or equivalent area, and some subjects are also shown for rural residence at the State level. Most subjects are shown for SMSA's of 250,000 or more inhabitants, and a few are shown for central cities of these SMSA's.

6d

Series PC80-2 Volume 2.

SUBJECT REPORTS

To be issued: beginning 1983

Each of the reports in this volume focuses on a particular subject. Cross-tabulations of population characteristics are shown on a national, regional, and divisional level. A few reports show statistics for States, large cities, SMSA's, American Indian reservations, or Alaska Native villages. Separate reports are tentatively planned on any or all of the following characteristics: racial and ethnic groups, type of residence, fertility, families, marital status, migration, education, employment, occupation, industry, journey to work, income, poverty status, and other subjects.

Note that the preparation of subject reports is dependent upon availability of funding in 1983.

Series PC80-S1 **SUPPLEMENTARY REPORTS**

These reports present special compilations of 1980 census statistics dealing with specific population subjects. The reports tentatively include the following:

To be issued:

To be issued	No.	Series	Title
5/81	1.	PC80-S1-1	Age, Sex, Race, and Spanish Origin of the Population by Regions, Divisions, and States: 1980
5/81	2.	PC80-S1-2	Population and Households by States and Counties: 1980
7/81	3.	PC80-S1-3	Race of the Population by States: 1980
9/81	4.	PC80-S1-4	Population and Households for Census Designated Places: 1980
10/81	5.	PC80-S1-5	Standard Metropolitan Statistical Areas and Standard Consolidated Statistical Areas: 1980
	6.	Unassigned	Nonpermanent Residents by State and County: 1980
	7.	Unassigned	Population and Housing Unit Counts for Identified American Indian Areas and Alaska Native Villages: 1980
	8.	Unassigned	Persons of Spanish Origin by State: 1980

1980 Census of Housing

Final Reports

Volume 1.

CHARACTERISTICS OF HOUSING UNITS

This volume presents final housing unit counts and statistics on housing characteristics. It consists of reports for the following 57 areas: the United States, each of the 50 States, the District of Columbia, Puerto Rico, and the outlying areas of Guam, Virgin Islands of the United States, American Samoa, and the Trust Territory of the Pacific Islands. The volume consists of two chapters for each area, chapters A and B. Chapter A presents data collected on a complete-count basis. Chapter B presents estimates based on sample information, except for outlying areas where all data are collected on a complete-count basis. Both chapters present most statistics by race and Spanish origin for areas with at least a specified number of the relevant population groups.

The U.S. Summary report presents statistics for the United States, regions, divisions, States, and selected areas below the State level. The State or equivalent area reports (which include the District of Columbia, Puerto Rico, and outlying areas) present statistics for the State or equivalent area and its subdivisions.

Statistics for each of the 57 areas are issued in separate paperbound editions of chapters A and B.

Series HC80-1-A Chapter A

GENERAL HOUSING CHARACTERISTICS

To be issued: early 1982—mid-1982

Statistics on units at address, tenure, condominium status, number of rooms, persons per room, plumbing facilities, value, contract rent, and vacancy status are shown for some or all of the following areas or their equivalents: States, counties, county subdivisions, places (and towns and townships in selected States) of 1,000 or more inhabitants, SCSA's, SMSA's, urbanized areas, American Indian reservations, and Alaska Native villages. Selected tables contain housing characteristics for urban and rural areas.

Series HC80-1-B Chapter B

DETAILED HOUSING CHARACTERISTICS

To be issued: Fall 1982—early 1983

Some subjects included in the HC80-1-A reports are also covered in this report. Additional subjects covered include units in structure, year moved into unit, year structure built, heating equipment, fuels, air conditioning, water and sewage, gross rent, and selected monthly ownership costs. The statistics are shown for some or all of the following areas or their equivalents: States, counties, places (and towns and townships in selected States) of 2,500 or more inhabitants, SCSA's, SMSA's, urbanized areas, American Indian reservations, and Alaska Native villages. Selected tables show housing characteristics for rural-farm and rural-nonfarm residence at the State *and county* level

Series HC80-2 Volume 2.

METROPOLITAN HOUSING CHARACTERISTICS

To be issued: mid to late 1983 — This volume presents statistics on microfiche (tentatively, no printed reports planned) for most of the 1980 housing census subjects in considerable detail and cross-classification. Most statistics are presented by race and Spanish origin for areas with at least a specified number of the relevant population groups. Data are shown for States or equivalent areas, SMSA's and their central cities, and other cities of 50,000 or more inhabitants. There is one report for each SMSA, and one report for each State, the District of Columbia, and Puerto Rico. The set includes a U.S. Summary report showing these statistics for the United States and regions.

Series HC80-3 Volume 3.

SUBJECT REPORTS

To be issued: beginning 1983 — Each of the reports in this volume focuses on a particular subject. Detailed sample estimates and cross-tabulations of housing characteristics are provided on a national, regional, and divisional level. Separate reports are tentatively planned on housing of the elderly, mobile homes, and American Indian households.

Note that the preparation of subject reports is dependent upon availability of funding in 1983.

Series HC80-4 Volume 4.

COMPONENTS OF INVENTORY CHANGE

To be issued: late 1982 — This volume consists of two reports presenting statistics on the 1980 characteristics of housing units which existed in 1973, as well as on newly constructed units, conversions, mergers, demolitions, and other additions and losses to the housing inventory between 1973 and 1980. These reports present data derived from a sample survey conducted in the fall of 1980. Data are presented for the United States and regions. Some data are presented by inside and outside SMSA's and central cities.

HC80-5 Volume 5.

RESIDENTIAL FINANCE

To be issued: mid 1983 — This volume consists of one report presenting statistics on the financing of nonfarm homeowner, rental and vacant properties, including characteristics of the mortgage, property, and owner. The statistics are based on a sample survey conducted in the spring of 1981. Data are presented for the United States and regions. Some data are presented by inside and outside SMSA's and central cities.

HC80-S1-1 **SUPPLEMENTARY REPORT—Selected Housing Characteristics by States and Counties: 1980**

Issued: 10/81 — This report presents statistics from the 1980 Census of Housing on general characteristics of housing units for the 50 States and the District of Columbia, counties, and independent cities.

1980 Census of Population and Housing

Evaluation and Reference Reports

Series PHC80-E **EVALUATION AND RESEARCH REPORTS**

These reports present the results of the extensive evaluation program conducted as an integral part of the 1980 census. This program relates to such matters as completeness of enumeration and quality of the data on characteristics.

Series PHC80-R **REFERENCE REPORTS**

These reports present information on the various administrative and methodological aspects of the 1980 census. The series includes:

PHC80-R1 **Users' Guide.**

To be issued: beginning early 1982 — This report covers subject content, procedures, geography, statistical products, limitations of the data, sources of user assistance, notes on data use, a glossary of terms, and guides for locating data in reports and tape files. The guide is issued in loose-leaf form and sold in parts (R1-A, -B, etc.) as they are prepared.

PHC80-R2 **History.**

To be issued: 1984 — This report describes in detail all phases of the 1980 census, from the earliest planning, and through all stages, to the dissemination of data and evaluation of results. It contains detailed discussions of 1980 census questions and their use in previous decennial censuses.

Figure 4 (continued)

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PHC80-R3 **Alphabetical Index of Industries and Occupations.**

To be issued: beginning in 1980 with updates through 1983

This report was developed primarily for use in classifying responses to certain census questions relating to an employer's kind of business and an employee's kind of work. The index lists approximately 20,000 industry and 29,000 occupation titles in alphabetical order.

PHC80-R4 **Classified Index of Industries and Occupations.**

To be issued: beginning in 1980 with updates through 1983

This report defines the industrial and occupational classifications adopted for the 1980 Census of Population. It presents the individual titles that constitute each of the 231 industry and 503 occupation categories in the classification systems. The individual titles are the same as those shown in the Alphabetical Index. The 1980 occupation classification reflects the new U.S. Standard Occupational Classification (SOC). As in the past, the 1980 industry classification also reflects the Standard Industrial Classification (SIC).

PHC80-R5 **Geographic Identification Code Scheme.**

To be issued: Spring 1982

This report identifies the names and related geographic codes for each State, county, minor civil division, place, region, division, SCSA, SMSA, American Indian reservation, and Alaska Native village for which the Census Bureau tabulated data from the 1980 census.

COMPUTER TAPES

Summary Tape Files—General

In addition to the printed and microfiche reports, results of the 1980 census also are provided on computer tape for the United States and Puerto Rico in the form of summary tape files (STF's). These data products have been designed to provide statistics with iter subject and geographic detail than is feasible or desirable provide in printed and microfiche reports. The STF data are le available, subject to suppression of certain detail where necessary to protect confidentiality, at nominal cost.

There are five STF's, and the amount of geographic and subject detail presented varies. STF's 1 and 2 contain complete-count data, and STF's 3, 4, and 5 contain sample-estimate data. Note that the term "cells" used below refers to the number of subject statistics provided for each geographic area, and the number of cells is indicative of the complexity of the subject content of the file.

Additionally, each of the STF's consists of a set of tapes with geographic coverage varying by file within the set. These are issued a State at a time, followed by the national level tapes. More complete descriptions of the STF's than given in the summaries below can be found in the technical documentation for the specific file, and in the *1980 Census of Population and Housing Users' Guide*.

Summary Tape Files

STF 1
To be available: 9/81—early 1982

This file provides 321 cells of complete-count population and housing data. Data are summarized for the United States, regions, divisions, States, SCSA's, SMSA's, urbanized areas, congressional districts, counties, county subdivisions, places, census tracts, enumeration districts in unblocked areas, and blocks and block groups in blocked areas. This file set includes data shown in the PHC80-1, PHC80-3, and PC80-1-A reports.

STF 2
To be available: early 1982—mid-1982

This file contains 2,292 cells of detailed complete-count population and housing data, of which 962 are repeated for race and/or Spanish origin groups present in the tabulation area. Data are summarized for the United States, regions, divisions, States, SCSA's, urbanized areas, counties, county subdivisions, places of 1,000 or more inhabitants, census tracts, American Indian reservations, and Alaska Native villages. This file set includes data shown in the PHC80-2, PC80-1-B, and HC80-1-A reports.

STF 3
To be available: Spring 1982—Fall 1982

This file contains 1,126 cells of population and housing data estimated from the sample for the same area as in STF 1, excluding blocks. This file set includes data shown in the PHC80-3 reports. In addition, the Census Bureau is exploring the possibility of producing STF 3 data for 5-digit ZIP Code areas on a cost-reimbursable, special-tabulation basis.

STF 4
To be available: mid-1982—late 1982

This file is the geographic counterpart of STF 2, but the number of cells of data is approximately three times greater. STF 4 provides detailed population and housing data estimated from the sample, some of which are repeated for race, Spanish origin, and ancestry groups. Data are summarized for areas similar to those shown for STF 2, except that data for places are limited to those with 2,500 or more inhabitants. This file set includes data shown in the PHC80-2, PC80-1-C, and HC80-1-B reports.

STF 5
To be available: mid to late 1983

This file contains over 100,000 cells of population and housing data estimated from the sample and provides highly detailed tabulations and cross-classifications for States, SMSA's, and counties and cities of 50,000 or more inhabitants. Most subjects are classified by race and Spanish origin. This file set includes data shown in the PC80-1-D and HC80-2 reports.

Other Computer Tape Files

P.L. 94-171 Population Counts
Issued: 2/81–3/81

In accordance with Public Law (P.L.) 94-171, the Census Bureau provided population tabulations to all States for legislative reapportionment/redistricting. The file was issued on a State-by-State basis. It contains the final population counts classified by race and Spanish origin. The data are tabulated for the following levels of geography as applicable: States, counties, county subdivisions, incorporated places, census tracts, block groups, and blocks or enumeration districts. For States participating in the voluntary program to define election precincts in conjunction with the Census Bureau, the data are also tabulated for election precincts.

Master Area Reference File (MARF)
To be available: 9/81– early 1982

This geographic reference file is an extract of STF 1 designed for those who require a master list of geographic codes and areas, along with basic census counts arranged hierarchically from the State down to the block group and enumeration district level and is issued on a State-by-State basis. The file contains records for States, counties, county subdivisions, places, census tracts, enumeration districts in unblocked areas, and block groups in blocked areas. Each record shows the total population by five race groups, population of Spanish origin, number of housing units, number of households, number of families, and a few other items.

Geographic Base File/ Dual Independent Map Encoding—GBF/DIME
Beginning in 1978 periodic updates

These files are computerized representations of the Metropolitan Map Series, including address ranges and ZIP Codes, which generally cover the urbanized portions of SMSA's. GBF/DIME files are used to assign census geographic codes to addresses (geocoding). The files are issued by SMSA.

Public-Use Microdata Samples
To be available: mid-1982– late 1982

Public-use microdata samples are computerized files containing most population and housing characteristics as shown on a sample of individual census records. These files contain no names or addresses, and geographic identification is sufficiently broad to protect confidentiality.

There are three mutually exclusive samples, the A sample including 5 percent, and the B and C samples each including 1 percent of all persons and housing units. States and most large SMSA's will be identifiable on one or more of the files. Microdata files allow the user to prepare customized tabulations.

Census/EEO Special File
To be available: Fall 1982– early 1983

In addition to the regular summary tape files, the Bureau plans to prepare a "Census/EEO Special File." This public-use computer file will provide sample census data with specified relevance to EEO and affirmative action uses. The file will contain two tabulations, one with detailed occupational data and the other with years of school completed by age. The data in both tabulations will be crossed by sex and Hispanic origin or race for non-Hispanics. These data will be provided for all counties, for all SMSA's, and for incorporated places with a population of 50,000 or more.

MAPS

ıps necessary to define areas are generally published as part of : corresponding reports. Detailed map packages showing the ›cks in the *1980 Census of Population and Housing Block ıtistics* reports (PHC80-1) must be purchased separately. Maps :essary to define enumeration districts are available on a cost-reproduction basis.

MICROFICHE

Some of the computer tape products are available on microfiche. Like the summary tape file sets, the STF microfiche are issued a State at a time, followed by the national-level microfiche. These include:

STF 1A Microfiche—Data from the STF 1 file set are presented in tabular form for STF 1A summarization levels (block data from STF 1B are not included).

P.L. 94-171 Counts Microfiche—Data from the P.L. 94-171 are presented in a listing format on microfiche. The microfi was issued on a State-by-State basis.

SUBJECT ITEMS INCLUDED IN THE 1980 CENSUS

100-Percent Items[1]

Population

Household relationship
Sex
Race
Age
Marital status
Spanish/Hispanic origin or descent

Housing

Number of units at address
Access to unit
Complete plumbing facilities
Number of rooms
Tenure (whether unit is owned or rented)
Condominium identification
Value of home (owner-occupied units and condominiums)
Contract rent (renter-occupied units)
Vacant for rent, for sale, etc., and duration of vacancy

Sample Items[2]

Population

School enrollment
Educational attainment
State or foreign country of birth
Citizenship and year of immigration
Current language and English proficiency
Ancestry
Place of residence 5 years ago
Activity 5 years ago
Veteran status and period of service
Presence of disability or handicap
Children ever born
Marital history
Employment status last week
Hours worked last week
Place of work
Travel time to work
Means of transportation to work
Number of persons in carpool
Year last worked
Industry
Occupation
Type of employment
Number of weeks worked in 1979
Usual hours worked per week in 1979
Number of weeks looking for work in 1979
Amount of income in 1979 by source

Housing

Type of unit and units in structure
Stories in building and presence of elevator
Year built
Year moved into this house
Acreage and crop sales
Source of water
Sewage disposal
Heating equipment
Fuels used for house heating, water heating, and cooking
Costs of utilities and fuels
Complete kitchen facilities
Number of bedrooms
Number of bathrooms
Telephone
Air conditioning
Number of automobiles
Number of light trucks and vans
Homeowner shelter costs for mortgage, real estate taxes, and hazard insurance

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[1] Censuses similar in subject content to that of the United States were also taken in Puerto Rico, Virgin Islands of the United States, American Samoa, Guam, Northern Mariana Islands, and the remaining parts of the Trust Territory of the Pacific Islands. Subjects were added or deleted as necessary to make the census content appropriate to the area. The questionnaire for Puerto Rico had complete-count items and sample items, but in the other areas all questions were complete-count items.

[2] For most areas of the country in 1980, one out of every six housing units or households received the sample form. Areas estimated to contain 2,500 or less persons in 1980 had a three-out-of-every-six sampling rate, which is required to obtain reliable statistics needed for participation in certain Federal programs.

Figure 5 illustrates the preliminary tabulation specifications for the journey to work questions from STF4. Figure 6 indicates the level of geographic detail to which place of work will be summarized on the tape, using an example from four counties in Florida. STF4 is scheduled to be released on a state-by-state basis. Special software, such as the Census Bureau's CENSPAC program and other similar programs, should be used to extract the necessary information from the STF's.

All the information on the printed reports is also available on the STF's. The printed and microfiche reports are a quick and relatively simple means of reviewing Census data. However, the tapes are necessary if the user wishes to prepare customized tabulations or to perform any substantial additional processing of Census data. The Census Bureau and U.S. Department of Transportation have been cooperating to develop an interface between Census data and UTPS. The recently released UTPS program UCEN70 allows the manipulation of 1970 Census data in UTPS programs. A new version of UCEN70 for 1980 data has not yet been released. Some examples of the use of UTPS programs with Census data include address matching, geocoding, zone definition, and mapping. Figure 7 illustrates a chloropleth map made using the Census program EASYMAP.

The preceding discussion relates to data that the Census Bureau makes available to the public. The user may work directly with this data, or may contract with one of several private data services to perform the work. In either case, it should be noted that all persons and firms outside the Census Bureau have access to more or less the same information. If data needs go beyond summary information, generally the only means of accomplishing this is to request a special tabulation directly from the Census Bureau. Bureau personnel have direct access to the individual survey responses, and can produce special tabulations that are unavailable elsewhere. However, this should be used only as a last resort, as it is extremely expensive and time-consuming. Seemingly simple requests can cost thousands of dollars and take several months. (One exception to this is the availability of the public use microdata sample (PUMS) file. This file contains a sample of individual survey responses from the Census, modified to assure confidentiality. Although lacking in geographic detail, these records can produce very specific subject matter crosstabulations, down to the level of each particular survey question.)

A final source of Census data for transportation is the "Urban Transportation Planning Package". This consists of a tape file (probably one or two tapes per state) containing all of the transportation-related Census data at a fine level of detail. This will contain some data unavailable on any other summary tape. States and urban areas may request this data of the Bureau, at an additional cost. Figure 8 describes the availability of this package.

USE OF CENSUS DATA IN PLANNING ANALYSIS

This section describes how Census data can be applied to the screening and demand analysis steps discussed in Parts 1 and 2 of the text.

Figure 5

Preliminary Tabulation
Specifications for Summary
Tape File 4

Tabulation	Number of data items
B29. PLACE OF WORK (22)	22

Universe: Persons 16 Years And Over, At Work (Or In Armed Forces, At Work) During The Census Week

The first 20 data items of this matrix locate workers within 20 specified areas (i.e., work places). These work places are uniquely defined for each county or parish of residence (town in New England). The work places may be counties or parishes (towns in New England), cities, or central business districts of SMSA central cities. Item 21 is a tally of all workers living in the summary area of residence whose work place is somewhere other than one of those included in items 1 through 20. Item 22 is a tally of workers coded to "U.S., State not reported," "State only" or "not reported."

Data items 1 through 21 are meaningful for any summary area of residence within the particular county (or town) such as incorporated places. However, they are not meaningful for summary areas of residence larger than the county or town. Item 22 is meaningful for all summary areas of residence.

Work place 1
Work place 2
⋮
Work place 20
Other work places
Place of work not reported

Tabulation	Number of data items
B30. PLACE OF WORK - STATE AND COUNTY LEVEL (4)	4

Universe: Persons 16 Years And Over At Work
(Or In Armed Forces, At Work)

- Worked in State of residence:
  - Worked in county of residence
  - Worked outside county of residence
- Worked outside State of residence
- Not reported 13/

B31. PLACE OF WORK - PLACE LEVEL (4) — 4

Universe: Persons 16 Years And Over, At Work
(Or In Armed Forces, At Work)

- Living in incorporated place of 2,500 or more:
  - Worked in place of residence
  - Worked outside place of residence
  - Not reported 13/
- Not living in incorporated place of 2,500 or more

B32. PLACE OF WORK - SMSA LEVEL (5) — 5

Universe: Persons 16 Years And Over At Work
(Or In Armed Forces, At Work)

- Living in SMSA:
  - Worked in SMSA of residence:
    - Worked in central city
    - Worked outside central city
  - Worked outside SMSA of residence
  - Not reported 13/
- Not living in SMSA

Figure 5 (continued)

Tabulation	Number of data items
B33. PLACE OF WORK - MCD LEVEL (3)	3

Universe: Persons 16 Years And Over, At Work (Or In Armed Forces, At Work), Living In The 9 Northeastern States

Worked in MCD of residence
Worked outside MCD of residence
Not reported 13/

B34. MEANS OF TRANSPORTATION TO WORK (21)	21

Universe: Persons 16 Years And Over, At Work (Or In Armed Forces, At Work)

- Drive alone:
  - Car
  - Truck
  - Van
- Share driving:
  - Car
  - Truck
  - Van
- Drive Others Only:
  - Car
  - Truck
  - Van
- Ride as passenger only:
  - Car
  - Truck
  - Van
- Bus or streetcar
- Subway or elevated
- Railroad
- Taxicab
- Bicycle
- Motorcycle
- Walked only
- Other means
- Worked at home

Figure 5 (continued)

Tabulation	Number of data items
B35. TYPE OF PRIVATE VEHICLE (3) BY VEHICLE OCCUPANCY (7)	21

Universe: Persons 16 Years And Over, At Work (Or In Armed Forces, At Work), Using A Private Vehicle To Get To Work

Car:
  Drive alone
  Carpool:
    In 2-person carpool
    In 3-person carpool
    In 4-person carpool
    In 5-person carpool
    In 6-person carpool
    In 7-or-more person carpool
Truck:
  (Repeat Vehicle Occupancy)
Van:
  (Repeat Vehicle Occupancy)

B36. TRAVEL TIME TO WORK (8) — 8

Universe: Persons 16 Years And Over, At Work (Or In Armed Forces, At Work), Who Did Not Work At Home

Less than 5 minutes
5 to 9 minutes
10 to 14 minutes
15 to 19 minutes
20 to 29 minutes
30 to 44 minutes
45 to 59 minutes
60 or more minutes

B37. AGGREGATE TRAVEL TIME TO WORK (IN MINUTES) BY TRAVEL TIME TO WORK (2) 7/ — 2

Universe: Persons 16 Years And Over, At Work (Or In Armed Forces, At Work), Who Did Not Work At Home

Less than 45 minutes
45 or more minutes

Figure 6
Geographic Codes for Place of Work

Summary Tape File 4 (Florida)

(Hillsborough County) Tampa-St. Petersburg SMSA

Data Item	Places of Work
01	Tampa city—CBD
02	Remainder of Tampa city
03	Remainder of Hillsborough Co.
04	St. Petersburg city—CBD
05	Remainder of St. Petersburg city
06	Remainder of Pinellas Co.
07	Lakeland city
08	Remainder of Polk Co.
09	Pasco Co.
10	Hardee Co.
11	Manatee Co.
12	Sarasota Co.
13	De Soto Co.
14	Hernando Co.
15	Citrus Co.
16	Sumter Co.
17	Lake Co.
18	Orlando city
19	Remainder of Orange Co.
20	Seminole Co.

(Holmes County)

Data Item	Places of Work
01	Holmes Co.
02	Jackson Co.
03	Washington Co.
04	Walton Co.
05	Geneva Co., Alabama
06	Dothan city, Alabama
07	Remainder of Houston Co., Alabama
08	Panama City
09	Remainder of Bay Co.
10	Okaloosa Co.
11	Calhoun Co.
12	Covington Co., Alabama
13	Coffee Co., Alabama
14	Dale Co., Alabama
15	Henry Co., Alabama
16	Gadsden Co.
17	Liberty Co.
18	Gulf Co.
19	Santa Rosa Co.
20	Seminole Co., Georgia

(Indian River County)

Data Item	Places of Work
01	Indian River Co.
02	Titusville city
03	Remainder of Brevard Co.
04	Osceola Co.
05	Okeechobee Co.
06	Fort Pierce city
07	Remainder of St. Lucie Co.
08	Martin Co.
09	Highlands Co.
10	Lakeland city
11	Remainder of Polk Co.
12	Glades Co.
13	Orlando city
14	Remainder of Orange Co.
15	Hardee Co.
16	West Palm Beach city
17	Remainder of Palm Beach Co.
18	De Soto Co.
19	Hendry Co.
20	Lake Co.

(Jackson County)

Data Item	Places of Work
01	Jackson Co.
02	Gadsden Co.
03	Liberty Co.
04	Calhoun Co.
05	Panama City
06	Remainder of Bay Co.
07	Washington Co.
08	Holmes Co.
09	Geneva Co., Alabama
10	Dothan city, Alabama
11	Remainder of Houston Co., Alabama
12	Seminole Co., Georgia
13	Decatur Co., Georgia
14	Miller Co., Georgia
15	Early Co., Georgia
16	Walton Co.
17	Gulf Co.
18	Tallahassee city
19	Remainder of Leon Co.
20	Wakulla Co.

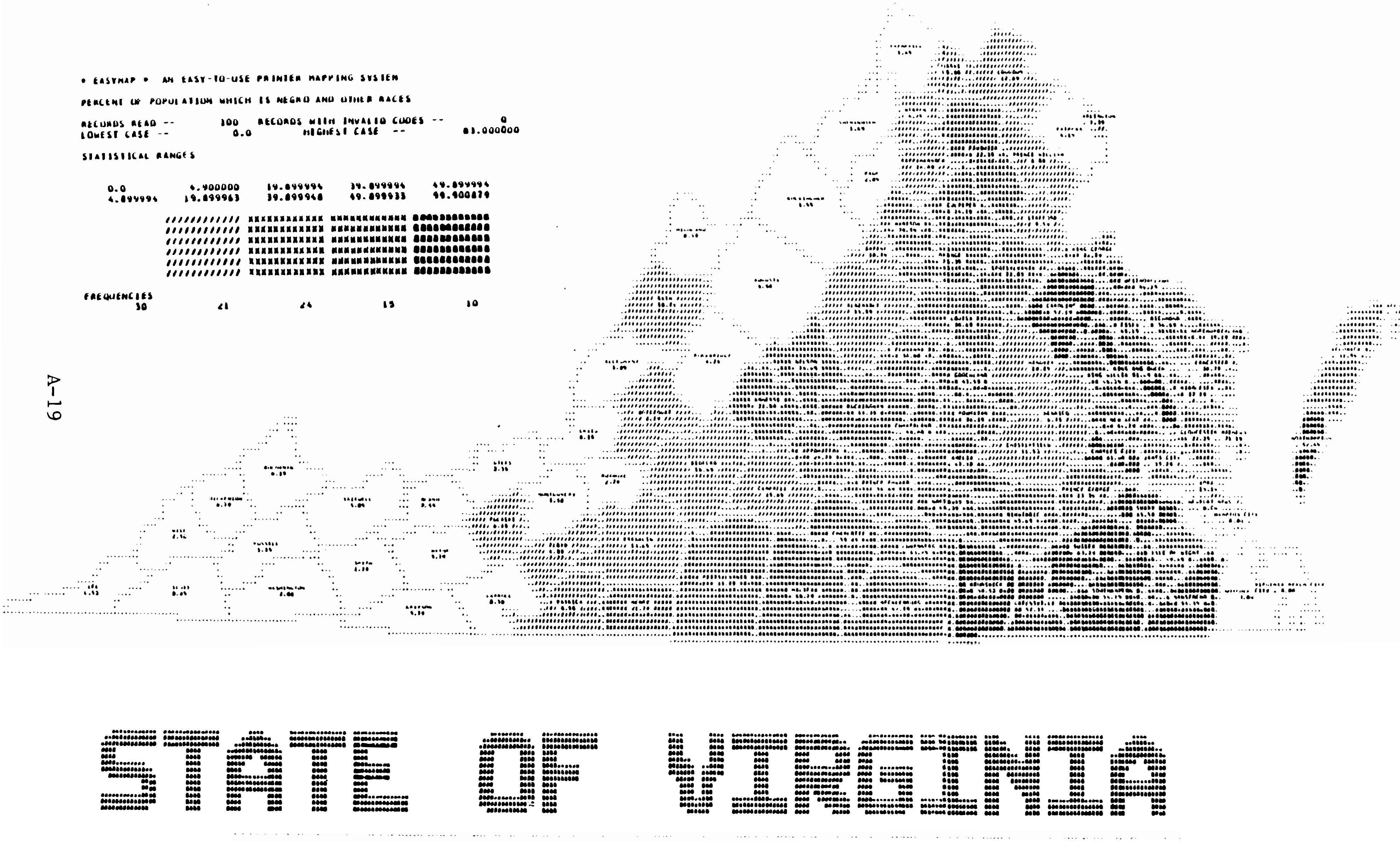

Figure 7
Example of Choropleth Map Using EASYMAP

Figure 8

UNITED STATES DEPARTMENT OF COMMERCE
Bureau of the Census
Washington, D.C. 20233

December 4, 1981

To: Interested Persons

From: Philip N. Fulton PNF
Chief, Journey-to-Work and Migration Statistics Branch
Population Division
U.S. Bureau of the Census

Subject: 1980 Census Urban Transportation Planning Package (UTPP)

Attached, for your information, is a copy of the specifications for the 1980 census Urban Transportation Planning Package (UTPP). As the "note" on the cover page indicates, the UTPP is a special tabulation of census data for individual standard metropolitan statistical areas (SMSA's), tailored to geographic areas that are used in transportation planning. Local transportation planning organizations submit specifications to the Census Bureau for the geographic detail required for their SMSA, and the Bureau then produces a standard set of tabulations for those planning areas on a cost reimbursable basis.

In addition to its special, user-oriented cross-tabulations of social, demographic, and economic data items, the primary advantage of the UTPP is that it will provide place-of-work data tabulated at geographic levels (i.e., census tract and block group) that are much finer than any shown on the standard Summary Tape Files. Planning organizations that require tabulations based on local traffic zones may obtain them for zones by special request, at an additional cost.

A firm cost estimate cannot be prepared for a given area until agreement is reached on the type of geography required for the tabulation. However, at this time we feel that the basic UTPP, tabulated at the census tract level, should cost about $10 per 1,000 SMSA population. If the purchaser requires traffic zones instead of census tracts, it would probably increase the cost by another $2 or $3 per 1,000 population.

We hope to start inviting requests for cost estimates from local planning agencies in early 1982. Announcement of the program will be made by the U.S. Department of Transportation and by the Bureau through our monthly publication, Data User News. We expect to begin producing UTPP's in late summer, 1982, and continue into 1983 as final sample data become available.

If you have questions on the UTPP, or the Bureau's Journey-to-Work Statistics Program in general, please call me at (301) 763-3850.

The first application is in Step 1.2, Define Corridor Travel Characteristics. The corridors themselves can be defined using a combination of road maps and Census tract-level population and housing unit counts (Series PHC 80-2 reports). In less developed areas that are not tracted, a convenient unit of Census geography is the Census county division (CCD), which divide a county into 3-5 (usually) smaller areas. The Final Population and Housing Unit Counts (Series PHC 80-V) contain this information.

The next important data item is information on work travel patterns and volumes. For each corridor, the predominant travel patterns (usually radial trips) and the daily inbound volume of trips must be identified. Data from the Urban Transportation Planning Package can be used to identify tract-to-tract work trip patterns within an SMSA. Outside SMSAs, the main source would be the "journey to work" section of the STF 4B file and the PC80-1-C reports (General Social and Economic Characteristics). In order to utilize this information, the study area, subareas of interest, and specific corridor boundaries must be identified in terms of Census geography. This is greatly facilitated if maps showing Census tracts, places, CCDs, and other such units are available.

Two other data items requred for the initial screening process are residential density and central area employment. Residential density is defined as households per net residential acre. (In this definition, "households" is considered synonymous with "housing units" and "dwelling units".) Housing units are reported in the Series PHC 80-2 (Census Tracts) reports (by tract) and in the Series PHC 80-V reports for counties and CCDs. Total land area by county is shown in the Series PC 80-1-A (Number of Inhabitants) report. However, this must be used with caution, since the denominator in this formula is supposed to represent net residential land area. In this case, Census data on area should be used only if other data are unavailable.

Data on employment (jobs), per se, is not directly available from the Census, since this survey focuses on household and individual characteristics. However, the Census Bureau may prepare a special report on employment by small area as part of its PC 80-2 (Subject Reports) series. Alternatively, employment may be estimated as the destination part of the journey to work question (i.e., as a crosstabulation of work trips by destination). This would exclude, of course, jobs that were unfilled, or jobs to which the person did not travel during Census week (e.g., an employee on vacation). But it may still prove a useful estimate of employment at the tract or CCD level. The source of this data is the same as for the travel pattern information: the Urban Transportation Planning Package, the STF 4B tape, and the PC 80-1-C reports.

The next step in the analysis of travel options is the estimation of modal usage, generally using the modal summary tables. As Step 2.1 indicates, the analyst may use the default socioeconomic distributions listed in Table 3 of the main text. Alternatively, Census data may be used to determine values that are more appropriate for a given area.

Residential Density: This is calculated as the percentage of housing units in areas of low, medium, and high density, calculated on a small area basis (such as a traffic zone or Census tract). As mentioned above, housing units are available in the Series PHC 80-2 and PHC 80-V reports. Net residential acres are usually estimated by land use planners.

Household Income: The number and percentage of housing units stratified by household income is dire ctly available from the STF 3A file and Series PHC 80-2 (tracts) and PHC 80-3 (counties and incorporated places) reports. The data is presented in more detail than necessary and the analyst will have to aggregate income levels into "low", "medium", and "high", as defined in the text. The Census definition of income is used.

Employment Concentration: This is not available from the 1980 Census of Population and Housing. However, the Census Bureau performs a separate annual survey of businesses, and publishes the data by county and state in a report entitled "County Business Patterns" (see Appendix C).

Type of Employment: The Census questionnaire asked (of the sample group) what kind of work they did. This was asked as an open-ended question, and the Bureau coded the responses using standard codes, representing the more generally recognized types of employment. Census reports PHC 80-R3 and PHC 80-R4 provide alphabetical and classified indices of industries and occupations used in the 1980 Census. As with income, the analyst will have to aggregate the categories into "white collar", "retail", and "blue collar". This data is available from the STF 4A file and Series PHC 80-2 and PC 80-1-C reports.

Work Trip Length: Trip distance is not directly available from the Census. Travel time to work is reported in some detail, and it may be possible to assume an average speed and thereby derive the distribution of work trips by distance.

The remaining potential use of Census data in the analysis of modal options is in the supplemental transit/HOV analysis (i.e., involving use of the corridor sketch planning program). Generally, at this point, detailed network and traffic zone data are required. However, Census tabulations of the journey to work can be helpful in checking (or even creating) the input work person trip table. This table could be developed based on data in the Urban Transportation Planning Package. If the Census Bureau is provided with a traffic zone/tract equivalency table, a traffic zone trip table can be included in the Package.

APPENDIX B

TECHNIQUE FOR ESTIMATING FUTURE TRIPS

INTRODUCTION

A major element of this study methodology is the estimation of future travel. For smaller urban areas where VDH&T does not have available a future trip table or a trip table is desired for an intermediate time period, it is necessary to adopt a systematic procedure for updating the available trip table. One of the most common ways of quickly and simply developing a future year trip table is to "factor up" an existing one. Such a process has been incorporated into the corridor sketch planning program used in this study (see Appendix D). This program includes the option of applying zonal production and attraction factors to the input person trip table. The production factors are applied to the rows of the trip table, and the attraction factors are applied to the columns. These factors represent growth rates for the purpose of estimating future trip patterns. Generally, for work trips, production factors are derived from household forecasts and attraction factors from employment forecasts. Factors are calculated as the ratio of future to existing values for each zone.

One of the problems with such factoring is that initially, the sum of the factored productions rarely equals the sum of the factored attractions. The factoring process needs to resolve this so that the resulting trip table is balanced with respect to the new productions and attractions. One of the most common methods of achieving this result is the Fratar technique, which involves an iterative method. One of the problems of this method is that it does not always converge to a final acceptable answer. The technique implemented in the corridor sketch planning program uses a more sophisticated matrix balancing technique which operates in a single pass through the table. This process achieves the desired results by scaling the new production and attraction totals to whichever is the larger of the two and then allocating the change in the row totals to each column. The computational method involved is described in the next section.

METHOD

The first step is to determine the "desired" (i.e., new) productions and attractions by zone, and then the total. This is accomplished by multiplying the production and attraction factors by the row and column totals, respectively. Then, the total new attractions are scaled to equal the total new productions, if the latter is the larger of the two. Otherwise, the total new productions are scaled to equal the total new attractions. This ensures that the resulting new matrix is balanced. Following this, all matrix elements are factored by the row (production) factors to ensure that the desired row totals are achieved. This, however, usually results in the column totals not being equal to the desired column totals.

Next, the difference between the factored and desired column totals is computed. Then, a process known as "proportional fiting" is performed on each row of the matrix. In this process, the total column difference (computed in the prior step) is allocated to the columns in each row in proportion to the new row total. This is performed for each row in sequence, until the last row is reached and all of the total column difference is apportioned. The key to the method is that, as each new row is calculated, it is "removed" from the calculation, so that each row is only affected by the remaining matrix elements and not those that precede it.

This technique has several useful features:

1) it is performed in one "pass" through the matrix and does not iterate,

2) it always converges,

3) it preserves some of the "pattern" of the original matrix, while effectively introducing the changes induced by the factors, and

4) it can allocate positive values to cells which originally contained zeroes, and vice-versa (the Fratar technique cannot do this.)

The best way to explain this process is through an example application, which is shown in Figure 1.

Figure 1
MATRIX FACTORING EXAMPLE

ORIGINAL MATRIX (given):

	zone	column 1	2	3	4	5	row totals
row	1	0	100	200	0	50	350
	2	50	0	100	0	100	250
	3	100	150	0	0	200	450
	4	0	0	0	0	0	0
	5	100	200	400	0	0	700
column totals		250	450	700	0	350	1,750

FACTORS (given):

	Zone 1	2	3	4	5
production factors	0.857	0.960	1.311	0	1.100
attraction factors	0.847	0.921	1.053	0	1.105

INITIAL NEW ROW AND COLUMN TOTALS:

	Zone 1	2	3	4	5	total
production totals	300	240	590	0	770	1,900
attraction totals	212	414	737	0	387	1,750

SCALE UP ATTRACTION FACTORS SO THAT ATTRACTION TOTALS SUM TO 1,900:

	Zone 1	2	3	4	5	total
revised attraction factors	0.920	1.000	1.143	0	1.200	—
revised new attraction totals	230	450	800	0	420	1,900

APPLY PRODUCTION FACTORS (ONLY) TO MATRIX ELEMENTS:

	1	2	3	4	5	row totals
1	0	85.7	171.4	0	42.9	300
2	48.0	0	96.0	0	96.0	240
3	131.1	196.7	0	0	262.2	590
4	0	0	0	0	0	0
5	110.0	220.0	440.0	0	0	770
intermediate column totals	289.1	502.4	707.4	0	401.1	1,900

(note that intermediate column totals do not equal desired column totals)

CALCULATE TOTAL COLUMN DIFFERENCES:

	Column					
	1	2	3	4	5	totals
desired totals	230	450	800	0	420	1,900
intermediate totals	289.1	502.4	707.4	0	401.1	1,900
difference	-59.1	-52.4	92.6	0	18.9	0

CALCULATE PROPORTION OF TOTAL COLUMN DIFFERENCE TO BE APPORTIONED TO ROW 1:

row 1 share of matrix = 300/1,900 = 0.1579
apply this share to the total column difference

	Column				
	1	2	3	4	5
proportional share	-9.3	-8.3	14.6	0	3.0

(e.g., -59.1 * 0.1579 = -9.3)

(ADD THIS PROPORTIONAL SHARE TO THE FACTORED ROW 1 ELEMENTS:)

	Column					
	1	2	3	4	5	total
new row 1 elements	-9.3	77.4	186.0	0	45.9	300

(e.g., 85.7 - 8.3 = 77.4)

Note that the new row 1, column 1 element is negative (-9.3). This is not allowed, so this cell must be set back to zero, and the other cells revised to maintain the correct new total of 300. This is done by multiplying the other cells by 1-9.3/(300+9.3), which equals 0.9699.

	Column 1	2	3	4	5	total
evised new row 1 elements	0	75.1	180.4	0	44.5	300

(e.g., 77.4 * 0.9699 = 75.1)

This completes the factoring of row 1. For row 2, the same process is followed, except that the row 2 share of the matrix is calculated based on the remaining rows, excluding row 1.

Therefore, the row 2 share of the remaining matrix is:

240/(1,900-300) = 0.1500

Also, the total column differences are adjusted by the amounts already apportioned to the columns of row 1:

	Column 1	2	3	4	5
ew total column differences	-59.1	-41.8	83.6	0	17.3

(e.g., -52.4 + (85.7-75.1) = -41.8)

Now, the proportional new 2 share (0.1500) is applied to these new total column differences, and the process repeats as for row 1.

Continuing in this manner for all rows, the final matrix is as follows:

		Row 1	2	3	4	5	row totals
	1	0	75.1	180.4	0	44.5	300
	2	38.1	0	105.8	0	96.1	240
olumn	3	109.7	178.6	32.0	0	269.7	590
	4	0	0	0	0	0	0
	5	82.2	196.3	481.8	0	9.7	770
olumn totals		230	450	800	0	420	1,900

APPENDIX C

DATA SOURCES FOR TRAVEL MARKET DISTRIBUTIONS AND MODAL SUMMARY TABLES

APPENDIX C
DATA SOURCES FOR TRAVEL MARKET DISTRIBUTIONS AND MODAL SUMMARY TABLES

This appendix describes the information sources for the development of the commuter travel market distributions and modal summary tables for the Virginia Commuter Study (i.e., Tables 3-9 in the text). Where applicable, assumptions made and adjustments performed regarding base data are explained.

SOCIOECONOMIC DISTRIBUTIONS OF COMMUTER TRAVEL MARKETS

Urban Area Size

The size of an urban area has certain implications regarding peak hour congestion, CBD parking fees, peak hour transit service which might be offered, etc. In order to acknowledge the effect of these typical conditions on mode choice behavior, three urban area sizes were examined and used to stratify typical mode shares. The three different area sizes were defined to maintain consistency with the data available in the literature and ensure applicability to the urban areas in Virginia. Urban areas were grouped into these categories, based on the following population totals:

Small urban area - under 100,000 population
Medium urban area - 100,000-500,000 population
Large urban area - over 500,000 population

Household Income

Household income was obtained from the Census Bureau publication, Money Income in 1978 of Households in the United States. To the degree possible, the following income ranges were used:

Low income - under $10,000
Medium income - $10,000-$25,000
High income - over $25,000

These income ranges were defined by Barton-Aschman as one element in standardizing the modal response differences by income reported in the literature.

Employment Concentration

The distribution of workers by employer size (excluding self-employed persons and other categories for which data was not reported) was derived from Census Bureau information on 1979 Virginia County Business Patterns. Because this source listed number of firms by employment size, as opposed to number of workers by employment size, it was necessary to make certain assumptions and adjustments. It was assumed that the number of employees for a firm within a given range equalled the mid-point of that range. A check was then made for those areas with no employers in the largest (1,000+ employees) category, since the largest category has no mid-point. As anticipated, the actual total number of employees was in all cases lower than the estimated total, indicating that employment size tended toward the lower end of each range. This overestimation was remarkably consistent, the ratio of actual and estimated employment ranging between .88 and .96, the average being .922. The estimated employment for firms of under 1,000 employees was multipled by .922 and the difference between this figure and the area total was assigned to the 1,000+ category.

Representative urban areas in Virginia were selected for analysis, as follows:

Large urban area	-	Richmond Tidewater region (Newport News, Norfolk, Hampton, Portsmouth)
Medium urban area	-	Roanoke Petersburg Lynchburg
Small urban area	-	Martinsville Fredericksburg Staunton

Type of Employment

Employment type (white collar, retail, and blue collar) was obtained from 1970 Census data. The representative urban areas above, with the addition of the Washington, D.C. SMSA in the large urban area category were used as sources.

Work Trip Length

One way commute trip length, excluding those working at home was acquired from the 1977 National Personal Transportation Study.

MODAL SUMMARY TABLES

Carpooling

The carpool mode share comes from the Federal Highway Administration publication Home-to-Work Trips and Travel, based on the 1977 National Personal Transportation Study. Carpooling is defined as a vehicle carrying between two and six persons. Seven or more person vehicles, excluding transit vehicles, are considered vanpools regardless of vehicle type). The proportional adjustment factors and carpool encouragement factors were derived from several case studies of carpooling. Chief among these were:

Wagner, Frederick A. Evaluation of Carpool Demonstration Projects. 1978. A study of 26 areawide carpooling programs.

Pratt, R. H., et.al. Traveler Response to Transportation System Changes. 1977. First Edition. A compendium of Transportation System Management project results, including carpooling.

Kendall, D.C. Carpooling: Status and Potential. 1975. National survey results and specific project results from throughout the United States.

Vanpooling

The vanpool mode share was determined by the Home-to-Work Trips and Travel publication mentioned above and represents all persons journeying to work in 7+ person non-transit vehicles. The primary sources for all vanpooling encouragement factors were the following documents:

Jacobson, J. O. Employer Vanpool Programs: Factors in Their Success or Failure. 1977. A survey of 58 vanpooling programs.

Stevens, K. B., et.al. Characteristics of Vanpools and Vanpoolers in Maryland. 1980. A survey of Baltimore and Washington area vanpoolers.

Pratt, R. H. and J. N. Copple. Traveler Response to Transportation System Changes. 1981. Second Edition. Update of the previous edition referenced under carpooling.

Wagner, F. A. and J. H. Suhrbier. Vanpool Research : State of the Art Overview. 1979. Comprehensive review of project results.

Owens, R. D. and H. L. Sever. The 3M Commute-A-Van: Status Report and Status Report II. 1974 and 1977. Description of one of the first employer sponsored vanpool programs.

The vanpool encouragement factors relate experience with employer-oriented vanpooling efforts (i.e., employees were contacted by or through their employers). These factors should not be applied indiscriminately to wide-ranging travel markets.

Buspooling

The buspooling mode share and adjustment factors were obtained from individual case studies and are applicable only in those travel markets for which the buspool mode is an available option. Thus, the modal share is only of those trips within a corridor containing buspool service and then only to those destinations served by buspools.

Express Transit

Data for both forms of express transit, buses in mixed traffic and busway, was also derived from individual case studies and the same caveats apply that were stated for buspools.

APPENDIX D

DOCUMENTATION FOR THE CORRIDOR SKETCH PLANNING PROGRAM

INTRODUCTION

The primary purpose of sketch planning analysis is to quickly ascertain if an alternative is clearly incapable of meeting specified transportation objectives or, conversely, if there is a reasonable expectation that the alternative can meet those objectives. This introductory statement embodies three key words: quickly, clearly, and reasonable. A sketch planning methodology should be capable of quickly providing usage estimates, since a large number of alternatives should be considered in the sketch planning phase. These alternatives may include: (1) different alignment or corridors; (2) modal/technology comparisons; (3) alternative operating policies, e.g., headways, fares, feeder bus services, etc.; or (4) economic and land-use policy scenarios, e.g., parking costs, gasoline costs, population and employment densities, etc. A full-scale travel demand model set constrains the analyst from investigating a large number of alternatives because of substantial input data requirements and the significant corresponding cost required to apply the models.

A quick, inexpensive planning methodology will allow for the evaluation of numerous alternatives, but there is a trade-off inherent in this inexpensive, fast turn-around process. This trade-off is a substantial reduction in the precision of the model's estimates. Sketch planning, by its nature, can never be as precise as more sophisticated simulation methods. The key to choosing or designing a sketch planning technique is to reach an acceptable compromise between the cost of applying the technique and the precision of the estimates produced. The basic tenet that sketch planning should be directed towards the rejection or acceptance of an alternative allows this type of compromise to be made. By establishing an acceptable tolerance for acceptance/rejection, the required precision of the sketch planning technique can be comfortably defined.

There are a number of possible applications for sketch planning models, as there are in the more traditional planning process. For example, sketch planning techniques can be applied to: (1) technology assessment; (2) capital cost estimation; (3) operating cost estimation; (4) social cost estimation, e.g., displacement, energy costs, and environmental impacts; or, (5) demand estimation. The model discussed in this section concentrates primarily on demand estimation, although its output may also be used to assist in the performance of air quality analyses. Long-range sketch planning techniques such as this one are normally applied at the regional or corridor level. More detailed planning techniques such as those dealing with specific routes or links are primarily applied at the detailed zonal level.

The use of sketch planning techniques in an overall planning framework is important for several reasons. Too often an alternative which has been investigated using the "full-scale" techniques is accepted simply because it is too expensive to investigate a wider range of alternatives. Full-scale planning estimates also tend to be accepted as the final work, primarily because of the expense required to apply the techniques. Sketch planning does not have these drawbacks. Such techniques should be in expensive and quick, albeit imprecise, and thus more amiable to policy and issue planning, since they allow decision-makers to concentrate on issues rather than specific numerical estimates.

The requirement that a sketch planning technique be inexpensive and quick, and the inherent precision of sketch planning tools essentially prohibits these techniques from being all-purpose planning tools. To develop an effective technique, the analyst should first decide on the primary estimates which are to be made (e.g., regional travel, corridor travel, or sub-area travel) and then design the techniques specifically for this purpose. It is, therefore, possible (and logical) that several different sketch planning techniques be used in a region, each technique contributing a different level of estimates.

The corridor sketch planning program documentated in this report fullfills one aspect of sketch planning, namely to be able to estimate corridor travel volumes to test the viability of fixed-guideway transit lines and/or high occupancy vehicle (HOV) lanes. The model applied in this program has neither the high precision of zone-level travel demand modeling, nor the high cost associated with producing these zone-level estimates. The program has been developed in such a manner that a substantial amount of zone-level information is used, but there is no requirement to develop, code, or perform data processing on a zone-level "UTPS" transit network. The ability of the program to use and produce zone-level data allows a high level of detail in the demand estimates, and a considerable time and cost savings will result from not having to code transit networks. The program has been designed in a modular format so that the user may choose a fairly basic set of options requiring a minimal amount of information, or he may choose a more complex set of options which requires a considerably larger amount of information.

The basic program input requirements are: (1) a person work trip table; (2) a highway travel time matrix; (3) a highway distance matrix; (4) transit walk and wait times by zone; (5) the usual mode choice zonal data, i.e., daily parking costs, households by income level, and highway terminal times. Optionally, the user may also input percentages to be used for allocating regional VMT to air quality districts and facility types. The program can produce the following output: (1) a set of trip-end summaries by mode; (2) a set of reports showing regional trips by mode and income, guideway loadings, and VMT by air quality district and facility type; and (3) a set of UTPS trip tables by mode.

The corridor sketch planning program has been written using the UTPS program UMODEL. The user should, therefore, be familiar with UTPS program documentation for UMODEL before using this program. The FORTRAN source code for the program is attached at the end of Appendix D.

The program is intended for the analysis of work trips only, and it is assumed that the input person work trips are in production/attraction format, i.e., trips specified with the origin end being the place of residence and the destination end being the place of employment. The ability of a transit system to attract work trips is, of course, a very major element in determining the feasibility of transit system, while the production/attraction format is a requirement of the basic mode choice model. Under normal circumstances, daily transit travel can be estimated by assuming that transit work trips make up approximately two-thirds of all transit trips.

METHODOLOGY

The corridor sketch planning program's methodology consists of three phases: (1) the estimation of transit travel times and costs; (2) the estimation of modal demand, i.e., transit trips, carpool trips, and non-carpool auto trips; and (3) the development of reports and computer files containing the demand estimates.

The most unique aspect of this methodology is the estimation of transit travel times and costs. The technique used to estimate travel demand was taken primarily from mode choice models estimated for the cities of Seattle, Minneapolis-St. Paul, and New Orleans, while the reports and computer files are standard UTPS reports and files.

The estimation of transit travel times is separated into two distinct phases: (1) the estimation of regular (i.e., non-guideway) transit times, i.e., buses operating in mixed traffic; and (2) the estimation of travel times for transit services operating on a fixed guideway. The estimation of regular transit times is dependent upon the user's specifying the average walk and wait times for the various available transit services (local radial bus, local non-radial bus, express bus) from each zone. The methodology used to calculate the regular transit times is then to: (1) use the walk times of both the origin and destination zone; (2) use the wait time of either the origin or destination zone, whichever is greater; and (3) calculate the in-vehicle transit time by using the highway distance and a regional transit speed, depending on the type of service. This method of estimating transit times is described in the article "Design-Synthesis Approach to Transit Planning" in Transportation Research Record 639, published in 1977.

When the local transit system is required in order to access the guideway transit service, the methodology consists of: (1) using an additional set of walk and wait times to represent the feeder bus service: and (2) estimating the distance from the zone to the guideway and applying the appropriate regional bus speed to calculate transit in-vehicle time.

The calculation of guideway transit time is a little more detailed since the user may specify two types of guideway transit. Both options involve the specification of an angle (azimuth) and distance from the primary activity center zone, which together are used to approximate the location of the guideway facility. Both options first estimate the feeder bus time from the origin zone to the guideway (see above). The transit service provided on the guideway may be defined either as express bus service or as light rail service. In the former case, the guideway transit time is estimated from the point where the guideway is accessed to the primary activity center zone. If this is not the final destination, the transit time from the primary activity center zone to the final destination must be added. If the light rail option is exercised, there is the additional possibility of intracorridor and outbound trips using the guideway. Travel times for these types of trips are estimated using the appropriate combination of feeder bus times and guideway transit time. Figure 1 illustrates how the concept of a fixed guideway is described in this process.

Once the transit travel times are estimated, the next step of the methodology is to estimate the trips by mode. The program performs this step by applying a five-mode logit model described below. This model produces estimates of transit trips, automobile person trips which will use the HOV lane (if one exists), and "normal" (non-HOV) automobile person trips. Once these trips have been estimated, the program produces a set of reports and computer files summarizing the demand estimates. The reports may consist of: (1) a summary of modal trips by income: (2) a summary of trips using the guideway service, indicating where they enter and exit the facility; (3) a summary of VMT by air quality district and highway facility type; and (4) the number of trip ends for each mode. The computer files are modal zone-to-zone trip tables, in UTPS format, which can be used for summary purposes using other UTPS programs.

MODEL STRUCTURE

A mode choice model is simply a mathematical algorithm which is used to estimate the modal shares of the total demand for travel. These estimated shares are based on the time and cost characteristics of the various competing modes and the socioeconomic characteristics of the travellers. The mode choice model used in this program is a multinomial logit model (MNL), designed to produce policy-oriented travel forecasts. The model estimates the probability of a given traveller using one of several modes given certain information which is largely a function of overall urban transportation policy considerations. The MNL model has been shown to replicate the actual travel mode choices of individuals quite well and its mathematical properties make it relatively easy to calibrate. In addition, the coefficients of such models tend to remain stable over time, so that their use in forecasting is enhanced.

Many early logit models were bi-modal in that they estimated modal shares for auto and transit only. The multinomial version estimates shares for three or more modes. The model incorporated into the corridor sketch planning program is a two-stage logit model. The first stage estimates shares for three modes: transit, drive alone, and group auto (otherwise known as ridesharing, or any auto with two or more occupants). The second stage splits out the group auto trips into autos with two, three, or four or more occupants. The main advantages of this stratification are that logical relationships among auto driver, auto passenger, and transit trips can be estimated and that different travel times and costs can be used for the drive alone and ridesharing modes. This type of model has been successfully calibrated in many other areas and is suitable for a variety of analysis techniques.

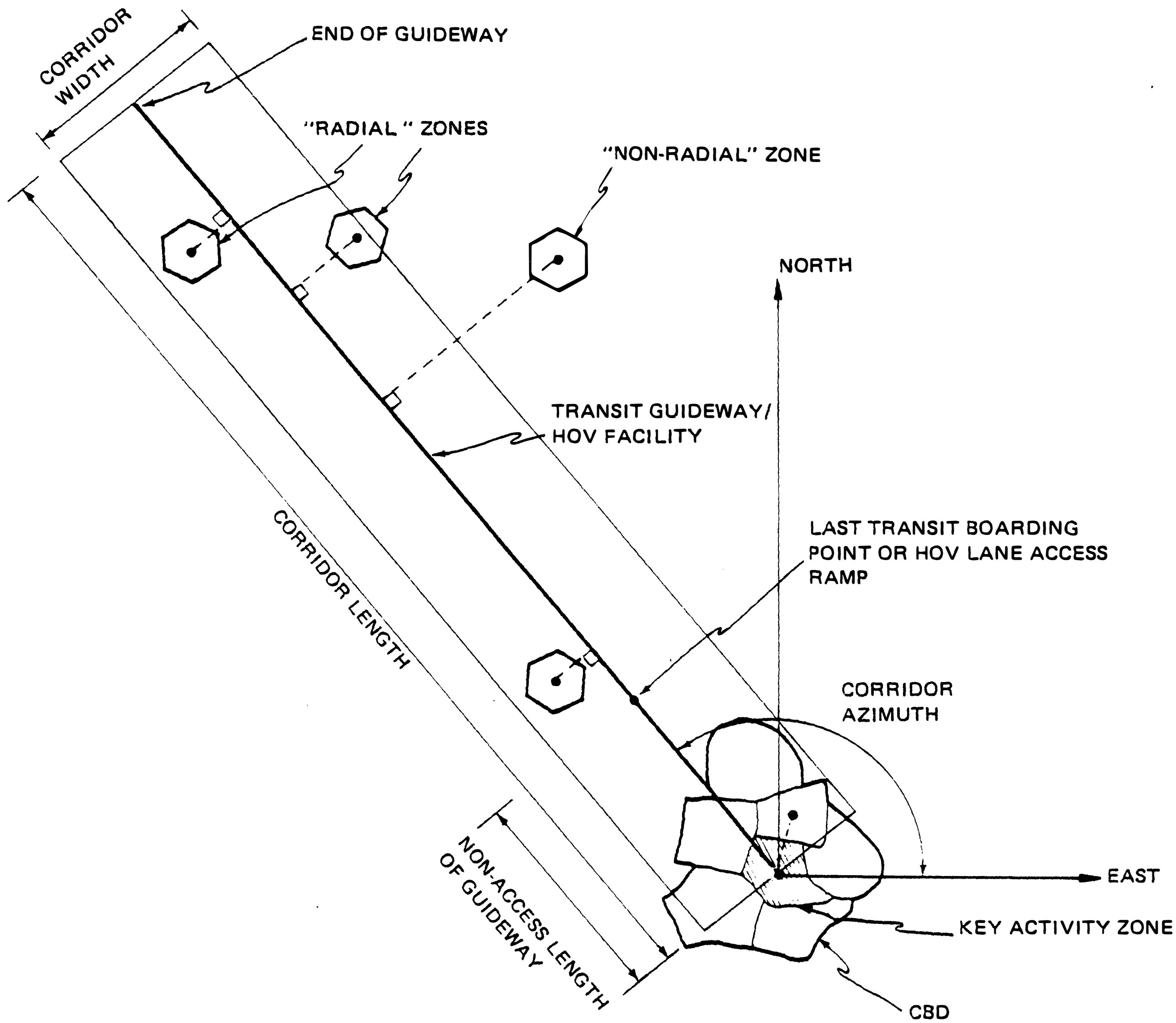

Figure 1
SCHEMATIC DIAGRAM FOR DEFINING A CORRIDOR TRANSIT / HOV FIXED GUIDEWAY FACILITY

Virginia Commuting Study

---- ACCESS/EGRESS MOVEMENTS
● ZONE CENTROIDS

This approach is particularly suited for the consideration of HOV incentives, since it allows transportation system and traveler characteristics to dynamically influence auto occupancies and permits the explicit consideration of time and/or cost advantages for HOVs. In addition, the program allows for the flexible definition of the minimum occupancy that constitutes a carpool.

The mode choice model is described in terms of the basic logit formulation and the equations used to calculate the disutility of each mode. The basic logit formulation estimates the probability of choosing mode i as follows:

$$P(i) = \frac{\exp(-U(i))}{\sum_{K=1}^{n} \exp(-U(K))}$$

Where:

P(i)	=	probability of choosing mode i
U(i)	=	disutility function of mode i
U(K)'s	=	disutility functions of all available modes, K=1, 2,...n
exp	=	the exponential function ($\exp(x) = e^{x}$)

In short, as the impedance of mode i increases, U(i) becomes algebraically larger (more positive), -U(i) becomes smaller (more negative), and exp (-U(i)) becomes smaller (closer to zero) so that the likelihood that mode i will be used decreases relative to the other modes. In Table 1, the disutility functions (the U(i)'s) are given names: TRN (transit), ONE (drive alone), and GROUP.

The disutility equations for each of the three modes are given in Table 1. Each disutility function is a linear combination of transportation system variables and traveler socioeconomic variables, factored by coefficients to modify their contributions to the overall disutility. The definitions of the variables are given in Table 2. The coefficients in Table 1 are based on similar logit models developed in Seattle, New Orleans, and Minneapolis-St. Paul. They have been modified slightly to replicate travel conditions in Northern Virginia. This was done as part of the process of validating the model for the Northern Virginia Case Study.

DATA REQUIREMENTS

The corridor sketch planning program requires a considerable amount of data. Fortunately, much of this data is information already required to produce zone-level forecasts and therefore should be readily available. This information is as follows:

Table I
MODE CHOICE MODEL DISUTILITY EQUATIONS

TRN	=	0.030	*	WAITI	+	0.044	*	(WALK + WAIT2)
	+	0.031	*	TRN RUN	+	0.510	*	AUTO CONN
	+	0.014	*	FARE				
ONE	=	0.050	*	HWY EXC	+	0.031	*	HWY RUNI
	+	0.014	*	HWY CSTI	+	0.014	*	PRK CSTI
	+	0.9845	*	INCIDA	+	0.4525	*	INC2DA
	-	0.2204	*	INC3DA	-	0.5572	*	INC4DA
GROUP	=	0.040	*	HWY EXC	+	0.031	*	HWY RUNG
	+	0.014	*	HWY CSTG	+	0.014	*	PRK CSTG
	+	1.5353	*	INCIGR	+	1.1599	*	INC2GR
	+	0.9861	*	INC3GR	+	0.9727	*	INC4GR

Table 2
VARIABLE DEFINITIONS

Acronym	Definition	Units
WAIT1	Boarding time for the first transit vehicle	minutes
WALK	Time to access the transit system (by walk or auto)	minutes
WAIT2	Time spent transferring between transit vehicles	minutes
TRN RUN	Total in-vehicle transit time	minutes
AUTO CONN	Dummy variable indicating whether or not an auto is required to access the transit system (0=no, 1=yes)	--
FARE	One-way peak transit fare	cents
HWY EXC	Time spent parking and un-parking a vehicle (also called highway excess or terminal time)	minutes
HWY RUN1	Auto in-vehicle time for drive alone trips	minutes
HWY RUNG	Auto in-vehicle time for group auto trips (same as HWY RUN1, plus an additional time for each passenger)	minutes
HWY CST1	One-way auto operating cost for drive alone trips	cents
HWY CSTG	One-way auto operating cost for group auto	cents
PRK CST1	One-half the average daily parking cost for drive alone trips	cents
PRK CSTG	One-half the average daily parking cost for group auto trips	cents
INC1DA	Dummy variables indicating if traveller is in the lowest income quartile for drive alone trips (0=no, 1=yes)	--

Table 2 (Continued)
VARIABLE DEFINITIONS

Acronym	Definition	Units
INC1GR	Same as INC1DA, for group auto trips	--
INC2DA	Same as INC1DA, for low-middle income quartile	--
INC2GR	Same as INC1GR for low-middle income quartile	--
INC3DA	Same as INC1DA, for high-middle income quartile	--
INC3GR	Same as INC1GR, for high-middle income quartile	--
INC4DA	Same as INC1DA, for highest income quartile	--
INC4GR	Same as INC1GR, for highest income quartile	--

person work trip table*
highway travel time matrix
highway distance matrix
daily parking costs
highway terminal time
number of households by income quartile
transit fare matrix (optional)

Zonal data which will probably not be available from the zone-level forecasts are: (1) zonal coordinates; (2) zone definitions; (3) zonal walk and wait times as described previously. Table 3 contains a detailed listing and explanation of the zonal and interchange data required by the program. It should be noted that this program is intended as a fairly general tool, and hence the maximum number of zones allowed is 100. Zone systems larger than this will have to be compressed to meet this constraint. Tables 4-6 illustrate typical input zonal data files. Table 4 contains demographic and system data. Table 5 contains the CBD flag, zonal coordinates, and production and attraction factors. Table 6 shows transit level of service data.

In addition, in order for the program to produce information regarding the distribution of regional VMT by air quality district and facility type, the user must input percentages which may be used to distribute VMT in this manner. A maximum of fifteen air quality analysis districts may be defined. The percentages must be input using two computer files. The first file contains the percent of a trip between any pair of air quality districts which passes through each district. There must be one record in the file for each pair of air quality districts. The format of each of these records in shown in Table 7. This table also indicates the format for a second computer file which contains the proportion of VMT by facility type for each air quality district.

CODING TRANSIT LEVEL OF SERVICE

In order to provide a quick response time from the initial identification of an alternative to the estimate of usage, the program uses a "level of service" specification of transit service. This is in direct contrast to the route-specific representation typical of most transportation models. The level of service specification involves identifying the availability of up to four service types in each zone, and for each service type, providing three service parameters. The service types recognized by the model are: local radial transit, local non-radial transit, express guideway transit and express non-

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* The program allows the option of inputting a vehicle (auto driver) trip table, instead of person trips. In this case, the program uses the estimated auto driver share to estimate the number of total person trips.

Table 3
DATA REQUIREMENTS FOR THE CORRIDOR SKETCH PLANNING PROGRAM

Data Item Number (14)	Data Type (14)	Z Array Position (14)	Description
1	P	1	Zone Number (1)
2	A	2	CBD Zone Flag (= 1, if Zone in CBD) (13)
3	P	3	X-coordinate of Zone (2)
4	P	4	Y-coordinate of Zone (2)
5	P	5	Walk Time to Regular Express (3)
6	P	6	Wait Time for Regular Express (4)
7	P	7	Auto-Connect Flag for Regular Express (5)
8	P	8	Walk Time to Local Radial Transit (3)
9	P	9	Wait Time for Local Radial Transit (4)
10	P	10	Walk Time to Local Non-Radial Transit (3)
11	P	11	Wait Time for Local Non-Radial Transit (3)
12	P	12	Auto-Connect Flag for Local Bus (5)
13	P	13	Walk Time to Feeder Bus to Guideway Transit (3)
14	P	14	Wait Time for Feeder Bus to Guideway Transit (4)
15	P	15	Auto-Connect Flag for Guideway Express/LRT (5)
16	A	16	Highway Terminal Time for Carpools (6)
17	A	17	Daily Parking Cost for Carpools (7)
18	A	18	Normal Highway Terminal Time (6)
19	A	19	Normal Daily Parking Cost (7)
20	P	20	Households in First Income Quartile (8)
21	P	21	Households in Second Income Quartile (8)
22	P	22	Households in Third Income Quartile (8)
23	P	23	Households in Fourth Income Quartile (8)
24	P*(15)	24	Production Factor (9)
25	A*(15)	25	Attraction Factor (9)
26	X	—	Person or Auto-Driver Work Trip Table (10)

ˉable 3 (cont'd)
)ATA REQUIREMENTS FOR THE CORRIDOR
SKETCH PLANNING PROGRAM

Data Item Number (14)	Data Type (14)	Z Array Position (14)	Description
27	X	—	Highway Travel Time Matrix (11)
28	X	—	Highway Distance Matrix (11)
29	X	—	Transit Fare Matrix (12)

Notes to Table 3

(1) The zone number identifies the zone to which the data on each record belongs. This zone number must be coded on each record of each zonal data file, and it must appear in the same columns in each file.

(2) The zonal coordinates are needed to estimate the travel distance from the origin zone to the guideway facility, and the distance travelled on the guideway.

(3) Transit walk times represent the average access time to or from the transit system to which they refer. Should be coded as 99 if service is not available.

(4) Transit wait times should be one-half the combined headway of the buses providing the particular service to residents of the zone. Should be coded as 99 if service is not available.

(5) Auto-connect flags should be coded as 1 when the predominant means of accessing the particular transit service is by automobile (as opposed to feeder bus or walking).

(6) Terminal times are developed by local transportation planners to represent the average time to access the highway network in each zone. The program allows different terminal times for vehicles containing a minimum number of persons (high-occupancy vehicles).

(7) Parking costs are developed by local transportation planners to represent the average daily parking cost in each zone. The program allows different parking costs to be assessed to vehicles containing a minimum number of persons (high-occupancy vehicles).

(8) Households by income class are developed by local transportation planners to represent the number of households in each of four income quartiles.

(9) Production and attraction factors may be optionally input if it is desired to factor the input trip table to estimate future conditions.

(10) The trip table may be created by "squeezing down" a full zonal trip table to the sketch planning zone level. If an auto-driver trip table is input, it will be automatically converted to an estimated person trip table by the program.

(11) The highway distance and travel time matrices are created by taking the output matrices from UROAD, and converting them to the sketch planning zone level, weighting by the number of trips in the trip table.

(12) Transit fares may either be estimated using a mileage-based fare system, in which case one need not input a fare matrix, or a fare matrix may be input, yielding transit fares directly. If no fare matrix is input, the corresponding data ID card may be eliminated.

(13) The CBD zone flag identifies zones which are located within the CBD. This enables the program to determine those zones for which direct express bus service is available.

Notes to Table 3
(Cont'd)

(14) These columns correspond to columns on the UMODEL data identification cards.

(15) The asterisks signify that these are optional data items. If these items are input, the asterisks should be removed from the data ID cards.

Table 4
TYPICAL DEMOGRAPHIC AND SYSTEM DATA

ZONE	COMM-ERCIAL ACRES	RESI-DENTIAL ACRES	TOTAL ACRES	TOTAL EMPLOY-MENT	HIGHWAY TERM. TIME	DAILY PARKING COST	HOUSEHOLDS BY INCOME LOW	LOW-MID	HIGH-MID	HIGH
1	22	187	225	38846	7	218	175	430	430	568
2	119	85	230	58526	7	231	819	1144	1144	982
3	105	82	212	62428	7	228	232	342	842	018
4	52	59	192	27499	5	205	476	159	159	014
5	0	92	147	43127	5	229	0	0	0	000
6	0	138	186	29492	7	215	0	0	0	000
7	227	115	461	16671	4	168	1544	2134	2134	1541
8	167	40	224	9725	4	170	3385	2199	2199	677
9	363	93	518	7880	4	134	6702	2437	2437	607
10	169	71	269	2659	4	20	1879	696	696	207
11	239	215	538	38235	4	185	1798	758	758	478
12	10	145	173	13019	4	194	196	130	130	121
13	70	398	609	69101	7	201	788	626	626	604
14	0	11	703	3455	4	185	0	0	0	000
15	40	290	1466	38975	5	155	633	410	410	257
16	52	58	288	17060	6	154	721	976	976	321
17	640	792	2355	40990	3	143	2734	2335	2335	2211
18	2218	709	3602	14435	3	31	7463	6791	6791	3921
19	5773	1099	8793	30540	3	56	7654	7976	7976	8649
20	4665	3596	9696	56500	3	37	17323	13871	13871	8435
21	614	2029	5952	10741	3	7	590	1000	1000	689
22	2331	400	3622	3955	3	0	898	1646	1646	1796
23	3337	329	4409	4883	3	0	1647	3233	3233	3647
24	1714	715	2797	13252	3	8	1536	3017	3017	3401
25	4765	1464	7568	20304	3	8	2637	4371	4371	5110
26	1665	455	2848	8582	3	28	1371	2193	2193	3381
27	4069	305	7572	23117	3	27	881	1452	1452	5030
28	2778	850	5005	7057	2	0	2354	3376	3376	6595
29	1327	423	4352	1761	2	0	1201	1861	1861	1079
30	1421	441	4538	2075	2	0	674	1043	1043	603
31	2272	1140	5184	3520	2	0	777	1531	1531	1350
32	2270	444	4077	2160	2	0	811	2100	2100	2357
33	3426	413	4692	6429	2	0	646	1613	1613	3277
34	4433	2790	10361	16894	2	0	1016	2713	2713	4860
35	1648	283	2451	4057	2	0	317	336	336	398
36	172	717	1402	12838	2	43	219	431	431	487
37	730	223	6401	853	2	0	167	457	457	784
38	4768	1210	7848	4099	2	0	2020	2830	2830	5795
39	226	2167	8608	8212	2	0	50	55	55	038
40	1134	916	6950	4988	2	0	460	847	847	717
41	1137	25	5927	259	2	0	287	1261	1261	1324
42	615	57	5588	305	2	0	464	1202	1202	1350
43	2674	652	5242	2696	2	0	864	1977	1779	2373
44	2356	1161	8460	19759	2	5	1918	2665	2665	3416
45	2485	250	5247	3740	2	0	631	1637	1639	2394
46	1203	102	3757	943	2	0	270	602	602	982
47	1810	199	10202	2013	2	0	169	323	323	1545
48	417	647	18003	1868	2	0	142	365	365	712
49	500	14	16345	99	2	0	42	297	277	424
50	946	82	14284	484	2	0	88	448	448	768
51	758	246	16076	1020	2	0	195	713	713	1244
52	2515	621	11551	1960	2	0	299	1090	1090	1795
53	460	137	12217	1233	2	0	128	562	562	867
54	2827	324	7265	3948	2	0	776	2325	2325	4264
55	1443	484	7935	6988	2	0	488	2191	2191	3248
56	818	160	11930	713	2	0	152	615	615	775
57	0	3003	7648	5025	2	0	0	0	0	000
58	1278	330	10316	2756	2	0	890	1805	1805	1420
59	467	82	3877	572	2	0	553	1144	1144	899
60	117	46	19968	330	2	0	110	92	92	086
61	357	573	40947	1466	2	0	281	285	285	229
62	1073	923	31090	6544	2	0	913	765	965	797
63	1328	355	110208	2446	2	0	868	800	300	742
64	532	108	44128	418	2	0	734	645	645	506
65	306	236	57806	843	2	0	287	243	243	217
66	1566	1052	7457	7706	2	0	2177	2258	2258	1370
67	1199	697	12179	2293	2	0	708	1387	1387	1366
68	2790	381	13869	2092	2	0	1723	2630	2630	2581
69	421	54	11570	307	2	0	173	265	265	262
70	3427	1025	12102	11673	2	0	1571	2397	2397	1701
71	1214	487	8889	4258	2	0	965	1548	1548	1015
72	1870	1633	18700	14441	2	0	1641	1707	1707	1509
73	412	65	37126	404	2	0	120	244	244	339
74	672	387	32102	1394	2	0	449	762	762	1018
75	430	475	27598	2144	2	0	329	373	373	417
76	649	164	43680	1288	2	0	357	495	495	527
77	0	0	0	0	2	0	25	25	25	025
78	0	0	0	0	2	0	25	25	25	025
79	0	0	0	0	2	0	25	25	25	025
80	0	0	0	0	2	0	25	25	25	025

Table 5
TYPICAL ADDITIONAL INPUT ZONAL DATA

ZONE	CBD FLAG	X COORD	Y COORD	PROD FACTOR	ATTR FACTOR
1	1	2712	1753	1.063	1.085
2	1	2702	1782	1.000	1.091
3	1	2733	1783	1.053	1.135
4	1	2768	1764	1.750	1.113
5	1	2783	1745	1.000	1.095
6	1	2737	1754	1.000	1.078
7	1	2654	1764	1.000	1.078
8	1	2715	1815	1.000	1.082
9	1	2744	1813	1.016	1.081
10	1	2786	1802	1.143	1.185
11	1	2808	1777	1.250	1.068
12	1	2809	1721	1.000	1.122
13	1	2761	1723	1.083	1.059
14	1	2693	1710	1.000	1.029
15	1	2670	1669	1.235	1.013
16	1	2617	1748	1.533	1.550
17	1	2694	1605	2.175	1.651
18	1	2559	1631	1.132	1.083
19	1	2498	1752	1.210	1.600
20	1	2594	1468	1.215	1.414
21		2343	1413	1.485	1.252
22		2325	1498	1.150	1.000
23		2238	1548	1.076	1.020
24		2428	1600	1.136	1.218
25		2266	1639	1.170	1.740
26		2259	1836	1.187	1.093
27		2355	1890	1.364	1.199
28		2640	1337	1.185	1.141
29		2534	1334	1.400	1.056
30		2430	1337	3.500	4.143
31		2296	1336	1.212	1.576
32		2153	1336	1.459	1.136
33		2131	1471	1.069	1.016
34		2127	1621	1.531	1.864
35		2130	1789	1.931	1.829
36		2182	1857	1.063	2.938
37		2179	1969	1.421	1.444
38		2567	1130	1.304	1.098
39		2348	1071	4.000	1.024
40		2262	1194	1.931	2.060
41		2095	1233	2.220	3.000
42		1979	1320	2.071	10.000
43		1985	1472	1.694	1.296
44		1931	1623	1.196	1.606
45		1971	1793	1.381	1.378
46		2034	1892	1.280	1.000
47		1996	2152	1.382	2.950
48		2162	990	4.688	1.632
49		1816	1241	2.000	2.000
50		1724	1474	3.278	1.600
51		1473	1576	7.030	26.600
52		1734	1696	2.372	14.700
53		1562	1836	2.714	7.500
54		1854	1895	1.505	1.564
55		1696	2002	1.876	3.857
56		1855	2207	3.182	3.714
57		1547	2005	1.000	2.560
58		1597	2206	2.644	3.107
59		1740	2306	2.421	5.000
60		1226	1841	3.750	3.333
61		1170	2217	2.909	4.333
62		1210	2472	2.222	2.569
63		1026	2881	2.844	2.667
64		829	2474	1.800	3.500
65		533	2217	2.000	2.000
66		2073	790	1.259	1.727
67		1906	994	2.500	3.391
68		1756	881	1.875	2.476
69		1621	1079	2.300	2.333
70		1467	1271	1.446	1.444
71		1339	1408	1.961	1.674
72		1966	566	1.894	1.264
73		1621	674	3.600	3.750
74		1374	933	1.417	1.174
75		1092	1299	1.933	2.857
76		1052	1577	2.579	3.615
77		417	2564	1.406	1.452
78		668	2027	1.470	1.406
79		954	1145	1.527	1.440
80		1759	388	1.494	1.921

Table 6
TYPICAL TRANSIT SERVICE LEVEL INPUT DATA

	REGULAR EXPRESS			LOCAL RADIAL		LOCAL NON-RADIAL			GUIDEWAY EXPRESS		
ZONE	WALK TIME	WAIT TIME	AUTO CONN FLAG	WALK TIME	WAIT TIME	WALK TIME	WAIT TIME	AUTO CONN FLAG	WALK TIME	WAIT TIME	AUTO CONN FLAG
1	99	99	0	2	1	2	1	0	99	99	0
2	99	99	0	2	1	2	1	0	99	99	0
3	99	99	0	2	1	2	1	0	99	99	0
4	99	99	0	2	1	2	1	0	99	99	0
5	99	99	0	2	1	2	1	0	99	99	0
6	99	99	0	2	1	2	1	0	99	99	0
7	99	99	0	2	1	2	1	0	99	99	0
8	99	99	0	2	1	2	1	0	99	99	0
9	99	99	0	2	1	2	1	0	99	99	0
10	99	99	0	2	1	2	1	0	99	99	0
11	99	99	0	2	1	2	1	0	99	99	0
12	99	99	0	2	1	2	1	0	99	99	0
13	99	99	0	2	1	2	1	0	99	99	0
14	99	99	0	2	1	2	1	0	99	99	0
15	4	3	0	4	2	4	3	0	6	4	0
16	4	3	0	4	2	4	5	0	99	99	0
17	4	3	0	4	2	6	5	0	6	4	0
18	4	4	1	10	4	10	5	0	6	4	0
19	4	4	1	10	4	10	5	0	99	99	0
20	7	4	0	7	4	12	4	0	10	4	0
21	9	3	0	4	30	4	30	1	12	3	0
22	9	2	0	8	8	12	30	0	12	2	0
23	9	4	0	8	4	12	30	0	12	4	0
24	9	3	0	4	3	4	3	0	12	8	0
25	9	3	0	8	3	8	5	0	99	99	0
26	6	2	1	10	2	10	2	0	99	99	0
27	4	5	1	4	4	4	4	1	99	99	0
28	10	3	0	10	3	99	99	0	21	0	1
29	12	5	0	3	6	99	99	1	17	0	1
30	10	5	0	10	8	99	99	0	10	4	0
31	4	5	0	4	8	99	99	0	4	5	0
32	12	5	0	6	8	99	99	0	12	5	0
33	3	3	1	12	8	12	8	0	17	0	1
34	8	4	0	4	3	99	99	1	99	99	0
35	4	2	1	2	15	2	15	1	99	99	0
36	2	2	1	2	4	2	6	1	99	99	0
37	6	8	1	8	4	8	6	1	99	99	0
38	12	6	0	3	6	99	99	1	25	0	1
39	4	8	1	4	10	99	99	1	23	0	1
40	2	10	1	2	15	99	99	1	11	0	1
41	7	5	1	7	15	99	99	1	19	0	1
42	3	8	1	5	15	99	99	1	23	0	1
43	2	10	1	2	8	99	99	1	26	0	1
44	6	5	0	6	5	6	5	0	99	99	0
45	3	10	1	3	10	99	99	1	99	99	0
46	99	99	0	3	15	99	99	1	99	99	0
47	99	99	0	3	15	99	99	1	99	99	0
48	7	15	1	99	99	99	99	0	30	0	1
49	20	15	1	99	99	99	99	0	99	99	0
50	14	10	1	14	15	99	99	1	99	99	0
51	25	10	1	25	15	99	99	1	99	99	0
52	16	10	1	16	15	99	99	1	99	99	0
53	4	30	1	12	5	99	99	0	99	99	0
54	12	5	0	12	5	99	99	0	99	99	0
55	4	5	1	3	5	99	99	1	99	99	0
56	4	30	1	4	30	99	99	1	99	99	0
57	20	5	1	99	99	99	99	0	99	99	0
58	21	5	1	99	99	99	99	0	99	99	0
59	24	5	1	99	99	99	99	0	99	99	0
60	25	5	1	99	99	99	99	0	99	99	0
61	25	5	1	99	99	99	99	0	99	99	0
62	12	30	1	99	99	99	99	0	99	99	0
63	25	30	1	99	99	99	99	0	99	99	0
64	25	30	1	99	99	99	99	0	99	99	0
65	25	30	1	99	99	99	99	0	99	99	0
66	9	3	1	99	99	99	99	0	40	0	1
67	15	3	1	99	99	99	99	0	39	0	1
68	19	4	1	99	99	99	99	0	55	0	1
69	25	10	1	99	99	99	99	0	99	99	0
70	10	10	1	99	99	99	99	0	99	99	0
71	18	10	1	99	99	99	99	0	99	99	0
72	9	15	1	99	99	99	99	0	60	0	1
73	25	15	1	99	99	99	99	0	60	0	1
74	25	30	1	99	99	99	99	0	99	99	0
75	25	30	1	99	99	99	99	0	99	99	0
76	25	30	1	99	99	99	99	0	99	99	0
77	99	99	0	99	99	99	99	0	99	99	0
78	30	30	1	99	99	99	99	0	99	99	0
79	99	99	0	99	99	99	99	0	99	99	0
80	20	20	1	99	99	99	99	0	60	0	1

NOTES: THERE IS ONLY ONE AUTO CONNECT FLAG FOR LOCAL TRANSIT SERVICE; THE SAME FLAG APPLIES TO RADIAL AS WELL AS NON-RADIAL SERVICE.
A VALUE OF '99' MEANS THAT THE SERVICE DOES NOT EXIST.

Table 7
FORMAT OF AIR QUALITY ANALYSIS DISTRICT INPUT DATA

First Record

Columns	Format	Contents		
1-5	I5	origin district number		
6-10	I5	destination district number		
11-14	F4.2	proportion of trip in district	1	(X.XX)
15-18	F4.2	proportion of trip in district	2	
19-22	F4.2	proportion of trip in district	3	
23-26	F4.2	proportion of trip in district	4	
27-30	F4.2	proportion of trip in district	5	
31-34	F4.2	proportion of trip in district	6	
35-38	F4.2	proportion of trip in district	7	
39-42	F4.2	proportion of trip in district	8	
43-46	F4.2	proportion of trip in district	9	
47-50	F4.2	proportion of trip in district	10	
51-54	F4.2	proportion of trip in district	11	
55-58	F4.2	proportion of trip in district	12	
59-62	F4.2	proportion of trip in district	13	
63-68	F4.2	proportion of trip in district	14	
67-70	F4.2	proportion of trip in district	15	

Second Record

Columns	Format	Contents
1-5	I5	air quality distict number
6-15	F10.2	proportion of VMT on interstate highways
16-25	F10.2	proportion of VMT on expressways
26-35	F10.2	proportion of VMT on primary arterials
36-45	F10.2	proportion of VMT on minor arterials
46-55	F10.2	proportion of VMT on collector streets
56-65	F10.2	proportion of VMT on local streets

guideway transit (also called regular express). Each service type is described in terms of its service parameters: access time, wait time, and access mode.

This more general description of the transit system reduces the effort to "code" and later modify transit system alternatives. It also allows the testing of policy-based service designs without the tedium of translating service levels into specific transit lines. This departure from the more typical representation of a transit system requires the analyst to change his focus from the detail of specific routes to the general level of service provided to a particular zone.

Alternatives to be tested may be initially defined in level of service terms or may be converted to level of service parameters from a line-specific definition. The results of the analysis, however, cannot be converted to line-specific impacts. The proper interpretation of the output of this program is limited to system-wide impacts.

In the following sections, the procedures for generating a level of service description of a transit system is given. As in any procedure involving evaluation or the use of judgment, consistency in the definition of alternatives and interpretation of procedures is important.

Step 1 Identify and map transit lines by service type. (It is assumed that the prevalent means of developing a level of service definition is to start with a line-specific definition.) The required materials for this process include a reproducible map of the zone system showing the street network, transit route maps and schedules, and an area measuring device, such as a polar planimeter. Transit lines are divided into four groups as discussed above, based on the type of service provided. In order to distinguish radial from non-radial transit lines, the analyst must identify those zones which constitute the central business district (CBD). The CBD represents an intermediate or perhaps a final destination for all local radial and express lines and may encompass more than one zone. Local radial lines are those which provide service to the CBD, while local non-radial lines do not. Express guideway service may be either buses operating on their own exclusive right-of-way or a light rail line. Any express lines not fitting this description would be classified as regular express.

While most lines will fall into just one category, some lines may provide more than one type of service. Examples of this are: an "L" shaped transit line, a line operating as express inbound and as local outbound, and an express line using a guideway for only a portion of the route. In these and similar instances, the transit line should be broken into line segments representing the different service types provided. In identifying services provided to each zone, branch lines should also be identified.

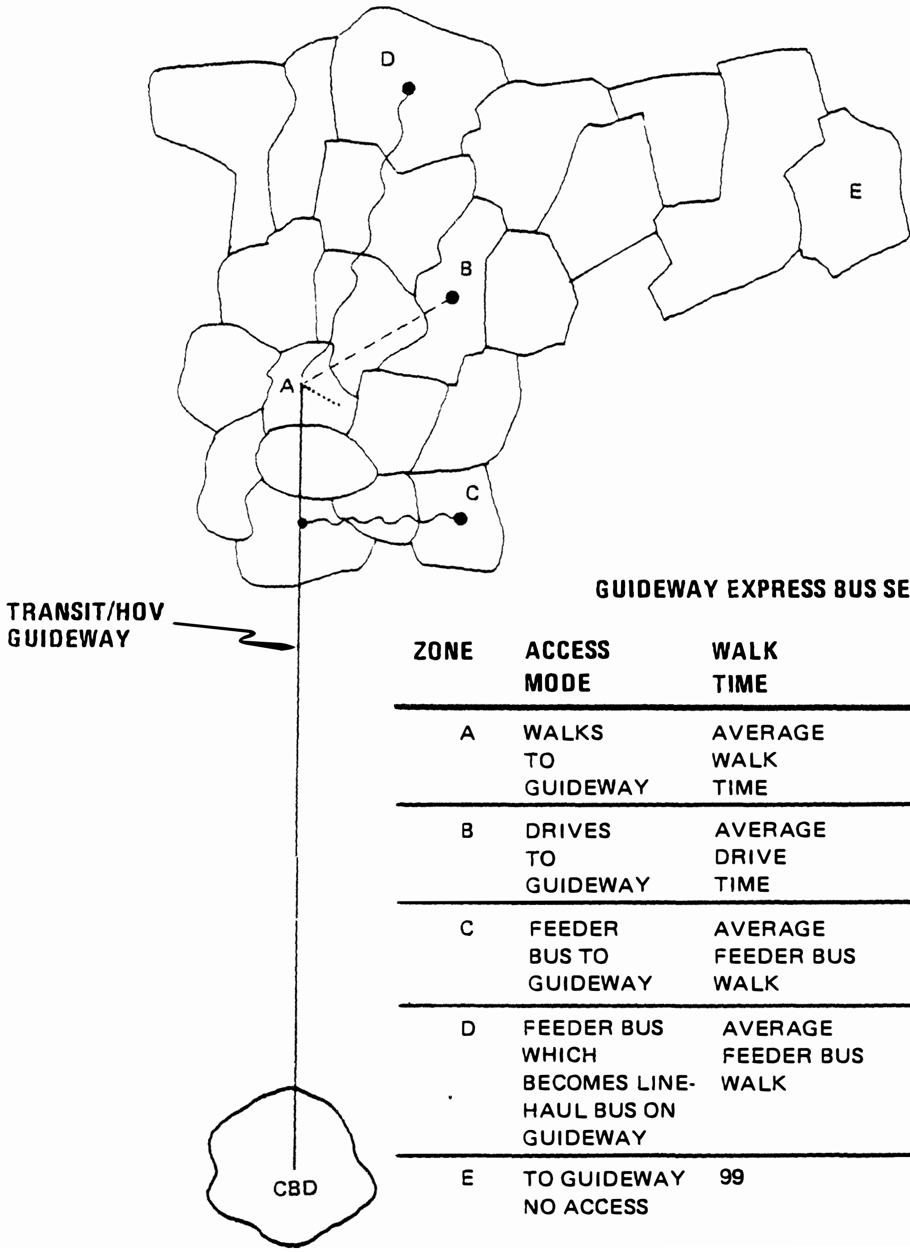
After the various lines and line segments have been identified by service type, they should be posted onto a map of the zone system. The basic stratification for mapping purposes is local versus express service but further stratification within each group (radial versus non-radial, and guideway and non-guideway) may be necessary. The map(s) prepared in this step provide necessary inputs to the following steps.

Step 2 Estimate access time and mode by service type. For each service type available, an access time must be coded. This access time is the average time for all persons in a zone to access any line of a given service type. The average (airline) distance required to access a particular type of service can be measured directly from the map prepared in Step 1. This distance is converted to time using a speed of 3 mph for walk access and 15 mph for auto access. In outlying areas, higher auto access speeds, up to 30 mph, may be used at the discretion of the analyst. Auto access speed should be used if the calculated walk time would exceed 15 minutes for local service or twenty minutes for express service. The auto access time should also be coded if, in the judgment of the analyst, the predominant mode of access to transit is auto. The auto access flag should be set to "1" if the access time assumes use of an auto. If the auto access flag is not set (0 or blank), walk access is assumed.

Feeder bus access to line-haul service may also be represented in the sketch planning framework. The model assumes that any access and wait time coded for express guideway transit is for feeder bus unless the auto access flag is set. Transfers between local radial and local non-radial transit can be indicated and this is discussed in Step 4. Transfers between local transit and regular express transit cannot be represented. Figure 2 shows how access times are coded for various types of zones.

Step 3 Estimate transit wait time by service type. For each zone having transit service, an average wait time must be coded for each type of service available. This measure should reflect all regular express and local lines (and line segments) of a given service type serving the zone in question. Wait time for guideway express service are specified separately, using a single user-coded parameter. Thus, it is necessary to combine the frequencies of the different lines of a particular service type in a zone. This is accomplished by weighting the frequencies of individual lines and line segments by the proportion of total service of each type provided. For a given zone and service type, the map prepared in Step 1 should be used to measure the percent of total route miles provided by each line or line segment. The frequencies of lines using this same route should be combined. If a line operates on the border of a zone, its route miles should be factored by 0.5 to reflect the limited service for that zone. The route miles for each line and line segment should be documented for use in developing future line-based alternatives.

The average wait time for a particular zone (x) and service type (y) can be calculated as follows:



GUIDEWAY EXPRESS BUS SERVICE LEVEL

ZONE	ACCESS MODE	WALK TIME	WAIT TIME	AUTO CONNECT FLAG
A	WALKS TO GUIDEWAY	AVERAGE WALK TIME	0*	0
B	DRIVES TO GUIDEWAY	AVERAGE DRIVE TIME	0	1
C	FEEDER BUS TO GUIDEWAY	AVERAGE FEEDER BUS WALK	AVERAGE FEEDER BUS WAIT	0
D	FEEDER BUS WHICH BECOMES LINE-HAUL BUS ON GUIDEWAY	AVERAGE FEEDER BUS WALK	0*	0
E	TO GUIDEWAY NO ACCESS	99	99	0

* PROGRAM USES THE USER—CODED PARAMETER DENOTING GUIDEWAY WAIT TIME.

Figure 2
EXAMPLES OF CODING GUIDEWAY EXPRESS BUS SERVICE LEVELS

ACCESS MODES
---- DRIVE
.... WALK
∿∿ BUS

Virginia Commuting Study

(1) $0.5 \, (H_i * P_i)$ where H_i = headway for Line (segment) in Zone X

$\sum_{i=1}$ P_i = percent of route-miles of service type Y provided by Line i

n = number of lines (segments) of service type Y in Zone X

or

(2) $0.5 \left(\sum_{i=1} \frac{P_i}{B_i} \right) * TP$ where

P_i = defined as above

TP = length of time period in minutes (60)

B_i = no. of bus runs on line i during the 730-830 AM weekday period

or

(3) 60 if equation (1) or (2) results in a wait time in excess of 60 minutes.

While the 7:30-8:30 AM period was chosen for Northern Virginia, in other circumstances it may be appropriate to use a longer AM peak period as the analysis time period.

For express guideway service, the model automatically considers the wait time for vehicles using the guideway, as mentioned above. Thus, the only guideway express wait time which should be coded is for feeder bus service to the guideway. If walk or auto access is used, wait time should be coded as zero. However, if buses circulate through a zone before using the guideway and thus provide both feeder service to and direct access on the guideway, wait time should be coded as the feeder bus wait time. Figure 2 illustrates how wait time should be coded for various kinds of zones.

Step 4 Review available service by service type. At this point, the analyst should have coded for each zone, access time and mode and wait time for each service type available within that zone. For zones with no service (of a particular type) available within its borders, it may still be appropriate to code service as being available. Within each service type, the analyst must use judgment to determine if access (walk or auto) to service in an adjacent zone is a realistic option for the zone's population. The walk or auto access time to the nearest line of the appropriate service type may be calculated to provide some guidance, but the judgment of the analyst must be the ultimate guide. If such walk access is judged a realistic option, access time and mode and wait time for the nearest line should be coded. If walk access is not feasible, the possibility of feeder bus transfers should be considered.

If feeder bus with a transfer is not available, then auto access may be considered.

If any of the above analyses results in the coding of service for a zone, the reasoning and measurements should be documented. If none of these options are judged realistic, a value of 99 should be coded as both the access and wait time to indicate that a particular service is not available.

TRIP TABLE FACTORING

The corridor sketch planning program includes the option of applying zonal production and attraction factors to the input person trip table. The production factors are applied to the rows of the trip table, and the attraction factors are applied to the columns. These factors represent growth rates for the purpose of estimating future trip patterns. Generally, for work trips, production factors are derived from household forecasts and attraction factors from employment forecasts. Factors are calculated as the ratio of future to existing values for each zone.

One of the problems with such factoring is that initially, the sum of the factored productions rarely equals the sum of the factored attractions. The factoring process needs to resolve this so that the resulting trip table is balanced with respect to the new productions and attractions. One of the most common methods of achieving this result is the Fratar technique, which involves an iterative method. One of the problems of this method is that it does not always converge to a final acceptable answer. The technique implemented in the corridor sketch planning program uses a more sophisticated matrix balancing technique which operates in a single pass through the table. This process achieves the desired results by scaling the new production and attraction totals to whichever is the larger of the two and then allocating the change in the row totals to each column. This method is described in more detail in Appendix B.

The process is implemented in the program by coding a special parameter and by providing production and attraction factors. Table 5 illustrated a typical set of production and attraction factors.

OPTIONS AND PARAMETERS

The corridor sketch planning program has a wide range of parameters and options which may be altered or selected by the user. There are 62 parameters which may be specified by the user through use of the UPARMS key word on the UMODEL &PARAM card. A complete list and explanation of these UPARMS is given in Table 8. Most of these parameters will default to reasonable values, and need not be altered by the user. Some UPARMS, on the other hand, are used to select program options and to define the corridor alternative being tested, and thus may be frequently altered by the user. UPARMS (1), for example, is used to indicate whether the input trip table represents person trips or vehicle trips, and whether it is desired to factor this table to future conditions. Other UPARMS are used to indicate whether or not a transit fare matrix is input, what kind of carpool facilities exist, how a carpool is defined, what kind of guideway transit service, if any, is in use, as well as the location and level of service for any guideway transit or HOV facilities. In general, the user will need to specify values for 5 to 10 uparms

Table 8
USER-CODED PARAMETERS FOR THE CORRIDOR SKETCH PLANNING PROGRAM

Keyword	Default Value	Northern Virginia Base Case Value	Description
ZONES	0.0	80	Highest Zone Number (1)
UPARMS(1)	2.0	2.0	Input Trip Table Option: 1 if Auto-Driver Trip Table Input, 2 if Person Trips Input but no Factoring Required, 3 if Person Trips Input and Factoring Required (2)
UPARMS(2)	2.0	2.0	Guideway Transit Type: 2 for Busway, 3 for Light Rail
UPARMS (3)	2.0	1.0	Transit Fare Input Option: 1 if Fare Matrix Input, 2 if no Matrix Input (3)
UPARMS (4)	1.0	3.0	Carpool Facilities Option: 1 if no carpool facilities exist, 2 if there is no HOV lane but other carpool incentives exist, 3 if an HOV lane exists
UPARMS (5)	1.0	6	Key Activity Zone Number (4)
UPARMS (6)	0.0	234.0	Azimuth of Guideway Facility in Degrees (5)
UPARMS (7)	0.0	11.4	Length of Guideway Facility in Miles (6)
UPARMS (8)	0.0	8.0	Headway of Guideway Transit Service in Minutes
UPARMS (9)	35.0	45.0	Speed of Guideway Transit Service in MPH
UPARMS (10)	1.25	1.1	Circuity Factor for Guideway Facility (7)
UPARMS (11)	0.0	4.2	Non-Access Length for Guideway Facility in Miles (8)
UPARMS (12)	12.0	12.0	Speed of local transit service in MPH
UPARMS (13)	1.67	1.67	Circuity Factor for local transit service (9)
UPARMS (14)	55.0	55.0	Boarding Fare in cents (10)
UPARMS (15)	3.0	--	Maximum Distance for Boarding Fare in Miles (10)
UPARMS (16)	1.0	--	Transit Fare per Mile in cents (10)
UPARMS (17)	0.0	--	Premium Fare for Guideway Transit Service in Cents (11)
UPARMS (18)	5.0	4.0	Carpool Definition (12)
UPARMS (19)	4.5	4.61	Average Car Occupancy for "4+" category
UPARMS (20)	35.0	50.0	HOV Lane Speed in MPH
UPARMS (21)	1.41	1.41	Circuity Factor for Local Portion of Carpool Trip (13)
UPARMS (22)	7.5	4.0	Automobile Operating Cost per Mile in Cents
UPARMS (23)	0.89	1.19	Average Work Trips per Household for Income Quartile 1 (Low)

Table 8 (cont'd)
USER-CODED PARAMETERS FOR THE CORRIDOR
SKETCH PLANNING PROGRAM

Keyword	Default Value	Northern Virginia Base Case Value	Description
UPARMS (24)	1.57	1.99	Average Work Trips per Household for Income Quartile 2 (Middle-Low)
UPARMS (25)	1.85	2.34	Average Work Trips per Household for Income Quartile 3 (Middle-High)
UPARMS (26)	2.03	2.47	Average Work Trips per Household for Income Quartile 4 (High)
UPARMS (27) — UPARMS (50) are the mode choice model coefficients.			
UPARMS (27)	0.030	0.030	Initial Wait Time Coefficient
UPARMS (28)	0.044	0.044	Transfer Wait and Walk Time Coefficient
UPARMS (29)	0.031	0.031	Run Time Coefficient
UPARMS (30)	0.0174	0.040	Group Auto Excess Time Coefficient
UPARMS (31)	0.014	0.014	Cost Coefficient
UPARMS (32)	0.0215	0.014	Parking Cost Coefficient
UPARMS (33)	1.5556	1.5353	Income Dummy Coefficient, 2 Persons/Car, Low Income
UPARMS (34)	1.1287	1.1599	Income Dummy Coefficient, 2 Persons/Car, Med.-Low Income
UPARMS (35)	0.7549	0.9861	Income Dummy Coefficient, 2 Persons/Car, Med.-High Income
UPARMS (36)	0.4750	0.9727	Income Dummy Coefficient, 2 Persons/Car, High Income
UPARMS (37)	2.1804	2.5511	Income Dummy Coefficient, 3 Persons/Car, Low Income
UPARMS (38)	2.0594	2.4816	Income Dummy Coefficient, 3 Persons/Car, Med.-Low Income
UPARMS (39)	1.8993	2.3215	Income Dummy Coefficient, 3 Persons/Car, Med.-High Income
UPARMS (40)	1.8013	1.8900	Income Dummy Coefficient, 3 Persons/Car, High Income
UPARMS (41)	2.6096	3.0393	Income Dummy Coefficient, 4+ Persons/Car, Low Income
UPARMS (42)	2.4491	2.9303	Income Dummy Coefficient, 4+ Persons/Car, Med.-Low Income
UPARMS (43)	2.2929	2.7741	Income Dummy Coefficient, 4+ Persons/Car, Med.-High Income
UPARMS (44)	2.1330	2.2807	Income Dummy Coefficient, 4+ Persons/Car, High Income
UPARMS (45)	0.87	0.51	Auto Connect Dummy Coefficient
UPARMS (46)	0.0693	0.05	Drive Alone Excess Time Coefficient

Table 8 (cont'd)
USER-CODED PARAMETERS FOR THE CORRIDOR SKETCH PLANNING PROGRAM

Keyword	Default Value	Northern Virginia Base Case Value	Description
UPARMS (47)	0.5218	0.9845	Income Dummy Coefficient, Drive Alone, Low Income
UPARMS (48)	-0.0617	0.4525	Income Dummy Coefficient, Drive Alone, Med.-Low Income
UPARMS (49)	-0.9346	-0.2204	Income Dummy Coefficient, Drive Alone, Med.-High Income
UPARMS (50)	-1.5379	-0.5572	Income Dummy Coefficient, Drive Alone, High Income
UPARMS (51)	1.0	1.0	Feeder Bus to Guideway Walk Time Factor (14)
UPARMS (52)	1.0	1.0	Feeder Bus to Guideway Wait Time Factor (14)
UPARMS (53)	0.004735	0.018939	Coordinate Factor (14)
UPARMS (54)	1.0	1.0	Carpool Terminal Time Factor (14)
UPARMS (55)	1.0	1.0	Carpool Parking Cost Factor (14)
UPARMS (56)	1.0	1.0	Highway Time Factor (14)
UPARMS (57)	0.01	0.1	Highway Distance Factor (14)
UPARMS (58)	1.0	1.0	Normal Parking Cost Factor (14)
UPARMS (59)	1.2	1.2	Ratio of Regular Express to Highway Time (15)
UPARMS (60)	ZONES	80	Last Internal Zone Number (16)
UPARMS (61)	2.0	2.0	Switch to Perform VMT Analysis by District: 1 if yes, 2 if no.
UPARMS (62)	2.0	2.0	Switch to Control Printing of Guideway Reports: 1 if yes, 2 if no.

Notes to Table 8

(1) This number of zones must correspond to the number of zones on all the zonal files and input matrices (trips, times, distances, transit fare). The maximum number of zones for this program is 100.

(2) If an auto-driver trip table is input, auto-driver trips for each interchange will be modified to estimate total person trips using the modal share for auto-driver trips. If factoring is requested, production and attraction factors must be input as part of the zonal data.

(3) If no fare matrix is input, a distance-based fare system will be assumed. See Note 10 for the formula used to compute distance-based fares.

(4) The centroid coordinates of this zone are used to define the downtown end point of the guideway facility.

(5) The azimuth is used to define the location of the guideway facility. The angle is measured counter-clockwise starting from due east.

(7) This circuity factor is used to convert computed straight-line distances along the guideway to actual distances.

(8) This distance represents the length of the guideway facility, measured outward from the key activity center zone, along which peak-direction access to the facility may not be gained.

(9) This circuity factor is used to convert computed straight-line distances for local transit service (e.g., feeder bus access to guideway) to actual distances.

(10) If no fare matrix is input, transit fares are computed according to the following distance-based formula:

Transit Fare = UPARMS(14) + UPARMS(16)*(Highway Distance - UPARMS(15))

with the minimum fare being UPARMS(14).

(11) This premium fare is added to the transit fare obtained either from a transit matrix, or from the above formula, if a guideway express transit service is used.

(12) This represents the minimum number of occupants a vehicle must have in order to use an HOV lane or to take advantage of any other carpool incentives which exist (e.g., preferential parking).

(13) This factor is used to convert straight-line distances, computed for the local portion of a carpool trip using an HOV lane, to actual distance.

(14) These factors are used to convert input zonal and interchange data to the proper units (times to minutes; coordinates and distances to miles; costs to cents).

(15) This ratio is used to estimate the time for a trip via regular express bus to the CBD.

(16) This number must be coded if there are external stations represented in the input matrices.

in a given run. The information in Table 8 explains what the proper UPARMS values are for various circumstances.

It should be noted that UPARMS 27-50 represent the mode choice model coefficients. The default values represent those used in an application of this program in the Nashville urban area. The values used for the Northern Virginia Case Study were assigned as the program was being executed, by substituting the appropriate UPARMS values in the job set-up (see Figure 3). Future applications of this program in Virginia should probably initially use the coefficients developed for Northern Virginia, and then adjust these as appropriate for local circumstances.

PROGRAM REPORTS AND TRIP TABLE OUTPUT

Trip End Summaries

The trip end summaries will be produced using the normal UMODEL trip end report formats. Up to four trip end summaries will be written depending on whether the user has specified the existence of an HOV lane. In any case, the first two trip end summaries will be printed. The first shows the basic modal shares in the following format:

1) First column - Transit trip ends
2) Second column - Auto driver trip ends
3) Third column - Auto passenger trip ends
4) Fourth column - Total person trip ends

The second trip end summary divides the transit trip ends between those using the guideway transit facility (if such a facility exists), and those not using guideway service. The format for this summary is:

1) First column - Transit trips using guideway service
2) Second column - Transit trips not using guideway
3) Third column - (Zeroes)
4) Fourth column - Total transit trip ends

If the user has specified the existence of an HOV lane, two additional trip end summarizes are produced. A third summary separates auto driver trips into those using the HOV lane, and those not using the lane. The following format is used:

1) First column - Auto driver trips using HOV lane
2) Second column - Auto driver trips not using HOV lane
3) Third column - (Zeroes)
4) Fourth column - Total auto driver trip ends

Finally, a fourth trip end summary separates auto passenger trips in the same manner, using a similar format.

FIGURE 3
TYPICAL PROGRAM SET-UP

```
U R B A N   T R A N S P O R T A T I O N   P L A N N I N G   S Y S T E M

11MAR82   9.53.49                    UMODEL                         PAGE    1

SIGNON 001 (INFORMATION): UMODEL   (28MAY76) BEGIN AT  9.53.49

SIGNON 1800 (WARNING): FILE URD.LOG NOT AVAILABLE OR CONTAINS
                       INVALID DATA. TUSE=     0  NPROG=  0  NREP=   0

                    C O N T R O L   C A R D   I M A G E S
1---5---10---15---20---25---30---35---40---45---50---55---60---65---70--
CORRIDOR SKETCH PLANNING MODEL -- NO. VA. BASE80
 &PARAM ZONES=80,OUTBPT=4,DISTS=7,
  NAME1='GWY TRN',NAME2='REG TRN',NAME3='HOV ADR',NAME4='REG ADR',
  NAME5='HOV APA',NAME6='REG APA',NAME7='PER TRP',
  UPARMS(3)=1.0,UPARMS(4)=3.0,UPARMS(5)=6.0,UPARMS(6)=234.0,
  UPARMS(7)=11.4,UPARMS(8)=8.0,UPARMS(9)=45.0,UPARMS(10)=1.10,
  UPARMS(11)=4.2,UPARMS(18)=4.0,UPARMS(19)=4.61,UPARMS(20)=50.0,
  UPARMS(23)=1.19,UPARMS(24)=1.99,UPARMS(25)=2.34,UPARMS(26)=2.47,
  UPARMS(22)=4.0,UPARMS(30)=0.04,UPARMS(31)=0.014,UPARMS(32)=0.014,
  UPARMS(53)=0.0189394,UPARMS(60)=80.0,UPARMS(57)=0.1,
  UPARMS(45)=0.51,UPARMS(47)=0.9845,UPARMS(48)= 0.4525,
  UPARMS(49)=-0.2204,UPARMS(50)=-0.5572,UPARMS(33)=1.5353,
  UPARMS(34)=1.1599,UPARMS(35)=0.9861,UPARMS(36)=0.9727,
  UPARMS(37)=2.5511,UPARMS(38)=2.4816,UPARMS(39)=2.3215,
  UPARMS(40)=1.8900,UPARMS(41)=3.0393,UPARMS(42)=2.9303,
  UPARMS(43)=2.7741,UPARMS(44)=2.2807,UPARMS(46)=0.05 &END
 &SELECT I=1,-80,REPORT=4  &END
 &EQUIV DIST=1,Z=26,27,36,37,46,47,54,55,56,58,59,62,-64,77 &END RT. 7
 &EQUIV DIST=2,Z=57,60,61,65,76,78  &END 50-66
 &EQUIV DIST=3,Z=69,-71,74,75,79    &END 29-211
 &EQUIV DIST=4,Z=25,34,35,44,45,49,-53  &END 50-66-29-211
 &EQUIV DIST=5,Z=21,-24,28,-33,38,-43,48,66,-68,72,73,80  &END I-95
 &EQUIV DIST=6,Z=1,-17  &END  D.C. CORE, ROSSLYN, CRYSTAL CITY
 &EQUIV DIST=7,Z=18,-20 &END  REST OF ARLINGTON & ALEXANDRIA
 &DATA
1---5---10---15---20---25---30---35---40---45---50---55---60---65---70--
```

FIGURE 3 (Cont'd)

```
CORRIDOR SKETCH PLANNING MODEL -- NO. VA. BASE80

11MAR82    9.53.49                UMODEL                          PAGE    4

              D A T A   I D E N T I F I C A T I O N   C A R D S
   +- ++   +--- +--- +- + +--- +--- +    +-----------------------+-------
1---5---10---15---20---25---30---35---40---45---50---55---60---65---70--
   1 P      1    5  1 1                 ZONE NUMBER
   2 A      6    7  2 2                 CBD FLAG (=1 IF ZONE IN CBD)
   3 P      8   14  3 2                 X-COORDINATE
   4 P     15   21  4 2                 Y-COORDINATE
   5 P      6   10  5 3                 WALK TIME TO EXPRESS (MIN)
   6 P     11   15  6 3                 WAIT TIME FOR EXPRESS (MIN)
   7 P     16   20  7 3                 AUTO-CONNECT FLAG FOR EXPRESS
   8 P     21   25  8 3                 WALK TIME TO LOCAL-RADIAL (MIN)
   9 P     26   30  9 3                 WAIT TIME FOR LOCAL-RADIAL (MIN)
  10 P     31   35 10 3                 WALK TIME TO LOCAL-NON-RADIAL
  11 P     36   40 11 3                 WAIT TIME FOR LOCAL-NON-RADIAL
  12 P     41   45 12 3                 AUTO-CONNECT FLAG FOR LOCAL BUS
  13 P     46   50 13 3                 WALK TIME TO GUIDEWAY EXPRESS (MIN)
  14 P     51   55 14 3                 WAIT TIME FOR GUIDEWAY EXPRESS (MIN)
  15 P     56   60 15 3                 AUTO-CONNECT FLAG FOR GUIDEWAY EXP
  16 A     39   40 16 1                 TERMINAL TIME FOR CARPOOLS (MIN)
  17 A     41   47 17 1                 DAILY PARKING COST FOR CARPOOLS (C)
  18 A     39   40 18 1                 NORMAL TERMINAL TIME (MIN)
  19 A     41   47 19 1                 NORMAL DAILY PARKING COST (68 CENTS)
  20 P     48   54 20 1                 HOUSEHOLDS IN FIRST INCOME QUARTILE
  21 P     55   61 21 1                 HOUSEHOLDS IN SECOND INCOME QUARTILE
  22 P     62   68 22 1                 HOUSEHOLDS IN THIRD INCOME QUARTILE
  23 P     69   75 23 1                 HOUSEHOLDS IN FOURTH INCOME QUARTILE
  24 P*            24                   PRODUCTION FACTOR
  25 A*            25                   ATTRACTION FACTOR
  26 X   2001                           WORK PERSON TRIPS
  27 X   1002                           PEAK HIGHWAY TIME (MIN)
  28 X   1003                           PEAK HIGHWAY DISTANCE (0.1 MI)
  29 X   1001                           PEAK TRANSIT FARE (1968 CENTS)
1---5---10---15---20---25---30---35---40---45---50---55---60---65---70--

MODEL3 3039 (INFORMATION): TITLE OF TABLE 1001 IS CENTS

MODEL3 3039 (INFORMATION): TITLE OF TABLE 1002 IS MINUTES

MODEL3 3039 (INFORMATION): TITLE OF TABLE 1003 IS 0.1 MILES

MODEL3 3039 (INFORMATION): TITLE OF TABLE 2001 IS WKTRIPS

UJIO 001 (INFORMATION): COMMENT RECORD
*TABLE  0004TRIPS

UJIO 001 (INFORMATION): COMMENT RECORD
* CHOP OFF ZONES 81-87 (REST OF D.C. AND MARYLAND)

UJIO 001 (INFORMATION): COMMENT RECORD
*ACTOR 80-DISTRICT PERSON TRIPS TO REFLECT VA. 1980 EXTERNAL SURVEY
```

Summary Reports

Three summary reports can be produced by the program. The first is a summary of trips by mode and income having the following form: (Note that the first four modes represent auto person trips by auto occupancy.):

SUMMARY REPORT 1

SUMMARY OF TRIPS BY MODE AND INCOME
(NOTE: DOES NOT INCLUDE EXTERNALS)

			MODE		
INCOME	ONE	TWO	THREE	FOUR+	TRANSIT
1					
2					
3					
4					
TOTAL					

A second (optional) report is a summary of the approximate locations at which trips access and egress the guideway transit facility, or HOV lane, if either or both of these exist. This report has the following form:

SUMMARY REPORT 2

ENTRANCE AND EXIT POINTS ON EXP/LRT CORRIDOR
(STRAIGHT LINE DISTANCE)

MILE FROM KEY ACTIVITY ZONE	INBOUND TRANSIT TRIPS		OUTBOUND TRANSIT TRIPS	
	BOARD	ALIGHT	BOARD	ALIGHT
0 (KAZ)				
1				
2				

	CARPOOL VEHICLE TRIPS		CARPOOL PERSON TRIPS	
	ENTER	EXIT	ENTER	EXIT
0 (KAZ)				
1				
2				

Finally, a third (optional) report gives a summary of VMT by air quality district and facility type. This report has the following form:

SUMMARY REPORT 3

SUMMARY OF VMT BY AQ DISTRICT AND FACILITY TYPE
(NOTE: INCLUDES ONLY INTERNAL-INTERNAL WORK
AUTO TRIPS. IF THIS IS NOT A BASE RUN, THESE
FIGURES MUST BE COMPARED WITH REPORT 3 FROM
BASE RUN TO GET ESTIMATED CHANGES IN VMT.)

AQ DISTRICT	INTERSTATE	EXPRESSWAY	PRIMARY ARTERIAL	MINOR ARTERIAL	COLLECTOR	LOCAL	TOTAL
1							
2							
3							
15							
TOTAL							

Trip Table Matrices

The program will output trip tables in the standard UTPS compressed matrix format. These tables are written on the J9 file and have the following definitions:

1) If no HOV lane exists, the following tables are output:

   Table 1 - Transit trips using guideway transit facility
   Table 2 - Transit trips not using guideway transit facility
   Table 3 - Auto driver trips
   Table 4 - Auto passenger trips
   Table 5 - Total person trips

2) If an HOV lane exists, the output trip tables are as follows:

   Table 1 - Transit trips using guideway transit facility
   Table 2 - Transit trips not using guideway transit facility
   Table 3 - Auto driver trips using HOV lane
   Table 4 - Auto driver trips not using HOV lane
   Table 5 - Auto passenger trips using HOV lane
   Table 6 - Auto passenger trips not using HOV lane
   Table 7 - Total person trips

AUTO OCCUPANCY ANALYSIS

The corridor sketch planning program outputs auto driver and auto passenger trips, but in some cases, it is desired to know more about auto occupancy characteristics. The Virginia commuter analysis methodology uses drive alone and group auto (ridesharing) as its major auto modes. Generally, we want to know how many person trips drive alone versus carpool. An auto occupancy model has been developed that estimates the proportion of trips by auto occupancy mode, based on average auto occupancy values. The model is based on data from the Washington D.C. area, but has been found generally valid for other regions as well. The model is described in Table 9, with an example of its use shown in Table 10.

Table 9
AUTO OCCUPANCY MODEL

A. Model used to estimate integer car occupancy given an average car occupancy.

B. Model is composed of four linear regression equations as follows:

1. Probability of vehicle with 1 person = 1.59606 - 0.63763 * Car Occupancy

2. Probability of a vehicle with 2 persons = -0.31143 + 0.3808* Car Occupancy

3. Probability of a vehicle with 3 persons = -.17082 + .155* Car Occupancy

4. Probability of a vehicle with 4 persons = -.11381 + .10183* Car Occupancy

C. If car occupancy is less than 1.12, the car occupancy used in the model is 1.12.

D. If car occupancy is greater than 2.5, equations are:

1. Probability of 1 person/car vehicle = 0.001975

2. Probability of 2 person/car vehicle = .64058 - 0.726* (Car Occupancy -2.5)

3. Probability of 3 person/car vehicle = .21668 + 0.438* (Car Occupancy -2.5)

4. Probability of 4 person/car vehicle = .140765 + .288* (Car Occupancy -2.5)

Table 10
EXAMPLE USE OF AUTO OCCUPANCY MODEL

From sketch planning program:

auto drivers	=	1,000
auto passengers	=	400

Therefore, auto occupancy = (1,000 + 400)/1,000 = 1.40

Apply regression equations:

probability of a vehicle with	1 persons	=	0.7034
	2 persons	=	0.2217
	3 persons	=	0.0462
	4 or more persons	=	0.0288
	total		1.0000

Multiply by occupancy to get probability of persons by mode:

1 person	=	0.7034	*	1	=	0.7034
2 persons	=	0.2217	*	2	=	0.4434
3 persons	=	0.0462	*	3	=	0.1386
4 or more persons	=	0.0288	*	4.5	=	0.1296
				total	=	1.4150

(4.5 is assumed average occupancy of 4+ vehicles)

probability of a person in	1 person/car	=	0.7034/1.4150	=	0.4971
	2 persons/car	=	0.4434/1.4150	=	0.3134
	3 persons/car	=	0.1386/1.4150	=	0.0980
	4 or more persons/car	=	0.1296/1.4150	=	0.0915
	total			=	1.0000

Therefore,
drive alone share = 0.4971
ridesharing share = 0.5029

```
      REAL*4 UPARMS,KONN                                                00311000
C                                                                       00312000
      LOGICAL*4 DONLY,HALFWD,IGNORE,STATS,TRACE                         00313000
C                                                                       00314000
      LOGICAL*1 RSEL,CONT                                               00315000
C                                                                       00316000
      RETURN                                                            00317000
C                                                                       00318000
      ENTRY MOD13A                                                      00319000
C***********************************************************************00320000
C*                                                                     *00321000
C*           ENTRY POINT MOD13A IS USED TO CHANGE THE VALUES OF        *00322000
C*           ANY OF THE INPUT PARAMETERS OR OPTIONS. IT IS ENTERED     *00323000
C*           ONCE, AFTER THE &PARAM,&OPTION &SELECT AND &EQUIV         *00324000
C*           CARDS HAVE BEEN READ, BUT BEFORE THE PARAMETERS AND       *00325000
C*           OPTIONS ARE PRINTED.                                      *00326000
C*                                                                     *00327000
C*---------------------------------------------------------------------*00328000
C*     MOD13A USER CODE IS INSERTED BETWEEN  329000 - 335000           *00329000
C                                                                       00329001     *          INSERTED*
C *** BEGIN MOD13A ***                                                  00329002     *          INSERTED*
C                                                                       00329003     *          INSERTED*
C            SKETCH PLANNING PROGRAM                                    00329004     *          INSERTED*
C                                                                       00329005     *          INSERTED*
C     THIS PROGRAM APPLIES CALIBRATED CAR OCCUPANCY AND MODE CHOICE     00329006     *          INSERTED*
C       MODELS TO ESTIMATE THE EFFECT OF EXPRESS BUS OR LIGHT RAIL      00329007     *          INSERTED*
C       SERVICE ON RESERVED R-O-W (HEREIN REFERRED TO AS 'EXP/LRT'),    00329008     *          INSERTED*
C       AND/OR HOV LANES, ON JOURNEY-TO-WORK BEHAVIOR.  THE             00329009     *          INSERTED*
C       INPUTS INCLUDE:  A TRIP TABLE (EITHER PERSON TRIPS OR AUTO-     00329010     *          INSERTED*
C       DRIVER TRIPS), THE LOCATION OF THE PROPOSED EXPRESS/LIGHT RAIL/ 00329011     *          INSERTED*
C       HOV FACILITY, ALL PERTINENT LEVEL-OF-SERVICE INFORMATION FOR ALL00329012     *          INSERTED*
C       MODES OF TRANSPORTATION, THE NUMBER OF HOUSEHOLDS BY INCOME     00329013     *          INSERTED*
C       QUARTILE IN EACH ZONE, WORK-TRIP PRODUCTION RATES FOR EACH      00329014     *          INSERTED*
C       INCOME QUARTILE, AND THE COEFFICIENTS FOR THE CAR-OCCUPANCY AND 00329015     *          INSERTED*
C       MODE-CHOICE MODELS.  A ZONE SYSTEM OF UP TO 100 ZONES MAY BE    00329016     *          INSERTED*
C       USED.                                                           00329017     *          INSERTED*
C     FOR THE CALCULATION OF VMT BY AIR QUALITY DISTRICT AND FACILITY   00329018     *          INSERTED*
C       TYPE, ADDITIONAL INPUTS ARE REQUIRED.  THE PERCENT OF A TRIP    00329019     *          INSERTED*
C       BETWEEN EACH PAIR OF DISTRICTS WHICH TRAVERSES EACH DISTRICT,   00329020     *          INSERTED*
C       AND THE PERCENT OF TRAVEL WITHIN EACH DISTRICT BY FACILITY TYPE 00329021     *          INSERTED*
C       MUST BE ACCESSIBLE TO THE PROGRAM ON LOGICAL UNITS 1 AND 2,     00329022     *          INSERTED*
C       RESPECTIVELY.  ZONE-DISTRICT EQUIVALENCIES MUST BE INPUT TO THE 00329023     *          INSERTED*
C       PROGRAM.                                                        00329024     *          INSERTED*
C     IF A PERSON-TRIP TABLE IS INPUT, IT MAY OPTIONALLY BE FACTORED TO 00329025     *          INSERTED*
C       FUTURE CONDITIONS.  THIS REQUIRES THE INPUT OF PRODUCTION AND   00329026     *          INSERTED*
C       ATTRACTION FACTORS.                                             00329027     *          INSERTED*
C                                                                       00329028     *          INSERTED*
C     TRANSIT FARES WILL BE DERIVED EITHER FROM AN INPUT FARE MATRIX, OR00329029     *          INSERTED*
C       AS A FUNCTION OF DISTANCE TRAVELLED.                            00329030     *          INSERTED*
C                                                                       00329031     *          INSERTED*
C                                                                       00329032     *          INSERTED*
C     THE FOLLOWING ARE THE DATA ID CARDS TO BE USED WITH THIS PROGRAM: 00329033     *          INSERTED*
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C                                                                            00329034    *     INSERTED*
C 1 P                              ZONE NUMBER                               00329035    *     INSERTED*
C 2 A                              CBD ZONE FLAG (=1 IF ZONE IN CBD)         00329036    *     INSERTED*
C 3 P                              X-COORDINATE OF ZONE                      00329037    *     INSERTED*
C 4 P                              Y-COORDINATE OF ZONE                      00329038    *     INSERTED*
C 5 P                              WALK TIME TO EXPRESS                      00329039    *     INSERTED*
C 6 P                              WAIT TIME FOR EXPRESS                     00329040    *     INSERTED*
C 7 P                              AUTO-CONNECT FLAG FOR EXPRESS             00329041    *     INSERTED*
C 8 P                              WALK TIME FOR LOCAL RADIAL TRANSIT        00329042    *     INSERTED*
C 9 P                              WAIT TIME FOR LOCAL RADIAL TRANSIT        00329043    *     INSERTED*
C10 P                              WALK TIME FOR LOCAL NON-RADIAL            00329044    *     INSERTED*
C11 P                              WAIT TIME FOR LOCAL NON-RADIAL            00329045    *     INSERTED*
C12 P                              AUTO-CONNECT FLAG FOR LOCAL BUS           00329046    *     INSERTED*
C13 P                              WALK TIME FOR CORRIDOR EXP/LRT            00329047    *     INSERTED*
C14 P                              WAIT TIME FOR CORRIDOR EXP/LRT            00329048    *     INSERTED*
C15 P                              A-C FLAG FOR CORRIDOR EXP/LRT             00329049    *     INSERTED*
C16 A                              HIGHWAY TERMINAL TIME FOR CARPOOLS        00329050    *     INSERTED*
C17 A                              DAILY PARKING COST FOR CARPOOLS           00329051    *     INSERTED*
C18 A                              NORMAL HIGHWAY TERMINAL TIME              00329052    *     INSERTED*
C19 A                              NORMAL DAILY PARKING COST                 00329053    *     INSERTED*
C20 P                              HOUSEHOLDS IN FIRST INCOME QUARTILE       00329054    *     INSERTED*
C21 P                              HOUSEHOLDS IN SECOND INCOME QUARTILE00329055    *     INSERTED*
C22 P                              HOUSEHOLDS IN THIRD INCOME QUARTILE       00329056    *     INSERTED*
C23 P                              HOUSEHOLDS IN FOURTH INCOME QUARTILE00329057    *     INSERTED*
C24 P*                             PRODUCTION FACTOR                         00329058    *     INSERTED*
C25 A*                             ATTRACTION FACTOR                         00329059    *     INSERTED*
C26 X                              PERSON OR AUTO-DRIVER WORK TRIPS          00329060    *     INSERTED*
C27 X                              HIGHWAY TRAVEL TIME                       00329061    *     INSERTED*
C28 X                              HIGHWAY DISTANCE                          00329062    *     INSERTED*
C29 X                              TRANSIT FARE                              00329063    *     INSERTED*
C                                                                            00329064    *     INSERTED*
C      NOTES: 1. THE ASTERISKS IN COLUMN 6 OF CARDS 24 AND 25 WOULD BE       00329065    *     INSERTED*
C                 REMOVED IF PRODUCTION AND ATTRACTION FACTORS ARE TO BE00329066    *     INSERTED*
C                 INPUT.                                                     00329067    *     INSERTED*
C              2. CARD 29 SHOULD BE INCLUDED ONLY WHEN A TRANSIT FARE        00329068    *     INSERTED*
C                 MATRIX IS TO BE INPUT.                                     00329069    *     INSERTED*
C     THE FOLLOWING ARE THE UPARMS PARAMETERS USED IN THIS PROGRAM           00329070    *     INSERTED*
C      (DESCRIPTIVE VARIABLE NAME SHOWN IN PARENTHESES):                     00329071    *     INSERTED*
C                                                                            00329072    *     INSERTED*
C                                                            DEFAULT         00329073    *     INSERTED*
C  NO. DESCRIPTION                                            VALUE          00329074    *     INSERTED*
C                                                                            00329075    *     INSERTED*
C   1  INPUT TRIP TABLE OPTION: 1=AUTO-DRIVER TRIPS INPUT,                   00329076    *     INSERTED*
C        2=PERSON TRIPS INPUT - NO FACTORING,                                00329077    *     INSERTED*
C        3=PERSON TRIPS INPUT - FACTORING REQUIRED  (TTO)        2.0         00329078    *     INSERTED*
C   2  EXP/LRT SYSTEM TYPE: 2=BUSWAY,                                        00329079    *     INSERTED*
C        3=LIGHT RAIL  (EST)                                     2.0         00329080    *     INSERTED*
C   3  TRANSIT FARE INPUT OPTION: 1=FARE MATRIX INPUT,                       00329081    *     INSERTED*
C        2=FARE MATRIX NOT INPUT  (TFO)                          2.0         00329082    *     INSERTED*
C   4  CARPOOL FACILITIES OPTION: 1=NO CARPOOL FACILITIES,                   00329083    *     INSERTED*
C        2=NO CARPOOL LANE, BUT OTHER INCENTIVES,                            00329084    *     INSERTED*
C        3=CARPOOL LANE EXISTS (HOV)                             1.0         00329085    *     INSERTED*
```

C	5	KEY ACTIVITY CENTER ZONE NUMBER (KAZ)	1.0	00329086	*	INSERTED*
C	6	AZIMUTH OF EXPRESS/HOV CORRIDOR IN DEGREES (AXC)	0.0	00329087	*	INSERTED*
C	7	LENGTH OF CORRIDOR (LXC)	0.0	00329088	*	INSERTED*
C	8	GWY EXPRESS HEADWAY (HXS)	0.0	00329089	*	INSERTED*
C	9	GWY EXPRESS BUS SPEED (SXS)	35.0	00329090	*	INSERTED*
C	10	GWY EXPRESS CIRCUITY FACTOR (CFXC)	1.25	00329091	*	INSERTED*
C	11	NON-ACCESS LENGTH OF GWY EXPRESS CORRIDOR (LNA)	0.0	00329092	*	INSERTED*
C	12	LOCAL TRANSIT SPEED (SLB)	12.0	00329093	*	INSERTED*
C	13	LOCAL TRANSIT CIRCUITY FACTOR (CFLB)	1.67	00329094	*	INSERTED*
C	14	BOARDING FARE (FBOARD)	55.0	00329095	*	INSERTED*
C	15	MAXIMUM DISTANCE FOR BOARDING FARE (MAXD)	3.0	00329096	*	INSERTED*
C	16	TRANSIT FARE PER MILE (FPM)	1.0	00329097	*	INSERTED*
C	17	PREMIUM FARE FOR EXP/LRT SERVICE (FPREM)	0.0	00329098	*	INSERTED*
C	18	DEFINITION OF CARPOOL (HOVDEF)	5.0	00329099	*	INSERTED*
C	19	AVERAGE CAR OCCUPANCY FOR "4+" CATEGORY (OCC4)	4.5	00329100	*	INSERTED*
C	20	CARPOOL LANE SPEED (SHOV)	35.0	00329101	*	INSERTED*
C	21	LOCAL CARPOOL CIRCUITY FACTOR (CFCPLC)	1.41	00329102	*	INSERTED*
C	22	AUTOMOBILE OPERATION COST PER MILE (OCPM)	7.5	00329103	*	INSERTED*
C	23	AVERAGE WORK TRIPS PER DU - LOW INCOME (TRATE(1))	0.89	00329104	*	INSERTED*
C	24	AVERAGE WORK TRIPS PER DU - MED-LO INCOME (TRATE(2))	1.57	00329105	*	INSERTED*
C	25	AVERAGE WORK TRIPS PER DU - MED-HI INCOME (TRATE(3))	1.85	00329106	*	INSERTED*
C	26	AVERAGE WORK TRIPS PER DU - HIGH INCOME (TRATE(4))	2.03	00329107	*	INSERTED*
C	27	INITIAL WAIT TIME COEFFICIENT (BWAIT)	0.030	00329108	*	INSERTED*
C	28	SECOND WAIT, WALK TIME COEFFICIENT (BWALK)	0.044	00329109	*	INSERTED*
C	29	RUN TIME COEFFICIENT (BRUN)	0.031	00329110	*	INSERTED*
C	30	GROUP EXCESS TIME COEF. (BEXCG)	0.0174	00329111	*	INSERTED*
C	31	OUT-OF-POCKET COST COEF. (BOPC)	0.014	00329112	*	INSERTED*
C	32	PARKING COST COEF. (BPKC)	0.0215	00329113	*	INSERTED*
C	33	INCOME COEF. FOR OCC=2 (GROUP), LOW INCOME (BINC2(1))	1.5556	00329114	*	INSERTED*
C	34	INCOME COEF. FOR OCC=2 (GROUP), MED-LO INC. (BINC2(2))	1.1287	00329115	*	INSERTED*
C	35	INCOME COEF. FOR OCC=2 (GROUP), MED-HI INC. (BINC2(3))	0.7549	00329116	*	INSERTED*
C	36	INCOME COEF. FOR OCC=2 (GROUP), HIGH INCOME (BINC2(4))	0.4750	00329117	*	INSERTED*
C	37	INCOME COEF. FOR OCC=3, LOW INCOME (BINC3(1))	2.1804	00329118	*	INSERTED*
C	38	INCOME COEF. FOR OCC=3, MED-LOW INCOME (BINC3(2))	2.0594	00329119	*	INSERTED*
C	39	INCOME COEF. FOR OCC=3, MED-HI INCOME (BINC3(3))	1.8993	00329120	*	INSERTED*
C	40	INCOME COEF. FOR OCC=3, HIGH INCOME (BINC3(4))	1.8013	00329121	*	INSERTED*
C	41	INCOME COEF. FOR OCC=4, LOW INCOME (BINC4(1))	2.6096	00329122	*	INSERTED*
C	42	INCOME COEF. FOR OCC=4, MED-LOW INCOME (BINC4(2))	2.4491	00329123	*	INSERTED*
C	43	INCOME COEF. FOR OCC=4, MED-HI INCOME (BINC4(3))	2.2929	00329124	*	INSERTED*
C	44	INCOME COEF. FOR OCC=4, HIGH INCOME (BINC4(4))	2.1330	00329125	*	INSERTED*
C	45	AUTO-CONNECT COEF. (BAC)	0.87	00329126	*	INSERTED*
C	46	DRIVE-ALONE EXCESS TIME COEF. (BEXC1)	0.0693	00329127	*	INSERTED*
C	47	INCOME COEF. FOR DRIVE-ALONE, LOW INCOME (BINC1(1))	0.5218	00329128	*	INSERTED*
C	48	INCOME COEF. FOR DRIVE-ALONE, MED-LO INCOME (BINC1(2))	-0.0617	00329129	*	INSERTED*
C	49	INCOME COEF. FOR DRIVE-ALONE, MED-HI INCOME (BINC1(3))	-0.9346	00329130	*	INSERTED*
C	50	INCOME COEF. FOR DRIVE-ALONE, HIGH INCOME (BINC1(4))	-1.5379	00329131	*	INSERTED*
C	51	EXP/LRT SYSTEM WALK TIME FACTOR (FCXWK)	1.0	00329132	*	INSERTED*
C	52	EXP/LRT SYSTEM WAIT TIME FACTOR (FCXWA)	1.0	00329133	*	INSERTED*
C	53	COORDINATE FACTOR (FCCORD)	0.004735	00329134	*	INSERTED*
C	54	CARPOOL TERMINAL TIME FACTOR (FCCPIT)	1.0	00329135	*	INSERTED*
C	55	CARPOOL PARKING COST FACTOR (FCCPPC)	1.0	00329136	*	INSERTED*
C	56	HIGHWAY TIME FACTOR (FCHWYT)	1.0	00329137	*	INSERTED*

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C  57  HIGHWAY DISTANCE FACTOR (FCHWYD)                            0.01    00329138     *     INSERTED*
C  58  NORMAL PARKING COST FACTOR (FCHWPC)                         1.0     00329139     *     INSERTED*
C  59  RATIO OF DIRECT EXPRESS TO HIGHWAY TIME                     1.2     00329140     *     INSERTED*
C  60  LAST INTERNAL ZONE NUMBER (LIZ)                            ZONES    00329141     *     INSERTED*
C  61  SWITCH TO ALLOW INPUT OF VMT DATA AND TO PERFORM                    00329142     *     INSERTED*
C        VMT BY DISTRICT CALCULATIONS (DOVMT)                              00329143     *     INSERTED*
C        (1 = YES, 2 = NO)                                         2.0     00329144     *     INSERTED*
C  62    SWITCH TO CONTROL PRINTING OF GUIDEWAY REPORTS (GWYREP)           00329145     *     INSERTED*
C          (1 = YES, 2 = NO)                                       2.0     00329146     *     INSERTED*
C        NOTE: ATTEMPTING TO SET ANY UPARMS TO ZERO WILL RESULT IN THE     00329147     *     INSERTED*
C        DEFAULT VALUE BEING USED                                          00329148     *     INSERTED*
C                                                                          00329149     *     INSERTED*
C                                                                          00329150     *     INSERTED*
C      THE OUTPUT OF THIS PROGRAM CONSISTS OF UP TO SEVEN TRIP TABLES AS   00329151     *     INSERTED*
C        FOLLOWS:                                                          00329152     *     INSERTED*
C           1 - TRANSIT TRIPS USING EXP/LRT SERVICE                        00329153     *     INSERTED*
C           2 - TRANSIT TRIPS NOT USING EXP/LRT SERVICE                    00329154     *     INSERTED*
C           3 - AUTO-DRIVER TRIPS USING HOV LANE                           00329155     *     INSERTED*
C           4 - AUTO-DRIVER TRIPS NOT USING HOV LANE                       00329156     *     INSERTED*
C           5 - AUTO-PASSENGER TRIPS USING HOV LANE                        00329157     *     INSERTED*
C           6 - AUTO-PASSENGER TRIPS NOT USING HOV LANE                    00329158     *     INSERTED*
C           7 - TOTAL PERSON TRIPS                                         00329159     *     INSERTED*
C        (IF NO HOV LANE EXISTS, ONLY FIVE TRIP TABLES ARE OUTPUT,         00329160     *     INSERTED*
C        WITH THE FINAL THREE BEING AUTO-DRIVER TRIPS, AUTO-PASSENGER      00329161     *     INSERTED*
C        TRIPS, AND TOTAL PERSON TRIPS.)                                   00329162     *     INSERTED*
C                                                                          00329163     *     INSERTED*
C      THE PRINTED REPORTS INCLUDE A SUMMARY OF TRIPS ACCESSING AND        00329164     *     INSERTED*
C        EGRESSING ALONG THE LENGTH OF THE EXP/LRT CORRIDOR IN EACH        00329165     *     INSERTED*
C        DIRECTION.  UP TO FOUR  TRIP-END SUMMARIES WILL BE PRINTED AS     00329166     *     INSERTED*
C        FOLLOWS:                                                          00329167     *     INSERTED*
C           SUMMARY NO. 1 - TRANSIT, AUTO-DRIVER, AUTO-PASSENGER, TOTAL    00329168     *     INSERTED*
C           SUMMARY NO. 2 - EXP/LRT, OTHER TRANSIT, AND TOTAL TRANSIT      00329169     *     INSERTED*
C           SUMMARY NO. 3 - AUTO-DRIVER: USING HOV LANE, NOT USING HOV     00329170     *     INSERTED*
C                                   LANE, AND TOTAL                        00329171     *     INSERTED*
C           SUMMARY NO. 4 - AUTO-PASSENGER: USING HOV LANE, NOT USING HOV00329172     *     INSERTED*
C                                      LANE, AND TOTAL                     00329173     *     INSERTED*
C           (SUMMARIES 3 & 4 PRINTED ONLY IF HOV LANE EXISTS AND           00329174     *     INSERTED*
C                  UPARMS(62) = 1.0)                                       00329175     *     INSERTED*
C                                                                          00329176     *     INSERTED*
C --- TYPE STATEMENTS FOR MOD13A                                           00329177     *     INSERTED*
C                                                                          00329178     *     INSERTED*
      REAL*4 DEFALT(59)/3*2.0,2*1.0,3*0.0,35.0,1.25,0.0,12.0,1.67,         00329179     *     INSERTED*
     1                55.0,3.0,1.0,0.0,5.0,4.5,35.0,1.41,7.5,0.89,1.57,00329180     *     INSERTED*
     2                 1.85,2.03,0.030,0.044,0.031,0.0174,0.014,0.0215,00329181     *     INSERTED*
     3                 1.5556,1.1287,0.7549,0.4750,2.1804,2.0594,          00329182     *     INSERTED*
     4                 1.8993,1.8013,2.6096,2.4491,2.2929,2.1330,0.87,     00329183     *     INSERTED*
     5                 0.0693,0.5218,-0.0617,-0.9346,-1.5379,2*1.0,        00329184     *     INSERTED*
     6                 0.004735,3*1.0,0.01,1.0,1.2/                        00329185     *     INSERTED*
      INTEGER*4 TTO,EST,TFO,HOV,KAZ,HOVDEF,ICHK/0/,LIZ,IDST,JD,DOVMT,      00329186     *     INSERTED*
     1  GWYREP                                                             00329187     *     INSERTED*
      REAL*4 AXC,LXC,HXS,SXS,CFXC,LNA,SLB,CFLB,FBOARD,MAXD,FPM,FPREM,      00329188     *     INSERTED*
     1       OCC4,SHOV,CFCPLC,OCPM,BWAIT,BWALK,BRUN,BEXCG,BOPC,BPKC,BAC,00329189     *     INSERTED*
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     2        BEXC1,FCXWK,FCXWA,FCCORD,FCCPTT,FCCPPC,FCHWYT,FCHWYD,          00329190   *   INSERTED*
     3        FCHWPC,TRATE(4),BINC2(4),BINC3(4),BINC4(4),BINC1(4),           00329191   *   INSERTED*
     4        FINC(4,4),EINCG(4),TRAT,PCT(15),FP(6),DSTPCT(15,15,15),        00329192   *   INSERTED*
     5        FACPCT(15,6)                                                   00329193   *   INSERTED*
C                                                                            00329194   *   INSERTED*
C --- SET UPARMS TO DEFAULT VALUES UNLESS CODED BY USER                      00329195   *   INSERTED*
C                                                                            00329196   *   INSERTED*
      DO 20 I=1,59                                                           00329197   *   INSERTED*
        IF (UPARMS(I).EQ.0.0) UPARMS(I)=DFFALT(I)                            00329198   *   INSERTED*
   20 CONTINUE                                                               00329199   *   INSERTED*
        IF (UPARMS(60).EQ.0.0) UPARMS(60)=ZONES                              00329200   *   INSERTED*
        IF (UPARMS(61).EQ.0.0) UPARMS(61)=2.0                                00329201   *   INSERTED*
        IF (UPARMS(62).EQ.0.0) UPARMS(62)=2.0                                00329202   *   INSERTED*
C                                                                            00329203   *   INSERTED*
C --- ASSIGN DESCRIPTIVE NAMES TO UPARMS                                     00329204   *   INSERTED*
C                                                                            00329205   *   INSERTED*
      TTO = UPARMS(1)                                                        00329206   *   INSERTED*
      EST = UPARMS(2)                                                        00329207   *   INSERTED*
      TFO = UPARMS(3)                                                        00329208   *   INSERTED*
      HOV = UPARMS(4)                                                        00329209   *   INSERTED*
      KAZ = UPARMS(5)                                                        00329210   *   INSERTED*
      AXC = UPARMS(6) * 0.01745329                                           00329211   *   INSERTED*
      LXC = UPARMS(7)                                                        00329212   *   INSERTED*
      HXS = UPARMS(8)                                                        00329213   *   INSERTED*
      SXS = UPARMS(9)                                                        00329214   *   INSERTED*
      CFXC = UPARMS(10)                                                      00329215   *   INSERTED*
      LNA = UPARMS(11)                                                       00329216   *   INSERTED*
      SLB = UPARMS(12)                                                       00329217   *   INSERTED*
      CFLB = UPARMS(13)                                                      00329218   *   INSERTED*
      FBOARD = UPARMS(14)                                                    00329219   *   INSERTED*
      MAXD = UPARMS(15)                                                      00329220   *   INSERTED*
      FPM = UPARMS(16)                                                       00329221   *   INSERTED*
      FPREM = UPARMS(17)                                                     00329222   *   INSERTED*
      HOVDEF = UPARMS(18)                                                    00329223   *   INSERTED*
      OCC4 = UPARMS(19)                                                      00329224   *   INSERTED*
      SHOV = UPARMS(20)                                                      00329225   *   INSERTED*
      CFCPLC = UPARMS(21)                                                    00329226   *   INSERTED*
      OCPM = UPARMS(22)                                                      00329227   *   INSERTED*
      BWAIT = UPARMS(27)                                                     00329228   *   INSERTED*
      BWALK = UPARMS(28)                                                     00329229   *   INSERTED*
      BRUN = UPARMS(29)                                                      00329230   *   INSERTED*
      BEXCG = UPARMS(30)                                                     00329231   *   INSERTED*
      BOPC = UPARMS(31)                                                      00329232   *   INSERTED*
      BPKC = UPARMS(32)                                                      00329233   *   INSERTED*
      BAC = UPARMS(45)                                                       00329234   *   INSERTED*
      BEXC1 = UPARMS(46)                                                     00329235   *   INSERTED*
      FCXWK = UPARMS(51)                                                     00329236   *   INSERTED*
      FCXWA = UPARMS(52)                                                     00329237   *   INSERTED*
      FCCORD = UPARMS(53)                                                    00329238   *   INSERTED*
      FCCPTT = UPARMS(54)                                                    00329239   *   INSERTED*
      FCCPPC = UPARMS(55)                                                    00329240   *   INSERTED*
      FCHWYT = UPARMS(56)                                                    00329241   *   INSERTED*
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      FCHWYD = UPARMS(57)                                                00329242    *    INSERTED*
      FCHWPC = UPARMS(58)                                                00329243    *    INSERTED*
      DO 40 I=1,4                                                        00329244    *    INSERTED*
        TRATE(I) = UPARMS(I+22)                                          00329245    *    INSERTED*
        BINC2(I) = UPARMS(I+32)                                          00329246    *    INSERTED*
        BINC3(I) = UPARMS(I+36)                                          00329247    *    INSERTED*
        BINC4(I) = UPARMS(I+40)                                          00329248    *    INSERTED*
   40   BINC1(I) = UPARMS(I+46)                                          00329249    *    INSERTED*
      TRAT = UPARMS(59)                                                  00329250    *    INSERTED*
      LIZ = UPARMS(60)                                                   00329251    *    INSERTED*
      DOVMT=UPARMS(61)                                                   00329252    *    INSERTED*
      GWYREP=UPARMS(62)                                                  00329253    *    INSERTED*
C                                                                        00329254    *    INSERTED*
C --- CHECK FOR INVALID VALUES OF OPTIONS PARAMETERS (UPARMS(1-4))       00329255    *    INSERTED*
C                                                                        00329256    *    INSERTED*
      IF (TTO.GE.1.AND.TTO.LE.3) GO TO 60                                00329257    *    INSERTED*
      ICHK = 1                                                           00329258    *    INSERTED*
      WRITE (6,50)                                                       00329259    *    INSERTED*
   50 FORMAT (' VALUE OF INPUT TRIP TABLE OPTION PARAMETER (UPARMS(1)) I00329260    *    INSERTED*
     1S INVALID -- FATAL')                                               00329261    *    INSERTED*
   60 IF (EST.GE.2.AND.EST.LE.3) GO TO 80                                00329262    *    INSERTED*
      ICHK = 1                                                           00329263    *    INSERTED*
      WRITE (6,70)                                                       00329264    *    INSERTED*
   70 FORMAT (' VALUE OF EXP/LRT SYSTEM TYPE PARAMETER (UPARMS(2)) IS IN00329265    *    INSERTED*
     1VALID -- FATAL')                                                   00329266    *    INSERTED*
   80 IF (TFO.GE.1.AND.TFO.LE.2) GO TO 100                               00329267    *    INSERTED*
      ICHK = 1                                                           00329268    *    INSERTED*
      WRITE (6,90)                                                       00329269    *    INSERTED*
   90 FORMAT (' VALUE OF TRANSIT FARE INPUT OPTION PARAMETER (UPARMS(3))00329270    *    INSERTED*
     1 IS INVALID -- FATAL')                                             00329271    *    INSERTED*
  100 IF (HOV.GE.1.AND.HOV.LE.3) GO TO 120                               00329272    *    INSERTED*
      ICHK = 1                                                           00329273    *    INSERTED*
      WRITE (6,110)                                                      00329274    *    INSERTED*
  110 FORMAT (' VALUE OF CARPOOL FACILITIES OPTION PARAMETER (UPARMS(4))00329275    *    INSERTED*
     1 IS INVALID -- FATAL')                                             00329276    *    INSERTED*
  120 IF (ZONES.LE.100) GO TO 124                                        00329277    *    INSERTED*
      ICHK = 1                                                           00329278    *    INSERTED*
      WRITE (6,122)                                                      00329279    *    INSERTED*
  122 FORMAT (' MAXIMUM NUMBER OF ZONES EXCEEDED -- FATAL')              00329280    *    INSERTED*
  124 IF (ICHK.EQ.1) STOP                                                00329281    *    INSERTED*
C                                                                        00329282    *    INSERTED*
C --- CHECK FOR OTHER FATAL ERRORS                                       00329283    *    INSERTED*
C                                                                        00329284    *    INSERTED*
      IF (EST.NE.3.OR.LNA.EQ.0.) GO TO 125                               00329285    *    INSERTED*
      WRITE (6,123)                                                      00329286    *    INSERTED*
  123 FORMAT (' LIGHT RAIL OPTION IS IN USE,(UPARMS(2)=3), BUT CORRIDOR  00329287    *    INSERTED*
     1NON-ACCESS LENGTH (UPARMS(11)) IS NON-ZERO -- FATAL')              00329288    *    INSERTED*
      STOP                                                               00329289    *    INSERTED*
  125 IF (HOV.EQ.1) GO TO 128                                            00329290    *    INSERTED*
      IF (HOVDEF.GE.2.AND.HOVDEF.LE.OCC4) GO TO 128                      00329291    *    INSERTED*
      WRITE (6,126)                                                      00329292    *    INSERTED*
  126 FORMAT (' HOV OPTION IN USE (UPARMS(4)>1), BUT HOV DEFINITION (UPA00329293    *    INSERTED*
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     1RMS(18)) IS EITHER SMALLER THAN 2 OR LARGER THAN OCC4 (UPARMS(19))00329294   *   INSERTED*
     2 -- FATAL')                                                      00329295   *   INSERTED*
      STOP                                                             00329296   *   INSERTED*
  128 CONTINUE                                                         00329297   *   INSERTED*
C                                                                      00329298   *   INSERTED*
C --- SET OTHER PARAMETERS                                              00329299   *   INSERTED*
C                                                                      00329300   *   INSERTED*
      ITER = 3                                                         00329301   *   INSERTED*
      TABOUT = 5                                                       00329302   *   INSERTED*
      IF (HOV.EQ.3) TABOUT = 7                                         00329303   *   INSERTED*
      TESUM(1) = 3                                                     00329304   *   INSERTED*
      TESUM(2) = 2                                                     00329305   *   INSERTED*
      IF (HOV.NE.3.OR.GWYREP.EQ.2) GO TO 145                           00329306   *   INSERTED*
      TESUM(3) = 2                                                     00329307   *   INSERTED*
      TESUM(4) = 2                                                     00329308   *   INSERTED*
  145 CONTINUE                                                         00329309   *   INSERTED*
C                                                                      00329310   *   INSERTED*
C --- CREATE ARRAY  WITH EXPONENTIATED INCOME COEFFICIENTS               00329311   *   INSERTED*
C                                                                      00329312   *   INSERTED*
      DO 150 I=1,4                                                     00329313   *   INSERTED*
        EINC(2,I)= EXP(-1.*BINC2(I))                                   00329314   *   INSERTED*
        EINC(3,I)= EXP(-1.*BINC3(I))                                   00329315   *   INSERTED*
        EINC(4,I)= EXP(-1.*BINC4(I))                                   00329316   *   INSERTED*
        EINC(1,I)= EXP(-1.*BINC1(I))                                   00329317   *   INSERTED*
        EINCG(I) = EINC(2,I)                                           00329318   *   INSERTED*
  150 CONTINUE                                                         00329319   *   INSERTED*
C                                                                      00329320   *   INSERTED*
C --- READ IN VMT PERCENTAGES, IF DESIRED                                00329321   *   INSERTED*
C                                                                      00329322   *   INSERTED*
      IF (DOVMT.EQ.2) GO TO 207                                        00329323   *   INSERTED*
  160 READ (1,170,END=190) IDST,JD,PCT                                 00329324   *   INSERTED*
  170 FORMAT (2I5,15F4.2)                                              00329325   *   INSERTED*
      DO 180 K=1,15                                                    00329326   *   INSERTED*
        DSTPCT(IDST,JD,K) = PCT(K)                                     00329327   *   INSERTED*
  180 CONTINUE                                                         00329328   *   INSERTED*
      GO TO 160                                                        00329329   *   INSERTED*
  190 READ (2,200,END=207) IDST,FP                                     00329330   *   INSERTED*
  200 FORMAT (I5,6F10.2)                                               00329331   *   INSERTED*
      DO 205 K=1,6                                                     00329332   *   INSERTED*
        FACPCT(IDST,K) = FP(K)                                         00329333   *   INSERTED*
  205 CONTINUE                                                         00329334   *   INSERTED*
      GO TO 190                                                        00329335   *   INSERTED*
  207 CONTINUE                                                         00329336   *   INSERTED*
C                                                                      00329337   *   INSERTED*
C *** END OF MOD13A ***                                                00329338   *   INSERTED*
C                                                                      00329339   *   INSERTED*
./ NUMBER INSERT=YES,SEQ1=349000,NEW1=349001,INCR=1
C*                                                                    *00330000
C*                                                                    *00331000
C*                                                                    *00332000
C*                                                                    *00333000
C*                                                                    *00334000
```

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C***********************************************************************00335000
      RETURN                                                            00336000
C                                                                       00337000
      ENTRY MOD13B(Z,ZD)                                                00338000
      REAL*4 Z(NZON,ZONES)                                              00339000
C                                                                       00340000
      INTEGER*2 ZD(ZONES)                                               00341000
C***********************************************************************00342000
C*                                                                     *00343000
C*ENTRY POINT MOD13B IS CODED BY THE USER TO TRANSFORM                 *00344000
C*  INPUT ZONE VARIABLES OR TO GENERATE NEW ZONE VARIABLES             *00345000
C*  FROM THOSE INPUT.                                                  *00346000
C*                                                                     *00347000
C*---------------------------------------------------------------------*00348000
C*     MOD13B USER CODE IS INSERTED BETWEEN  349000 - 355000           *00349000
C                                                                       00349001    *    INSERTED*
C *** BEGIN MOD13B ***                                                  00349002    *    INSERTED*
C                                                                       00349003    *    INSERTED*
C --- HERE COME THE TYPE STATEMENTS                                     00349004    *    INSERTED*
C                                                                       00349005    *    INSERTED*
      REAL*4 XKAZ,YKAZ,WT1,WT2,WT3,WT4,SWT                              00349006    *    INSERTED*
      INTEGER*4 HH1,HH2,HH3,HH4,SHH                                     00349007    *    INSERTED*
C                                                                       00349008    *    INSERTED*
C --- SKIP TO MOD13D ON SECOND AND THIRD ITERATIONS                     00349009    *    INSERTED*
C                                                                       00349010    *    INSERTED*
      IF (ITNO.GE.2) GO TO 390                                          00349011    *    INSERTED*
C                                                                       00349012    *    INSERTED*
C --- CHECK FOR P AND A FACTORS IF FACTORING IS REQUIRED                00349013    *    INSERTED*
C                                                                       00349014    *    INSERTED*
      ICHK = 0                                                          00349015    *    INSERTED*
      IF (TTO.NE.3) GO TO 270                                           00349016    *    INSERTED*
      DO 210 I=1,LIZ                                                    00349017    *    INSERTED*
        IF (Z(24,I).NE.KONN) GO TO 230                                  00349018    *    INSERTED*
  210 CONTINUE                                                          00349019    *    INSERTED*
      ICHK = 1                                                          00349020    *    INSERTED*
      WRITE (6,220)                                                     00349021    *    INSERTED*
  220 FORMAT (' FACTORING REQUESTED BUT PRODUCTION FACTORS NOT INPUT -- 00349022    *    INSERTED*
     1FATAL')                                                           00349023    *    INSERTED*
  230 DO 240 I=1,LIZ                                                    00349024    *    INSERTED*
        IF (Z(25,I).NE.KONN) GO TO 260                                  00349025    *    INSERTED*
  240 CONTINUE                                                          00349026    *    INSERTED*
      ICHK = 1                                                          00349027    *    INSERTED*
      WRITE (6,250)                                                     00349028    *    INSERTED*
  250 FORMAT (' FACTORING REQUESTED BUT ATTRACTION FACTORS NOT INPUT -- 00349029    *    INSERTED*
     1FATAL')                                                           00349030    *    INSERTED*
  260 IF (ICHK.EQ.1) STOP                                               00349031    *    INSERTED*
C                                                                       00349032    *    INSERTED*
C --- IF HOV FACILITIES EXIST, CHECK FOR INPUT TERMINAL TIMES AND       00349033    *    INSERTED*
C       PARKING COSTS.  IF NONE EXIST, SET EQUAL TO HIGHWAY.            00349034    *    INSERTED*
C                                                                       00349035    *    INSERTED*
  270 IF (HOV.EQ.1) GO TO 350                                           00349036    *    INSERTED*
      DO 280 I=1,LIZ                                                    00349037    *    INSERTED*
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      IF (Z(16,I).NE.KONN) GO TO 310                                    00349038    *    INSERTED*
  280 CONTINUE                                                          00349039    *    INSERTED*
      DO 290 I=1,LIZ                                                    00349040    *    INSERTED*
        Z(16,I) = Z(18,I)                                               00349041    *    INSERTED*
  290 CONTINUE                                                          00349042    *    INSERTED*
      WRITE (6,300)                                                     00349043    *    INSERTED*
  300 FORMAT (' WARNING: HOV OPTION REQUESTED, BUT NO TERMINAL TIMES INP00349044    *    INSERTED*
     1UT FOR CARPOOLS -- SET EQUAL TO HIGHWAY TERMINAL TIMES.')         00349045    *    INSERTED*
  310 DO 320 I=1,LIZ                                                    00349046    *    INSERTED*
        IF (Z(17,I).NE.KONN) GO TO 350                                  00349047    *    INSERTED*
  320 CONTINUE                                                          00349048    *    INSERTED*
      WRITE (6,330)                                                     00349049    *    INSERTED*
  330 FORMAT (' WARNING: HOV OPTION REQUESTED, BUT NO PARKING COSTS INPU00349050    *    INSERTED*
     1T FOR CARPOOLS -- SET EQUAL TO HIGHWAY PARKING COSTS.')           00349051    *    INSERTED*
      DO 340 I=1,LIZ                                                    00349052    *    INSERTED*
        Z(17,I) = Z(19,I)                                               00349053    *    INSERTED*
  340 CONTINUE                                                          00349054    *    INSERTED*
  350 CONTINUE                                                          00349055    *    INSERTED*
C                                                                       00349056    *    INSERTED*
C --- CONVERT ZONAL VARIABLES TO PROPER UNITS                           00349057    *    INSERTED*
C                                                                       00349058    *    INSERTED*
      DO 360 I=1,LIZ                                                    00349059    *    INSERTED*
        Z(3,I) = FCCORD * Z(3,I)                                        00349060    *    INSERTED*
        Z(4,I) = FCCORD * Z(4,I)                                        00349061    *    INSERTED*
        Z(5,I) = FCXWK * Z(5,I)                                         00349062    *    INSERTED*
        Z(6,I) = FCXWA * Z(6,I)                                         00349063    *    INSERTED*
        Z(16,I) = FCCPTT * Z(16,I)                                      00349064    *    INSERTED*
        Z(17,I) = FCCPPC * Z(17,I)                                      00349065    *    INSERTED*
        Z(19,I) = FCHWPC * Z(19,I)                                      00349066    *    INSERTED*
  360 CONTINUE                                                          00349067    *    INSERTED*
C                                                                       00349068    *    INSERTED*
C --- DETERMINE COORDINATES OF KEY ACTIVITY ZONE                        00349069    *    INSERTED*
C                                                                       00349070    *    INSERTED*
      XKAZ = Z(3,KAZ)                                                   00349071    *    INSERTED*
      YKAZ = Z(4,KAZ)                                                   00349072    *    INSERTED*
C                                                                       00349073    *    INSERTED*
C --- COMPUTE MIX OF TRIPS BY INCOME FOR EACH ZONE, STORE IN Z ARRAY    00349074    *    INSERTED*
C                                                                       00349075    *    INSERTED*
      DO 380 I=1,LIZ                                                    00349076    *    INSERTED*
        HH1 = Z(20,I)                                                   00349077    *    INSERTED*
        HH2 = Z(21,I)                                                   00349078    *    INSERTED*
        HH3 = Z(22,I)                                                   00349079    *    INSERTED*
        HH4 = Z(23,I)                                                   00349080    *    INSERTED*
        SHH = HH1 + HH2 + HH3 + HH4                                     00349081    *    INSERTED*
        IF (SHH.GE.1) GO TO 370                                         00349082    *    INSERTED*
        HH1 = 1                                                         00349083    *    INSERTED*
        HH2 = 1                                                         00349084    *    INSERTED*
        HH3 = 1                                                         00349085    *    INSERTED*
        HH4 = 1                                                         00349086    *    INSERTED*
  370   WT1 = HH1 * TRATE(1)                                            00349087    *    INSERTED*
        WT2 = HH2 * TRATE(2)                                            00349088    *    INSERTED*
        WT3 = HH3 * TRATE(3)                                            00349089    *    INSERTED*
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            WT4 = HH4 * TRATE(4)                                              00349090     *            INSERTED*
          SWT = WT1 + WT2 + WT3 + WT4                                         00349091     *            INSERTED*
          Z(20,I) = WT1/SWT                                                   00349092     *            INSERTED*
          Z(21,I) = WT2/SWT                                                   00349093     *            INSERTED*
          Z(22,I) = WT3/SWT                                                   00349094     *            INSERTED*
          Z(23,I) = WT4/SWT                                                   00349095     *            INSERTED*
      380 CONTINUE                                                            00349096     *            INSERTED*
      390 CONTINUE                                                            00349097     *            INSERTED*
    C                                                                         00349098     *            INSERTED*
    C *** END OF MOD13B                                                       00349099     *            INSERTED*
    C                                                                         00349100     *            INSERTED*
./ NUMBER INSERT=YES,SEQ1=416000,NEW1=416001,INCR=1
    C*                                                                       *00350000
    C*                                                                       *00351000
    C*                                                                       *00352000
    C*                                                                       *00353000
    C*                                                                       *00354000
    C************************************************************************00355000
          RETURN                                                              00356000
    C                                                                         00357000
          ENTRY MOD13C(INT,TRIPS1,TRIPS2,STRAT,TABLE,TABRE1,                  00358000
         *              TABRE2,TABRE3,TABRE4,TABRE5,TABRO1,TABRO2,            00359000
         *              TABRO3,TABRO4,TABRO5,TABRP1,TABRP2,TABRP3,            00360000
         *              TABRP4,TABRP5,TE1,TE2,TE3,TE4,TE5,PERT1,              00361000
         *              PERT2,PERT3,PERT4,PERT5,TROUT,FFACT,GARB,PVAR)        00362000
    C                                                                         00363000
          INTEGER*4 TRIPS1(ZONES,TRPVAR),PVAR(NVAR)                           00364000
          REAL*4    TABRE1(TD1,TD2,TD3,TD4,TD5,TD6,TD7),                      00365000
         *          TABRE2(TD1,TD2,TD3,TD4,TD5,TD6,TD7),                      00366000
         *          TABRE3(TD1,TD2,TD3,TD4,TD5,TD6,TD7),                      00367000
         *          TABRE4(TD1,TD2,TD3,TD4,TD5,TD6,TD7),                      00368000
         *          TABRE5(TD1,TD2,TD3,TD4,TD5,TD6,TD7),                      00369000
         *          TABRO1(TD1,TD2,TD3,TD4,TD5,TD6,TD7),                      00370000
         *          TABRO2(TD1,TD2,TD3,TD4,TD5,TD6,TD7),                      00371000
         *          TABRO3(TD1,TD2,TD3,TD4,TD5,TD6,TD7),                      00372000
         *          TABRO4(TD1,TD2,TD3,TD4,TD5,TD6,TD7),                      00373000
         *          TABRO5(TD1,TD2,TD3,TD4,TD5,TD6,TD7),                      00374000
         *          TABRP1(TD1,TD2,TD3,TD4,TD5,TD6,TD7),                      00375000
         *          TABRP2(TD1,TD2,TD3,TD4,TD5,TD6,TD7),                      00376000
         *          TABRP3(TD1,TD2,TD3,TD4,TD5,TD6,TD7),                      00377000
         *          TABRP4(TD1,TD2,TD3,TD4,TD5,TD6,TD7),                      00378000
         *          TABRP5(TD1,TD2,TD3,TD4,TD5,TD6,TD7),                      00379000
         *          TE1(SLOTS,TEN1),TE2(SLOTS,TEN2),TE3(SLOTS,TEN3),          00380000
         *          TE4(SLOTS,TEN4),TE5(SLOTS,TEN5),PERT1(SLOTS,2),           00381000
         *          PERT2(SLOTS,2),PERT3(SLOTS,2),PERT4(SLOTS,2),             00382000
         *          PERT5(SLOTS,2)                                            00383000
          REAL*4 TROUT(ZONES,TABOUT)                                          00384000
    C                                                                         00385000
          INTEGER*2 INT(ZONES,INTVAR),TRIPS2(ZONES,TRPVAR)                    00386000
    C                                                                         00387000
          REAL*4 STRAT(MAXL,DIMENS),FFACT(NUMF,MAXT),                         00388000
         *      TABLE(LEVEL1,LEVEL2,LEVEL3,LEVEL4,LEVEL5,LEVEL6,LEVEL7),      00389000
```

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      *       GARB(TABOUT)                                                00390000
C                                                                         00391000
      REAL*4 LOOKUP,INTERP,MODELL,ACCESS                                  00392000
C***********************************************************************00393000
C*                                                                       *00394000
C*         ADDITIONAL ARRAYS FOR USE IN MOD13D,MOD13E AND MOD13F        *00395000
C*         MAY BE DIMENSIONED HERE                                       *00396000
C*                                                                       *00397000
C*----------------------------------------------------------------------*00398000
C*     MOD13C USER CODE IS INSERTED BETWEEN  399000 - 405000            *00399000
C*                                                                       *00400000
C*                                                                       *00401000
C*                                                                       *00402000
C*                                                                       *00403000
C*                                                                       *00404000
C***********************************************************************00405000
      RETURN                                                              00406000
C                                                                         00407000
      ENTRY MOD13D(IZ,*)                                                  00408000
C***********************************************************************00409000
C*                                                                       *00410000
C*       ENTRY POINT MOD13D IS USED TO APPLY MODELS ON A ROW            *00411000
C*       BASIS. IT IS ENTERED ONCE FOR EACH CHANGE IN THE               *00412000
C*       ORIGIN ZONE.                                                    *00413000
C*                                                                       *00414000
C*----------------------------------------------------------------------*00415000
C*     MOD13D USER CODE IS INSERTED BETWEEN  416000 - 422000            *00416000
C                                                                         00416001     *          INSERTED*
C *** BEGIN MOD13D ***                                                    00416002     *          INSERTED*
C                                                                         00416003     *          INSERTED*
C --- HERE COME THE TYPE STATEMENTS                                       00416004     *          INSERTED*
C                                                                         00416005     *          INSERTED*
      INTEGER*4 IPROD(100)/100*0/,IATTR(100)/100*0/,NATTR(100)/100*0/,   00416006     *          INSERTED*
     1          NPROD,LXMK,RMCK,LRMK,TTYPE(100),LTYPE(100),HOVMK(100),   00416007     *          INSERTED*
     2          LO,LOHI/0/,LI,LIHI/0/,ZSTRT,IXMK(100)/100*0/             00416008     *          INSERTED*
      REAL*4 SPROD,SATTR,PROD(100),ATTR(100),GT,HWYTKZ(100),HWYDKZ(100),00416009     *          INSERTED*
     1       TRIPS(100),SAZ,STAN,DATTR(100),XZ,YZ,LX,LY,ZFAC(100),       00416010     *          INSERTED*
     2       TAZ,FAZ,ZLN,EBLN,LBLN,AL,EBRT,LBRT,                         00416011     *          INSERTED*
     3       EXTME(100),EXPTR(100),LBPTR(100),AC,BC,ZC,ABC,BZC,RWOZ,     00416012     *          INSERTED*
     4       NRWO,NRWI,RWKO,HWYD,CC,XC,XDCC,DC,GC,RWAIT,RWALK,RRUN,      00416013     *          INSERTED*
     5       LUT(100),CUT,CWAIT1,CWAIT2,CWALK,CRUN,PRWA2,PRWALK,         00416014     *          INSERTED*
     6       PRRUN1,PRRUN2,PRUT,PXWA2,PXWALK,PXRUN1,PXRUN2,PXUT,SNEG,    00416015     *          INSERTED*
     7       PRODO,OTRIPS(100),CEMV,CFAC,OEUT,TTU(100),EUT,EUT1,         00416016     *          INSERTED*
     8       LRWK,LRWA1,LRWA2,EXPCM,LRRUN,EUT2,CTKO,THOV,SLP,TLP,HWYT,   00416017     *          INSERTED*
     9       HOVTME,HOVRUN(100),HOVEXC(100),HOVPKC(100),HOVDST           00416018     *          INSERTED*
      REAL*4 HOVOPC(100),HWYEXC(100),HWYRUN(100),HWYOPC(100),            00416019     *          INSERTED*
     1       HWYPKC(100),TFARE(100),PFEX,DEXT,TDST,LBDST,LRDST,          00416020     *          INSERTED*
     2       TRPTOT(5,4)/20*0./,XOCC,GPEXC,GPRUN,GPOPC,GPPKC,GPUT(4),    00416021     *          INSERTED*
     3       EGPUT,EGPUT1(4,4),TEGPUT,GRPUT(4),ACONN,GOCC(4),POCC(4,4),  00416022     *          INSERTED*
     4       TRNUT,ETRNUT,ONEUT,EONEUT,PCTTRN,PCTONE,PCTTWO,PCTTHR,TEMP,00416023     *          INSERTED*
     5       PCTFOR,PCTADR,PCTAPS,EGRPUT,EONUTI,TOTEUT,PTRN(4),PONE(4),  00416024     *          INSERTED*
     6       PGRP(4),INVGOC,PADR(4),PAPASS(4),PFAC,NXTTP,NTRTP,NLTTP,    00416025     *          INSERTED*
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     7         NAPASS,NADR,NHOVDR,NHOVPS,NNHOVD,NNHOVP,TINC,INKAZ,           00416026      *       INSERTED*
     8         OUTKAZ,INBRD(100)/100*0./,OUTBRD(100)/100*0./,                00416027      *       INSERTED*
     9         OUTALT(100)/100*0./,INALT(100)/100*0./,HOVVEH/0./,            00416028      *       INSERTED*
     *         ONVEH(100)/100*0./,UNPER(100)/100*0./,HOVPER/0./,TRIP,        00416029      *       INSERTED*
     1         RWIZ,RWKI,WALK(100),WAIT(100),RUN(100),ACN(100),KUT(100),     00416030      *       INSERTED*
     2         LCKUT(100),LWALK(100),LWAIT(100),LRUN(100),LACN(100),LACI,    00416031      *       INSERTED*
     3         VMTI,VMTK(15)/15*0./,VMT(15,6),TOTTRP(5)/5*0./,               00416032      *       INSERTED*
     4         VMTF(7)/7*0./                                                 00416033      *       INSERTED*
C                                                                            00416034      *       INSERTED*
C --- ZERO OUT OUTPUT TRIP TABLES                                            00416035      *       INSERTED*
C                                                                            00416036      *       INSERTED*
      DO 397 I=1,ZONES                                                       00416037      *       INSERTED*
        DO 393 J=1,TABOUT                                                    00416038      *       INSERTED*
          TROUT(I,J) = 0.                                                    00416039      *       INSERTED*
  393   CONTINUE                                                             00416040      *       INSERTED*
  397 CONTINUE                                                               00416041      *       INSERTED*
C                                                                            00416042      *       INSERTED*
C --- IF ORIGIN ZONE NOT INTERNAL, RETURN.  ON THIRD ITERATION, SKIP TO      00416043      *       INSERTED*
C         OUTPUT.                                                            00416044      *       INSERTED*
C                                                                            00416045      *       INSERTED*
  398 IF (IZ.LE.LIZ) GO TO 400                                               00416046      *       INSERTED*
      IF (ITNO.LE.2) GO TO 490                                               00416047      *       INSERTED*
      GO TO 1200                                                             00416048      *       INSERTED*
C                                                                            00416049      *       INSERTED*
C --- SORT OUT ITERATIONS                                                    00416050      *       INSERTED*
C                                                                            00416051      *       INSERTED*
  400 GO TO (410,500,610),ITNO                                               00416052      *       INSERTED*
C                                                                            00416053      *       INSERTED*
C *** BEGIN FIRST ITERATION ***                                              00416054      *       INSERTED*
C                                                                            00416055      *       INSERTED*
C --- IF FACTORING IS REQUIRED, CALCULATE NEW P'S AND A'S , FACTORS          00416056      *       INSERTED*
C         (STORE LATTER IN Z ARRAY)                                          00416057      *       INSERTED*
C                                                                            00416058      *       INSERTED*
  410 IF (TTO.NE.3) GO TO 480                                                00416059      *       INSERTED*
      DO 430 I=1,LIZ                                                         00416060      *       INSERTED*
        IPROD(IZ) = IPROD(IZ) + INT(I,PVAR(26))                              00416061      *       INSERTED*
        IATTR(I) = IATTR(I) + INT(I,PVAR(26))                                00416062      *       INSERTED*
  430 CONTINUE                                                               00416063      *       INSERTED*
      IF (IZ.NE.LIZ) GO TO 480                                               00416064      *       INSERTED*
      SPROD = 0.                                                             00416065      *       INSERTED*
      SATTR = 0.                                                             00416066      *       INSERTED*
      DO 440 I=1,LIZ                                                         00416067      *       INSERTED*
        PROD(I) = Z(24,I) * IPROD(I)                                         00416068      *       INSERTED*
        ATTR(I) = Z(25,I) * IATTR(I)                                         00416069      *       INSERTED*
        SPROD = SPROD + PROD(I)                                              00416070      *       INSERTED*
        SATTR = SATTR + ATTR(I)                                              00416071      *       INSERTED*
  440 CONTINUE                                                               00416072      *       INSERTED*
      GT = AMAX1(SPROD,SATTR)                                                00416073      *       INSERTED*
      IF (GT.EQ.SPROD) GO TO 460                                             00416074      *       INSERTED*
      DO 450 I=1,LIZ                                                         00416075      *       INSERTED*
        IF (SPROD.LT.0.01) GO TO 442                                         00416076      *       INSERTED*
        PROD(I) = PROD(I) * (GT/SPROD)                                       00416077      *       INSERTED*
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442   Z(24,I) = 0.0                                                      00416078   *   INSERTED*
        IF (IPROD(I).GT.0.01) Z(24,I) = PROD(I)/IPROD(I)                 00416079   *   INSERTED*
  450 CONTINUE                                                           00416080   *   INSERTED*
      GO TO 480                                                          00416081   *   INSERTED*
  460 IF (GT.EQ.SATTR) GO TO 480                                         00416082   *   INSERTED*
      DO 470 I=1,LIZ                                                     00416083   *   INSERTED*
        IF (SATTR.LT.0.01) GO TO 472                                     00416084   *   INSERTED*
        ATTR(I) = ATTR(I) * (GT/SATTR)                                   00416085   *   INSERTED*
  472   Z(25,I) = 0.0                                                    00416086   *   INSERTED*
        IF (IATTR(I).GT.0.01) Z(25,I) = ATTR(I)/IATTR(I)                 00416087   *   INSERTED*
  470 CONTINUE                                                           00416088   *   INSERTED*
C                                                                        00416089   *   INSERTED*
C --- BUILD ARRAYS OF HIGHWAY TIMES AND DISTANCES FROM EACH ZONE TO KAZ  00416090   *   INSERTED*
C                                                                        00416091   *   INSERTED*
  480 HWYTKZ(IZ) = INT(KAZ,PVAR(27)) * FCHWYT                            00416092   *   INSERTED*
      HWYDKZ(IZ) = INT(KAZ,PVAR(28)) * FCHWYD                            00416093   *   INSERTED*
  490 RETURN 1                                                           00416094   *   INSERTED*
C                                                                        00416095   *   INSERTED*
C *** BEGIN SECOND ITERATION ***                                         00416096   *   INSERTED*
C                                                                        00416097   *   INSERTED*
C                                                                        00416098   *   INSERTED*
C --- IF FACTORING IS REQUIRED, CALCULATE DELTA ATTRACTIONS              00416099   *   INSERTED*
C                                                                        00416100   *   INSERTED*
  500 IF (ITO.NE.3) GO TO 540                                            00416101   *   INSERTED*
      NPROD = 0                                                          00416102   *   INSERTED*
      DO 510 I=1,LIZ                                                     00416103   *   INSERTED*
        TRIPS(I)  =   INT(I,PVAR(26)) * Z(24,IZ) * Z(25,I)               00416104   *   INSERTED*
        NPROD = NPROD + TRIPS(I)                                         00416105   *   INSERTED*
  510 CONTINUE                                                           00416106   *   INSERTED*
        ZFAC(IZ) = 0.0                                                   00416107   *   INSERTED*
        IF (NPROD.GT.0.01) ZFAC(IZ) = PROD(IZ)/NPROD                     00416108   *   INSERTED*
      DO 520 I=1,LIZ                                                     00416109   *   INSERTED*
        TRIPS(I)  =   TRIPS(I)     * ZFAC(IZ)                            00416110   *   INSERTED*
        NATTR(I) = NATTR(I) + TRIPS(I)                                   00416111   *   INSERTED*
  520 CONTINUE                                                           00416112   *   INSERTED*
      IF (IZ.NE.LIZ) GO TO 540                                           00416113   *   INSERTED*
      DO 530 I=1,LIZ                                                     00416114   *   INSERTED*
        DATTR(I) = ATTR(I) - NATTR(I)                                    00416115   *   INSERTED*
  530 CONTINUE                                                           00416116   *   INSERTED*
C                                                                        00416117   *   INSERTED*
C --- CALCULATE DATA FOR TRIP TO KAZ VIA EXP/LRT                         00416118   *   INSERTED*
C                                                                        00416119   *   INSERTED*
C - - - CALCULATE LENGTHS OF EXP/LRT AND LOCAL PORTIONS                  00416120   *   INSERTED*
C                                                                        00416121   *   INSERTED*
  540 IF (LXC.EQ.0.) GO TO 600                                           00416122   *   INSERTED*
      IF (Z(13,IZ).EQ.99.) IXMK(IZ) = 9                                  00416123   *   INSERTED*
      XZ = Z(3,IZ)                                                       00416124   *   INSERTED*
      YZ = Z(4,IZ)                                                       00416125   *   INSERTED*
      LX = XZ - XKAZ                                                     00416126   *   INSERTED*
      LY = YZ - YKAZ                                                     00416127   *   INSERTED*
      IF (LX.NE.0.) GO TO 550                                            00416128   *   INSERTED*
      TAZ = 3.141593 - SIGN(1.570796,LY) - AXC                           00416129   *   INSERTED*
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      GO TO 560                                                         00416130   *          INSERTED*
  550 STAN = LY/LX                                                      00416131   *          INSERTED*
      SAZ = ATAN(STAN)                                                  00416132   *          INSERTED*
      IF (LX.LT.0.) SAZ = SAZ + 3.141593                                00416133   *          INSERTED*
      TAZ = AXC - SAZ                                                   00416134   *          INSERTED*
  560 FAZ = 1.570796 - TAZ                                              00416135   *          INSERTED*
      ZLN = SQRT(LX*LX + LY*LY)                                         00416136   *          INSERTED*
      EBLN = ZLN * SIN(FAZ)                                             00416137   *          INSERTED*
      LBLN = ZLN * SIN(TAZ)                                             00416138   *          INSERTED*
C                                                                       00416139   *          INSERTED*
C - - - TEST IF EXP/LRT IS POSSIBLE (ACCESS POINT ON CORRECT SIDE OF    00416140   *          INSERTED*
C         KAZ)                                                          00416141   *          INSERTED*
C                                                                       00416142   *          INSERTED*
      IF (EBLN.LE.0.) GO TO 600                                         00416143   *          INSERTED*
C                                                                       00416144   *          INSERTED*
C - - - MAKE ADJUSTMENTS, IF NECESSARY                                  00416145   *          INSERTED*
C                                                                       00416146   *          INSERTED*
  570 LBLN = ABS(LBLN)                                                  00416147   *          INSERTED*
      IF (EBLN.LE.LXC) GO TO 580                                        00416148   *          INSERTED*
      AL = EBLN - LXC                                                   00416149   *          INSERTED*
      LBLN = SQRT(AL*AL + LBLN*LBLN)                                    00416150   *          INSERTED*
      EBLN = LXC                                                        00416151   *          INSERTED*
  580 IF (EST.EQ.3.OR.EBLN.GE.LNA) GO TO 590                            00416152   *          INSERTED*
      AL = LNA - EBLN                                                   00416153   *          INSERTED*
      LBLN = SQRT(AL*AL + LBLN*LBLN)                                    00416154   *          INSERTED*
      EBLN = LNA                                                        00416155   *          INSERTED*
C                                                                       00416156   *          INSERTED*
C - - - CALCULATE BUS TIMES AND STORE                                   00416157   *          INSERTED*
C                                                                       00416158   *          INSERTED*
  590 EBRT = EBLN * CFXC * 60./SXS                                      00416159   *          INSERTED*
      LBRT = LBLN * CFLB * 60./SLB                                      00416160   *          INSERTED*
      IF (Z(15,IZ).EQ.1.) LBRT=0.                                       00416161   *          INSERTED*
      EXTME(IZ) = EBRT + LBRT                                           00416162   *          INSERTED*
      EXPTR(IZ) = EBLN                                                  00416163   *          INSERTED*
      LBPTR(IZ) = LBLN                                                  00416164   *          INSERTED*
      GO TO 605                                                         00416165   *          INSERTED*
C                                                                       00416166   *          INSERTED*
C - - - NO EXP/LRT SERVICE                                              00416167   *          INSERTED*
C                                                                       00416168   *          INSERTED*
  600 EXTME(IZ) = 999.                                                  00416169   *          INSERTED*
      IXMK(IZ) = 9                                                      00416170   *          INSERTED*
      EXPTR(IZ) = 0.                                                    00416171   *          INSERTED*
C                                                                       00416172   *          INSERTED*
C --- CALCULATE TIMES TO KAZ VIA NON-CORRIDOR TRANSIT                   00416173   *          INSERTED*
C                                                                       00416174   *          INSERTED*
  605 KUT(IZ) = 999.                                                    00416175   *          INSERTED*
      LCKUT(IZ) = 999.                                                  00416176   *          INSERTED*
      IF (Z(6,IZ).EQ.99.) GO TO 607                                     00416177   *          INSERTED*
C                                                                       00416178   *          INSERTED*
C - - - TIME VIA EXPRESS                                                00416179   *          INSERTED*
C                                                                       00416180   *          INSERTED*
      WALK(IZ) = Z(5,IZ)                                                00416181   *          INSERTED*
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      WAIT(IZ) = Z(6,IZ)                                                 00416182   *   INSERTED*
      RUN(IZ) = TRAT * HWYTKZ(IZ)                                        00416183   *   INSERTED*
      ACN(IZ) = Z(7,IZ)                                                  00416184   *   INSERTED*
      KUT(IZ) = BWAIT*WAIT(IZ) + BWALK*WALK(IZ) + BRUN*RUN(IZ)           00416185   *   INSERTED*
     1          + BAC*ACN(IZ)                                            00416186   *   INSERTED*
  607 IF (Z(9,IZ).EQ.99.) GO TO 609                                      00416187   *   INSERTED*
C                                                                        00416188   *   INSERTED*
C - - - TIME VIA LOCAL, CHOOSE BEST                                      00416189   *   INSERTED*
C                                                                        00416190   *   INSERTED*
  608 LWALK(IZ) = Z(8,IZ)                                                00416191   *   INSERTED*
      LWAIT(IZ) = Z(9,IZ)                                                00416192   *   INSERTED*
      LRUN (IZ) = HWYDKZ(IZ)*60./SLB                                     00416193   *   INSERTED*
      LACN(IZ) = Z(12,IZ)                                                00416194   *   INSERTED*
      LCKUT(IZ) = BWAIT*LWAIT(IZ) + BWALK*LWALK(IZ) + BRUN*LRUN(IZ)      00416195   *   INSERTED*
     1            + BAC*LACN(IZ)                                         00416196   *   INSERTED*
      IF(LCKUT(IZ).GE.KUT(IZ)) GO TO 609                                 00416197   *   INSERTED*
      WALK(IZ) = LWALK(IZ)                                               00416198   *   INSERTED*
      WAIT(IZ) = LWAIT(IZ)                                               00416199   *   INSERTED*
      RUN(IZ) = LRUN(IZ)                                                 00416200   *   INSERTED*
      ACN(IZ) = LACN(IZ)                                                 00416201   *   INSERTED*
      KUT(IZ) = LCKUT(IZ)                                                00416202   *   INSERTED*
  609 RETURN 1                                                           00416203   *   INSERTED*
C                                                                        00416204   *   INSERTED*
C *** BEGIN THIRD ITERATION ***                                          00416205   *   INSERTED*
C                                                                        00416206   *   INSERTED*
C --- CALCULATE NEW PERSON TRIPS (IF FACTORING REQUIRED)                 00416207   *   INSERTED*
C                                                                        00416208   *   INSERTED*
  610 IF (ITO.NE.3) GO TO 775                                            00416209   *   INSERTED*
      IF (PROD(IZ).EQ.0.) GO TO 775                                      00416210   *   INSERTED*
      SNEG = 0.                                                          00416211   *   INSERTED*
      PRODO= PROD(IZ)                                                    00416212   *   INSERTED*
      DO 760 I=1,LIZ                                                     00416213   *   INSERTED*
        OTRIPS(I) = INT(I,PVAR(26)) * Z(24,IZ) * Z(25,I) * ZFAC(IZ)      00416214   *   INSERTED*
        CEMV = 0.0                                                       00416215   *   INSERTED*
        IF (GT.GT.0.01) CEMV = DATTR(I)*PRODO/GT                         00416216   *   INSERTED*
        TRIPS(I)  =    OTRIPS(I)  + CEMV                                 00416217   *   INSERTED*
        IF (TRIPS(I).GE.0.)    GO TO 760                                 00416218   *   INSERTED*
        SNEG = SNEG + TRIPS(I)                                           00416219   *   INSERTED*
        PRODO    = PRODO    - TRIPS(I)                                   00416220   *   INSERTED*
        TRIPS(I)  =   0.                                                 00416221   *   INSERTED*
  760 CONTINUE                                                           00416222   *   INSERTED*
      CFAC = 0.0                                                         00416223   *   INSERTED*
      IF (PRODO.GT.0.0001) CFAC = SNEG/PRODO                             00416224   *   INSERTED*
      DO 770 I=1,LIZ                                                     00416225   *   INSERTED*
        IF (CFAC.NE.0.) TRIPS(I)  =   TRIPS(I) *  (CFAC+1.)              00416226   *   INSERTED*
        DATTR(I) = DATTR(I) - (TRIPS(I)  -   OTRIPS(I))                  00416227   *   INSERTED*
  770 CONTINUE                                                           00416228   *   INSERTED*
      GT = GT - PROD(IZ)                                                 00416229   *   INSERTED*
      GO TO 615                                                          00416230   *   INSERTED*
C                                                                        00416231   *   INSERTED*
C - - - NO FACTORING, OR PRODUCTIONS = 0                                 00416232   *   INSERTED*
C                                                                        00416233   *   INSERTED*
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  775 DO 777 I=1,LIZ                                                   *   INSERTED*
         TRIPS(I) = INT(I,PVAR(26))                                    *   INSERTED*
         IF (TTO.EQ.3.AND.PROD(IZ).EQ.0.) TRIPS(I) = 0.                *   INSERTED*
  777 CONTINUE                                                         *   INSERTED*
C                                                                      *   INSERTED*
C --- CALCULATE NON-CORRIDOR TRANSIT TIMES                             *   INSERTED*
C                                                                      *   INSERTED*
C - - - INITIAL CALCULATIONS                                           *   INSERTED*
C                                                                      *   INSERTED*
  615 AC = XKAZ - Z(3,IZ)                                              *   INSERTED*
      BC = YKAZ - Z(4,IZ)                                              *   INSERTED*
      ZC = SQRT(AC*AC + BC*BC)                                         *   INSERTED*
      IDST = ZD(IZ)                                                    *   INSERTED*
      RWOZ = Z(9,IZ)                                                   *   INSERTED*
      NRWO = Z(11,IZ)                                                  *   INSERTED*
      RWKO = Z(8,IZ)                                                   *   INSERTED*
      IF (BC.EQ.0.) GO TO 620                                          *   INSERTED*
      ABC = AC/BC                                                      *   INSERTED*
      BZC = BC/ZC                                                      *   INSERTED*
C                                                                      *   INSERTED*
C - - - FOR EACH INTERCHANGE, CHECK WHETHER MOVEMENT IS RADIAL         *   INSERTED*
C                                                                      *   INSERTED*
  620 DO 750 I=1,LIZ                                                   *   INSERTED*
        IF (TRIPS(I).EQ.0.) GO TO 750                                  *   INSERTED*
        RMCK = 0                                                       *   INSERTED*
        NRWI = Z(11,I)                                                 *   INSERTED*
        LUT(I) = 999.                                                  *   INSERTED*
        RWIZ = Z(9,I)                                                  *   INSERTED*
        RWKI = Z(8,I)                                                  *   INSERTED*
        CUT = 999.                                                     *   INSERTED*
        PRUT = 999.                                                    *   INSERTED*
        HWYD = INT(I,PVAR(28)) * FCHWYD                                *   INSERTED*
        LXMK = 0                                                       *   INSERTED*
        LTYPE(I) = 0                                                   *   INSERTED*
        LACI = LACN(I)                                                 *   INSERTED*
        IF (Z(2,I).EQ.1..OR.ZC.LE.1.) GO TO 660                        *   INSERTED*
  630   IF (BC.EQ.0.) GO TO 640                                        *   INSERTED*
        CC = Z(4,I) - Z(4,IZ)                                          *   INSERTED*
        XC = CC * ABC                                                  *   INSERTED*
        XDCC = Z(3,IZ) + XC                                            *   INSERTED*
        DC = Z(3,I) - XDCC                                             *   INSERTED*
        GC = ABS(DC*BZC)                                               *   INSERTED*
        GO TO 650                                                      *   INSERTED*
  640   GC = ABS(Z(4,I) - YKAZ)                                        *   INSERTED*
  650   IF (GC-1.) 660,660,670                                         *   INSERTED*
C                                                                      *   INSERTED*
C - - - TRIP TO CBD, CALCULATE UTILE                                   *   INSERTED*
C                                                                      *   INSERTED*
  655   IF (KUT(IZ).EQ.999.) GO TO 750                                 *   INSERTED*
        LUT(I) = KUT(IZ)                                               *   INSERTED*
        LTYPE(I) = 1                                                   *   INSERTED*
        GO TO 750                                                      *   INSERTED*
```

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C                                                                    00416286   *   INSERTED*
C - - - RADIAL: CALCULATE WAIT, WALK, RUN TIMES AND TIME UTILE        00416287   *   INSERTED*
C                                                                    00416288   *   INSERTED*
  660  RMCK = 1                                                      00416289   *   INSERTED*
       IF (KUT(IZ).EQ.999..OR.LCKUT(I).EQ.999..OR.LACI.EQ.1.) GO TO 75000416290   *   INSERTED*
       IF (HWYD.GT.HWYDKZ(IZ).AND.HWYD.GT.HWYDKZ(I)) GO TO 700       00416291   *   INSERTED*
       RWAIT = AMAX1(RWUZ,RWIZ)                                      00416292   *   INSERTED*
       RWALK =  RWKO   + RWKI                                        00416293   *   INSERTED*
       RRUN = HWYD * 60./SLB                                         00416294   *   INSERTED*
       LUT(I)    = BWAIT*RWAIT + BWALK*RWALK + BRUN*RRUN + BAC*Z(12,IZ)00416295   *   INSERTED*
       LTYPE(I)    = 1                                               00416296   *   INSERTED*
       GO TO 750                                                     00416297   *   INSERTED*
C                                                                    00416298   *   INSERTED*
C - - - NON-RADIAL: CALCULATE WAIT, WALK, RUN TIMES AND TIME UTILE    00416299   *   INSERTED*
C                                                                    00416300   *   INSERTED*
  670  IF (NRWO.EQ.99..OR.NRWI.EQ.99..OR.LACI.EQ.1.) GO TO 695        00416301   *   INSERTED*
       IF (HWYD.GT.4.) GO TO 680                                     00416302   *   INSERTED*
       CWAIT1 = AMAX1(NRWO,NRWI)                                     00416303   *   INSERTED*
       CWAIT2 = 0.                                                   00416304   *   INSERTED*
       GO TO 690                                                     00416305   *   INSERTED*
  680  CWAIT1 = AMIN1(NRWO,NRWI)                                     00416306   *   INSERTED*
       CWAIT2 = AMAX1(NRWO,NRWI)                                     00416307   *   INSERTED*
  690  CWALK = Z(10,IZ) + Z(10,I)                                    00416308   *   INSERTED*
       CRUN = HWYD * 60./SLB                                         00416309   *   INSERTED*
       CUT = BWAIT*CWAIT1 + BWALK*(CWAIT2+CWALK) + BRUN*CRUN         00416310   *   INSERTED*
     1                     + BAC*Z(12,IZ)                            00416311   *   INSERTED*
       GO TO 697                                                     00416312   *   INSERTED*
C                                                                    00416313   *   INSERTED*
C - - - CHECK POSSIBILITY OF USING RADIAL THROUGH CBD (PIN RADIAL)    00416314   *   INSERTED*
C                                                                    00416315   *   INSERTED*
  695  IF (KUT(IZ).EQ.999..OR.LACI.EQ.1.) GO TO 750                  00416316   *   INSERTED*
  697  IF (KUT(IZ).EQ.999..OR.LACI.EQ.1.) GO TO 720                  00416317   *   INSERTED*
       IF (LCKUT(I).EQ.999.) GO TO 705                               00416318   *   INSERTED*
  700  PRWA2 = LWAIT(I)                                              00416319   *   INSERTED*
       PRWALK = WALK(IZ) + LWALK(I)                                  00416320   *   INSERTED*
       PRRUN1 = RUN(IZ)                                              00416321   *   INSERTED*
       PRRUN2 = LRUN(I)                                              00416322   *   INSERTED*
       PRUT = BWAIT*WAIT(IZ) + BWALK*(PRWA2+PRWALK)                  00416323   *   INSERTED*
     1                       + BRUN*(PRRUN1+PRRUN2) + BAC*ACN(IZ)    00416324   *   INSERTED*
C                                                                    00416325   *   INSERTED*
C - - - CHECK POSSIBILITY OF USING OUTBOUND LIGHT RAIL (IF EST=3)     00416326   *   INSERTED*
C                                                                    00416327   *   INSERTED*
  705  IF (EST.NE.3.OR.IXMK(I).EQ.9.OR.Z(15,I).EQ.1.) GO TO 710       00416328   *   INSERTED*
       PXWA2 = HXS/2. + Z(14,I)                                      00416329   *   INSERTED*
       PXWALK = WALK(IZ) + Z(13,I)                                   00416330   *   INSERTED*
       PXRUN1 = RUN(IZ)                                              00416331   *   INSERTED*
       PXRUN2 = EXTME(I)                                             00416332   *   INSERTED*
       PXUT = BWAIT*WAIT(IZ) + BWALK*(PXWA2+PAWALK)                  00416333   *   INSERTED*
     1                       + BRUN*(PXRUN1+PXRUN2) + BAC*ACN(IZ)    00416334   *   INSERTED*
       IF (PXUT.GE.PRUT) GO TO 710                                   00416335   *   INSERTED*
       LXMK = 1                                                      00416336   *   INSERTED*
       PRUT = PXUT                                                   00416337   *   INSERTED*
```

```
C                                                                        *   INSERTED*
C - - - CLASSIFY TYPE OF MOVEMENT                                        *   INSERTED*
C                                                                        *   INSERTED*
  710   IF (RMCK.NE.1) GO TO 720                                         *   INSERTED*
        LTYPE(I) = 3                                                     *   INSERTED*
        LUT(I)     = PRUT                                                *   INSERTED*
        IF (LXMK.EQ.1) LTYPE(I) = 4                                      *   INSERTED*
        GO TO 750                                                        *   INSERTED*
  720   LUT(I)     = AMIN1(CUT,PRUT)                                     *   INSERTED*
        IF (LUT(I).EQ.999.) GO TO 750                                    *   INSERTED*
        IF (LUT(I).NE.PRUT)     GO TO 730                                *   INSERTED*
        LTYPE(I) = 3                                                     *   INSERTED*
        IF (LXMK.EQ.1) LTYPE(I) = 4                                      *   INSERTED*
        GO TO 750                                                        *   INSERTED*
  730   LTYPE(I) = 2                                                     *   INSERTED*
        GO TO 750                                                        *   INSERTED*
C                                                                        *   INSERTED*
C - - - NO NON-CORRIDOR TRANSIT SERVICE (SET LUT =999)                   *   INSERTED*
C                                                                        *   INSERTED*
  750 CONTINUE                                                           *   INSERTED*
C                                                                        *   INSERTED*
C --- CALCULATE FINAL TRANSIT TIMES; DETERMINE TYPE OF MOVEMENT          *   INSERTED*
C                                                                        *   INSERTED*
C - - - DETERMINE EXP/LRT UTILE FROM ORIGIN ZONE TO KAZ                  *   INSERTED*
C                                                                        *   INSERTED*
  780 IF (IXMK(IZ).NE.9) GO TO 800                                       *   INSERTED*
      OEUT = 999.                                                        *   INSERTED*
      GO TO 810                                                          *   INSERTED*
  800 OEUT = BWAIT*Z(14,IZ) + BWALK*(Z(13,IZ)+HXS/2.) + BRUN*EXTME(IZ)   *   INSERTED*
      IF (Z(15,IZ).EQ.1.) OEUT = BWALK*(4.*LBPTR(IZ)+0.5*HXS)            *   INSERTED*
     1                          + BRUN*EXTME(IZ) + BAC                   *   INSERTED*
C                                                                        *   INSERTED*
C - - - IF NO EXP/LRT SERVICE, SET TRANSIT TIME UTILE EQUAL TO           *   INSERTED*
C         NON-CORRIDOR                                                   *   INSERTED*
C                                                                        *   INSERTED*
  810 DO 880 I=1,LIZ                                                     *   INSERTED*
        IF (TRIPS(I).EQ.0.) GO TO 880                                    *   INSERTED*
        TTYPE(I) = 0                                                     *   INSERTED*
        LRMK = 0                                                         *   INSERTED*
        IF (OEUT.NE.999.) GO TO 820                                      *   INSERTED*
        TTU(I)     = LUT(I)                                              *   INSERTED*
        IF (LUT(I).NE.999.)    TTYPE(I) = 1                              *   INSERTED*
        GO TO 880                                                        *   INSERTED*
C                                                                        *   INSERTED*
C - - - CALCULATE EXP/LRT TIME UTILE                                     *   INSERTED*
C                                                                        *   INSERTED*
  820   IF (Z(2,I).NE.1) GO TO 830                                       *   INSERTED*
        EUT = OEUT                                                       *   INSERTED*
        GO TO 840                                                        *   INSERTED*
  830   EUT = 999.                                                       *   INSERTED*
        IF (LACN(I).EQ.1.) GO TO 835                                     *   INSERTED*
        EUT = OEUT + BWALK*(Z(9,I)+Z(8,I)) + BRUN*(HWYDKZ(I)*60./SLB)    *   INSERTED*
```

```
  835   IF (EST.NE.3.OR.IXMK(I).EQ.9.OR.Z(15,I).EQ.1.) GO TO 840          00416390   *   INSERTED*
C                                                                         00416391   *   INSERTED*
C - - - IF LIGHT RAIL IN USE, CHECK FOR INTRA-CORRIDOR MOVEMENT           00416392   *   INSERTED*
C                                                                         00416393   *   INSERTED*
        EUT1 = EUT                                                        00416394   *   INSERTED*
        LRWK = Z(13,IZ) + Z(13,I)                                         00416395   *   INSERTED*
        LRWA1 = Z(14,IZ)                                                  00416396   *   INSERTED*
        LRWA2 = Z(14,I) + 0.5*HXS                                         00416397   *   INSERTED*
        EXPCM = AMIN1(EXPTR(IZ),EXPTR(I))                                 00416398   *   INSERTED*
        LRRUN = EXTME(IZ) + EXTME(I) - 2.*(EXPCM*CFXC*60./SXS)            00416399   *   INSERTED*
        EUT2 = BWAIT*LRWA1 + BWALK*(LRWK+LRWA2) + BRUN*LRRUN              00416400   *   INSERTED*
        IF (Z(15,IZ).EQ.1.) EUT2 = BWALK*(4.*LBPTR(IZ)+Z(13,I)+LRWA2)     00416401   *   INSERTED*
     1                           + BRUN*LRRUN + BAC                       00416402   *   INSERTED*
        EUT = AMIN1(EUT1,EUT2)                                            00416403   *   INSERTED*
        IF (EUT.NE.EUT1) LRMK = 1                                         00416404   *   INSERTED*
C                                                                         00416405   *   INSERTED*
C - - - IF NO NON-CORRIDOR TRANSIT, SET TRANSIT TIME UTILE EQUAL TO       00416406   *   INSERTED*
C         EXP/LRT.  IF NON-CORRIDOR TRANSIT EXISTS, SELECT BEST.          00416407   *   INSERTED*
C                                                                         00416408   *   INSERTED*
  840   IF (LUT(I).EQ.999.)     GO TO 850                                 00416409   *   INSERTED*
        TTU(I)     = AMIN1(EUT,LUT(I))                                    00416410   *   INSERTED*
        IF (TTU(I).EQ.LUT(I))      GO TO 870                              00416411   *   INSERTED*
        GO TO 860                                                         00416412   *   INSERTED*
  850   TTU(I)     = EUT                                                  00416413   *   INSERTED*
C                                                                         00416414   *   INSERTED*
C - - - EXP/LRT IS BEST                                                   00416415   *   INSERTED*
C                                                                         00416416   *   INSERTED*
  860   TTYPE(I) = 2                                                      00416417   *   INSERTED*
        IF (LRMK.NE.1) GO TO 880                                          00416418   *   INSERTED*
        TTYPE(I) = 3                                                      00416419   *   INSERTED*
        IF (EXPTR(IZ).LT.EXPTR(I)) TTYPE(I) = 4                           00416420   *   INSERTED*
        GO TO 880                                                         00416421   *   INSERTED*
C                                                                         00416422   *   INSERTED*
C - - - NON-CORRIDOR IS BEST                                              00416423   *   INSERTED*
C                                                                         00416424   *   INSERTED*
  870   TTYPE(I) = 1                                                      00416425   *   INSERTED*
  880 CONTINUE                                                            00416426   *   INSERTED*
C                                                                         00416427   *   INSERTED*
C --- CALCULATE CARPOOL TIMES AND COSTS (IF HOV FACILITY EXISTS)          00416428   *   INSERTED*
C                                                                         00416429   *   INSERTED*
      IF (HOV.EQ.1) GO TO 930                                             00416430   *   INSERTED*
      IF (EXTME(IZ).EQ.999.) GO TO 890                                    00416431   *   INSERTED*
C                                                                         00416432   *   INSERTED*
C - - - CALCULATE INBOUND TIME VIA HOV LANE                               00416433   *   INSERTED*
C                                                                         00416434   *   INSERTED*
      CTKO = 0.                                                           00416435   *   INSERTED*
      THOV = EXPTR(IZ)*CFXC*60./SHOV                                      00416436   *   INSERTED*
      SLP = 0.0                                                           00416437   *   INSERTED*
      IF (HWYTKZ(IZ).GT.0.1) SLP = HWYDKZ(IZ)*60./HWYTKZ(IZ)              00416438   *   INSERTED*
      TLP = 0.0                                                           00416439   *   INSERTED*
      IF (SLP.GT.0.1) TLP = LBPTR(IZ)*CFCPLC*60./SLP                      00416440   *   INSERTED*
      CTKO = TLP + THOV                                                   00416441   *   INSERTED*
```

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C                                                                  00416442   *   INSERTED*
C - - - DETERMINE WHETHER HOV LANE IS USED                          00416443   *   INSERTED*
C                                                                  00416444   *   INSERTED*
  890 DO 920 I=1,LIZ                                               00416445   *   INSERTED*
        IF (TRIPS(I).EQ.0.) GO TO 920                              00416446   *   INSERTED*
        HOVMK(I) = 0                                               00416447   *   INSERTED*
        HWYT = INT(I,PVAR(27)) * FCHWYT                            00416448   *   INSERTED*
        IF (HOV.NE.3) GO TO 895                                    00416449   *   INSERTED*
        IF (EXTME(IZ).EQ.999.) GO TO 895                           00416450   *   INSERTED*
        HOVTME = CTKO + HWYTKZ(I)                                  00416451   *   INSERTED*
        IF (HOVTME.LT.HWYT) GO TO 900                              00416452   *   INSERTED*
  895   HOVRUN(I) = HWYT                                           00416453   *   INSERTED*
        GO TO 910                                                  00416454   *   INSERTED*
  900   HOVRUN(I) = HOVTME                                         00416455   *   INSERTED*
        HOVMK(I) = 1                                               00416456   *   INSERTED*
C                                                                  00416457   *   INSERTED*
C - - - CALCULATE HOV EXCESS TIME, COSTS.  STORE IN ZONES ARRAYS.   00416458   *   INSERTED*
C                                                                  00416459   *   INSERTED*
  910   HOVEXC(I) = Z(16,IZ) + Z(16,I)                             00416460   *   INSERTED*
        HOVPKC(I) = 0.5 * Z(17,I)                                  00416461   *   INSERTED*
        HOVDST = INT(I,PVAR(28)) * FCHWYD                          00416462   *   INSERTED*
        IF (HOVMK(I).EQ.1) HOVDST = LBPTR(IZ)*CFCPLC + EXPTR(IZ)*CFXC  00416463   *   INSERTED*
     1                                            + HWYDKZ(I)      00416464   *   INSERTED*
        HOVOPC(I) = HOVDST * OCPM                                  00416465   *   INSERTED*
  920 CONTINUE                                                     00416466   *   INSERTED*
C                                                                  00416467   *   INSERTED*
C --- CALCULATE HIGHWAY TIMES AND COSTS                             00416468   *   INSERTED*
C                                                                  00416469   *   INSERTED*
  930 DO 940 I=1,LIZ                                               00416470   *   INSERTED*
        IF (TRIPS(I).EQ.0.) GO TO 940                              00416471   *   INSERTED*
        HWYEXC(I)  = Z(18,IZ) + Z(18,I)                            00416472   *   INSERTED*
        HWYRUN(I)  = INT(I,PVAR(27)) * FCHWYT                      00416473   *   INSERTED*
        HWYOPC(I) = INT(I,PVAR(28)) * FCHWYD * OCPM                00416474   *   INSERTED*
        HWYPKC(I) = 0.5 * Z(19,I)                                  00416475   *   INSERTED*
  940 CONTINUE                                                     00416476   *   INSERTED*
C                                                                  00416477   *   INSERTED*
C --- CALCULATE TRANSIT FARES (IF FARE MATRIX NOT INPUT)            00416478   *   INSERTED*
C                                                                  00416479   *   INSERTED*
      IF (TFO.NE.1) GO TO 960                                      00416480   *   INSERTED*
      DO 950 I=1,LIZ                                               00416481   *   INSERTED*
        TFARE(I) = INT(I,PVAR(29))                                 00416482   *   INSERTED*
  950 CONTINUE                                                     00416483   *   INSERTED*
      GO TO 1000                                                   00416484   *   INSERTED*
  960 DO 990 I=1,LIZ                                               00416485   *   INSERTED*
        IF (TRIPS(I).EQ.0.) GO TO 990                              00416486   *   INSERTED*
        IF (TTU(I).EQ.999.) GO TO 990                              00416487   *   INSERTED*
        PFEX = 0.                                                  00416488   *   INSERTED*
        DEXT = 0.                                                  00416489   *   INSERTED*
        IF (TTYPE(I).NE.1) GO TO 970                               00416490   *   INSERTED*
C                                                                  00416491   *   INSERTED*
C - - - NON-CORRIDOR TRANSIT                                        00416492   *   INSERTED*
C                                                                  00416493   *   INSERTED*
```

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      TDST = INT(I,PVAR(28)) * FCHWYD                                  00416494    *    INSERTED*
      IF (LTYPE(I).EQ.3) TDST = HWYDKZ(IZ) + HWYDKZ(I)                 00416495    *    INSERTED*
      IF (LTYPE(I).NE.4) GO TO 980                                     00416496    *    INSERTED*
      PFEX = FPREM                                                     00416497    *    INSERTED*
      TDST = HWYDKZ(IZ) + CFXC*EXPTR(I) + CFLB*LBPTR(I)                00416498    *    INSERTED*
      GO TO 980                                                        00416499    *    INSERTED*
C                                                                      00416500    *    INSERTED*
C - - - EXP/LRT TRANSIT                                                00416501    *    INSERTED*
C                                                                      00416502    *    INSERTED*
  970 PFEX = FPREM                                                     00416503    *    INSERTED*
      TDST = CFLB*LBPTR(IZ) + CFXC*EXPTR(IZ) + HWYDKZ(I)               00416504    *    INSERTED*
      IF (TTYPE(I).LT.3) GO TO 980                                     00416505    *    INSERTED*
C                                                                      00416506    *    INSERTED*
C - - - LIGHT RAIL INTRACORRIDOR MOVEMENTS                             00416507    *    INSERTED*
C                                                                      00416508    *    INSERTED*
      LBDST = CFLB*(LBPTR(IZ)+LBPTR(I))                                00416509    *    INSERTED*
      LRDST = CFXC*ABS(EXPTR(IZ)-EXPTR(I))                             00416510    *    INSERTED*
      TDST = LBDST + LRDST                                             00416511    *    INSERTED*
C                                                                      00416512    *    INSERTED*
C - - - COMPUTE FARE, STORE IN ZONES ARRAY                             00416513    *    INSERTED*
C                                                                      00416514    *    INSERTED*
  980 IF (TDST.GT.MAXD) DEXT = TDST - MAXD                             00416515    *    INSERTED*
      TFARE(I) = FBOARD + (FPM*DEXT) + PFEX                            00416516    *    INSERTED*
  990 CONTINUE                                                         00416517    *    INSERTED*
C                                                                      00416518    *    INSERTED*
C --- APPLY CAR OCCUPANCY MODEL                                        00416519    *    INSERTED*
C                                                                      00416520    *    INSERTED*
C - - - CALCULATE TIMES AND COSTS BY CAR OCCUPANCY LEVEL               00416521    *    INSERTED*
C                                                                      00416522    *    INSERTED*
 1000 DO 1180 I=1,LIZ                                                  00416523    *    INSERTED*
      IF (TRIPS(I).EQ.0.) GO TO 1180                                   00416524    *    INSERTED*
      DO 1030 OCC=2,4                                                  00416525    *    INSERTED*
        XOCC = OCC                                                     00416526    *    INSERTED*
        IF (OCC.EQ.4) XOCC = OCC4                                      00416527    *    INSERTED*
        IF (HOV.EQ.1.OR.XOCC.LT.HOVDEF) GO TO 1010                     00416528    *    INSERTED*
C                                                                      00416529    *    INSERTED*
C - - - OCCUPANCY LEVEL QUALIFIES FOR HOV FACILITIES (IF THEY EXIST)   00416530    *    INSERTED*
C                                                                      00416531    *    INSERTED*
        GPEXC = HOVEXC(I)                                              00416532    *    INSERTED*
        GPRUN = HOVRUN(I) + 1.1*(XOCC-1.)                              00416533    *    INSERTED*
        GPOPC = HOVOPC(I)/XOCC                                         00416534    *    INSERTED*
        GPPKC = HOVPKC(I)/XOCC                                         00416535    *    INSERTED*
        GO TO 1020                                                     00416536    *    INSERTED*
C                                                                      00416537    *    INSERTED*
C - - - NO HOV FACILITIES, OR OCCUPANCY LEVEL DOES NOT QUALIFY         00416538    *    INSERTED*
C                                                                      00416539    *    INSERTED*
 1010   GPEXC = HWYEXC(I)                                              00416540    *    INSERTED*
        GPRUN = HWYRUN(I) + 1.1*(XOCC-1.)                              00416541    *    INSERTED*
        GPOPC = HWYOPC(I)/XOCC                                         00416542    *    INSERTED*
        GPPKC = HWYPKC(I)/XOCC                                         00416543    *    INSERTED*
C                                                                      00416544    *    INSERTED*
C - - - COMPUTE GROUP UTILE BY OCCUPANCY (WITHOUT INCOME COEFFICIENT)  00416545    *    INSERTED*
```

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C                                                                      00416546    *       INSERTED*
 1020     GPUT(OCC) = BEXCG*GPEXC + BRUN*GPRUN + BOPC*GPOPC + BPKC*GPPKC00416547    *       INSERTED*
          EGPUT = EXP(-1.*GPUT(OCC))                                   00416548    *       INSERTED*
C                                                                      00416549    *       INSERTED*
C - - - FACTOR IN INCOME COEFFICIENT TO EXPONENTIATED UTILE             00416550    *       INSERTED*
C                                                                      00416551    *       INSERTED*
          DO 1030 INC=1,4                                              00416552    *       INSERTED*
            EGPUTI(OCC,INC) = EGPUT * EINC(OCC,INC)                    00416553    *       INSERTED*
 1030   CONTINUE                                                       00416554    *       INSERTED*
C                                                                      00416555    *       INSERTED*
C - - - CALCULATE PERCENT IN EACH OCCUPANCY BY INCOME, AVERAGE OCCUPANCY00416556    *       INSERTED*
C         BY INCOME, WEIGHTED GROUP UTILE BY INCOME                    00416557    *       INSERTED*
C                                                                      00416558    *       INSERTED*
        DO 1050 INC=1,4                                                00416559    *       INSERTED*
          TEGPUT = EGPUTI(2,INC) + EGPUTI(3,INC) + EGPUTI(4,INC)       00416560    *       INSERTED*
          GRPUT(INC) = 0.                                              00416561    *       INSERTED*
          TEMP = 0.                                                    00416562    *       INSERTED*
          DO 1040 OCC=2,4                                              00416563    *       INSERTED*
            XOCC = OCC                                                 00416564    *       INSERTED*
            IF (OCC.EQ.4) XOCC = OCC4                                  00416565    *       INSERTED*
            POCC(OCC,INC)  =  EGPUTI(OCC,INC)/TEGPUT                   00416566    *       INSERTED*
            GRPUT(INC)  =  GRPUT(INC)  +  POCC(OCC,INC) * GPUT(OCC)    00416567    *       INSERTED*
            TEMP = TEMP + POCC(OCC,INC) / XOCC                         00416568    *       INSERTED*
 1040     CONTINUE                                                     00416569    *       INSERTED*
          GOCC(INC)  =  1./TEMP                                        00416570    *       INSERTED*
 1050   CONTINUE                                                       00416571    *       INSERTED*
C                                                                      00416572    *       INSERTED*
C --- APPLY MODE CHOICE MODEL                                          00416573    *       INSERTED*
C                                                                      00416574    *       INSERTED*
C - - - CALCULATE UTILES FOR TRANSIT AND DRIVE-ALONE (WITHOUT INCOME   00416575    *       INSERTED*
C         COEFFICIENT)                                                 00416576    *       INSERTED*
C                                                                      00416577    *       INSERTED*
        IF (TTU(I).EQ.999.) GO TO 1060                                 00416578    *       INSERTED*
        TRNUT = TTU(I) + BOPC*TFARE(I)                                 00416579    *       INSERTED*
        ETRNUT = EXP(-1.*TRNUT)                                        00416580    *       INSERTED*
        GO TO 1070                                                     00416581    *       INSERTED*
 1060   ETRNUT = 0.                                                    00416582    *       INSERTED*
 1070   ONEUT = BEXC1*HWYEXC(I) + BRUN*HWYRUN(I) + BOPC*HWYOPC(I)      00416583    *       INSERTED*
     1                        + BPKC*HWYPKC(I)                         00416584    *       INSERTED*
        EONEUT = EXP(-1.*ONEUT)                                        00416585    *       INSERTED*
C                                                                      00416586    *       INSERTED*
C - - - INITIALIZATIONS                                                00416587    *       INSERTED*
C                                                                      00416588    *       INSERTED*
        PCTTRN = 0.                                                    00416589    *       INSERTED*
        PCTONE = 0.                                                    00416590    *       INSERTED*
        PCTTWO = 0.                                                    00416591    *       INSERTED*
        PCTTHR = 0.                                                    00416592    *       INSERTED*
        PCTFOR = 0.                                                    00416593    *       INSERTED*
        PCTADR = 0.                                                    00416594    *       INSERTED*
        PCTAPS = 0.                                                    00416595    *       INSERTED*
C                                                                      00416596    *       INSERTED*
C - - - FACTOR IN INCOME COEFFICIENT TO EXPONENTIATED UTILES, SUM UTILES00416597    *       INSERTED*
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C                                                                    00416598    *    INSERTED*
      DO 1080 INC=1,4                                                00416599    *    INSERTED*
        EGRPUT = EXP(-1.*GRPUT(INC))  *  EINCG(INC)                  00416600    *    INSERTED*
        EONUTI = EONEUT * EINC(1,INC)                                00416601    *    INSERTED*
        TOTEUT = ETRNUT + EONUTI + EGRPUT                            00416602    *    INSERTED*
C                                                                    00416603    *    INSERTED*
C - - - CALCULATE MODE SPLIT BY INCOME                               00416604    *    INSERTED*
C                                                                    00416605    *    INSERTED*
        PTRN(INC)  =  ETRNUT/TOTEUT                                  00416606    *    INSERTED*
        PONE(INC)  =  EONUTI/TOTEUT                                  00416607    *    INSERTED*
        PGRP(INC)  =  EGRPUT/TOTEUT                                  00416608    *    INSERTED*
        INVGOC =1./GOCC(INC)                                         00416609    *    INSERTED*
        PADR(INC) = PONE(INC) + PGRP(INC)*INVGOC                     00416610    *    INSERTED*
        PAPASS(INC) = PGRP(INC)*(1.-INVGOC)                          00416611    *    INSERTED*
C                                                                    00416612    *    INSERTED*
C - - - SUM TO COMPUTE OVERALL MODAL SPLIT                           00416613    *    INSERTED*
C                                                                    00416614    *    INSERTED*
        PFAC = Z(INC+19,IZ)                                          00416615    *    INSERTED*
        PCTTRN = PCTTRN + PTRN(INC)*PFAC                             00416616    *    INSERTED*
        PCTONE = PCTONE + PONE(INC)*PFAC                             00416617    *    INSERTED*
        PCTTWO = PCTTWO + PGRP(INC)*POCC(2,INC)*PFAC                 00416618    *    INSERTED*
        PCTTHR = PCTTHR + PGRP(INC)*POCC(3,INC)*PFAC                 00416619    *    INSERTED*
        PCTFOR = PCTFOR + PGRP(INC)*POCC(4,INC)*PFAC                 00416620    *    INSERTED*
        PCTADR = PCTADR + PADR(INC)*PFAC                             00416621    *    INSERTED*
        PCTAPS = PCTAPS + PAPASS(INC)*PFAC                           00416622    *    INSERTED*
 1080 CONTINUE                                                       00416623    *    INSERTED*
C                                                                    00416624    *    INSERTED*
C --- IF AUTO DRIVER TRIPS INPUT, CONVERT TO PERSON TRIPS             00416625    *    INSERTED*
C                                                                    00416626    *    INSERTED*
      IF (TTO.EQ.1) TRIPS(I) = TRIPS(I)/PCTADR                       00416627    *    INSERTED*
C                                                                    00416628    *    INSERTED*
C --- PUT OUT TRIP TABLES AND TRIP-END SUMMARIES                      00416629    *    INSERTED*
C                                                                    00416630    *    INSERTED*
C - - - TRANSIT TRIP TABLES                                          00416631    *    INSERTED*
C                                                                    00416632    *    INSERTED*
      NXTTP = 0.                                                     00416633    *    INSERTED*
      NTRTP = TRIPS(I) * PCTTRN                                      00416634    *    INSERTED*
      IF (TTYPE(I).GE.2.OR.LTYPE(I).EQ.4) NXTTP = NTRTP              00416635    *    INSERTED*
      NLTTP = NTRTP - NXTTP                                          00416636    *    INSERTED*
      TROUT(I,1) = NXTTP                                             00416637    *    INSERTED*
      TROUT(I,2) = NLTTP                                             00416638    *    INSERTED*
C                                                                    00416639    *    INSERTED*
C - - - AUTO-DRIVER TRIPS, AUTO-PASSENGER TRIPS: HOV LANE EXISTS     00416640    *    INSERTED*
C                                                                    00416641    *    INSERTED*
      NAPASS = TRIPS(I) * PCTAPS                                     00416642    *    INSERTED*
      NADR = TRIPS(I) * PCTADR                                       00416643    *    INSERTED*
      IF (HOV.NE.3) GO TO 1100                                       00416644    *    INSERTED*
      NHOVDR = 0.                                                    00416645    *    INSERTED*
      NHOVPS = 0.                                                    00416646    *    INSERTED*
      IF (HOVMK(I).NE.1) GO TO 1090                                  00416647    *    INSERTED*
      IF (HOVDEF.GT.2) GO TO 1082                                    00416648    *    INSERTED*
      NHOVDR = NHOVDR + 0.5*TRIPS(I)*PCTTWO                          00416649    *    INSERTED*
```

```
      NHOVPS = NHOVPS + 0.5*TRIPS(I)*PCTTWO                            00416650  *  INSERTED*
 1082 IF (HOVDEF.GT.3) GO TO 1084                                      00416651  *  INSERTED*
      NHOVDR = NHOVDR + 0.333*TRIPS(I)*PCTTHR                          00416652  *  INSERTED*
      NHOVPS = NHOVPS + 0.667*TRIPS(I)*PCTTHR                          00416653  *  INSERTED*
 1084 NHOVDR = NHOVDR + TRIPS(I)*PCTFOR/OCC4                           00416654  *  INSERTED*
      NHOVPS = NHOVPS + TRIPS(I)*PCTFOR*(OCC4-1.)/OCC4                 00416655  *  INSERTED*
 1090 NNHOVD = NADR - NHOVDR                                           00416656  *  INSERTED*
      NNHOVP = NAPASS - NHOVPS                                         00416657  *  INSERTED*
      TROUT(I,3) = NHOVDR                                              00416658  *  INSERTED*
      TROUT(I,4) = NNHOVD                                              00416659  *  INSERTED*
      TROUT(I,5) = NHOVPS                                              00416660  *  INSERTED*
      TROUT(I,6) = NNHOVP                                              00416661  *  INSERTED*
      TROUT(I,7) = TRIPS(I)                                            00416662  *  INSERTED*
      GO TO 1110                                                       00416663  *  INSERTED*
C                                                                      00416664  *  INSERTED*
C - - - NO HOV LANE                                                    00416665  *  INSERTED*
C                                                                      00416666  *  INSERTED*
 1100 TROUT(I,3) = NADR                                                00416667  *  INSERTED*
      TROUT(I,4) = NAPASS                                              00416668  *  INSERTED*
      TROUT(I,5) = TRIPS(I)                                            00416669  *  INSERTED*
C                                                                      00416670  *  INSERTED*
C - - - TRIP-END SUMMARIES: 1. BY MODE                                 00416671  *  INSERTED*
C                                                                      00416672  *  INSERTED*
 1110 TE1(IZ,1) = TE1(IZ,1) + NTRTP                                    00416673  *  INSERTED*
      TE1(I,4) = TE1(I,4) + NTRTP                                      00416674  *  INSERTED*
      TE1(IZ,2) = TE1(IZ,2) + NADR                                     00416675  *  INSERTED*
      TE1(I,5) = TE1(I,5) + NADR                                       00416676  *  INSERTED*
      TE1(IZ,3) = TE1(IZ,3) + NAPASS                                   00416677  *  INSERTED*
      TE1(I,6) = TE1(I,6) + NAPASS                                     00416678  *  INSERTED*
      PERT1(IZ,1) = PERT1(IZ,1) + TRIPS(I)                             00416679  *  INSERTED*
      PERT1(I,2)  = PERT1(I,2)  + TRIPS(I)                             00416680  *  INSERTED*
C                                                                      00416681  *  INSERTED*
C - - - 2. EXP/LRT VS NON-CORRIDOR                                     00416682  *  INSERTED*
C                                                                      00416683  *  INSERTED*
      TE2(IZ,1) = TE2(IZ,1) + NXTTP                                    00416684  *  INSERTED*
      TE2(I,3) = TE2(I,3) + NXTTP                                      00416685  *  INSERTED*
      TE2(IZ,2) = TE2(IZ,2) + NLTTP                                    00416686  *  INSERTED*
      TE2(I,4) = TE2(I,4) + NLTTP                                      00416687  *  INSERTED*
      PERT2(IZ,1) = PERT2(IZ,1) + NTRTP                                00416688  *  INSERTED*
      PERT2(I,2) = PERT2(I,2) + NTRTP                                  00416689  *  INSERTED*
      IF (HOV.NE.3.OR.GWYREP.EQ.2) GO TO 1120                          00416690  *  INSERTED*
C                                                                      00416691  *  INSERTED*
C - - - 3. AUTO-DRIVERS: HOV LANE USED/NOT USED, IF HOV LANE EXISTS    00416692  *  INSERTED*
C                                                                      00416693  *  INSERTED*
      TE3(IZ,1) = TE3(IZ,1) + NHOVDR                                   00416694  *  INSERTED*
      TE3(I,3) = TE3(I,3) + NHOVDR                                     00416695  *  INSERTED*
      TE3(IZ,2) = TE3(IZ,2) + NNHOVD                                   00416696  *  INSERTED*
      TE3(I,4) = TE3(I,4) + NNHOVD                                     00416697  *  INSERTED*
      PERT3(IZ,1) = PERT3(IZ,1) + NADR                                 00416698  *  INSERTED*
      PERT3(I,2) = PERT3(I,2) + NADR                                   00416699  *  INSERTED*
C                                                                      00416700  *  INSERTED*
C - - - 4. AUTO-PASSENGERS: HOV LANE USED/NOT USED                     00416701  *  INSERTED*
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C                                                                   00416702    *    INSERTED*
         TE4(IZ,1) = TE4(IZ,1) + NHOVPS                             00416703    *    INSERTED*
         TE4(I,3) = TE4(I,3) + NHOVPS                               00416704    *    INSERTED*
         TE4(IZ,2) = TE4(IZ,2) + NNHOVP                             00416705    *    INSERTED*
         TE4(I,4) = TE4(I,4) + NNHOVP                               00416706    *    INSERTED*
         PERT4(IZ,1) = PERT4(IZ,1) + NAPASS                         00416707    *    INSERTED*
         PERT4(I,2) = PERT4(I,2) + NAPASS                           00416708    *    INSERTED*
C                                                                   00416709    *    INSERTED*
C --- SET UP REPORT 1 (SUMMARY OF TRIPS BY MODE BY INCOME)          00416710    *    INSERTED*
C                                                                   00416711    *    INSERTED*
 1120    DO 1130 INC=1,4                                            00416712    *    INSERTED*
           TINC = Z(INC+19,IZ) * TRIPS(I)                           00416713    *    INSERTED*
           TRPTOT(1,INC) = TRPTOT(1,INC) + TINC*PONE(INC)           00416714    *    INSERTED*
           TRPTOT(2,INC) = TRPTOT(2,INC) + TINC*POCC(2,INC)*PGRP(INC) 00416715  *    INSERTED*
           TRPTOT(3,INC) = TRPTOT(3,INC) + TINC*POCC(3,INC)*PGRP(INC) 00416716  *    INSERTED*
           TRPTOT(4,INC) = TRPTOT(4,INC) + TINC*POCC(4,INC)*PGRP(INC) 00416717  *    INSERTED*
           TRPTOT(5,INC) = TRPTOT(5,INC) + TINC*PTRN(INC)           00416718    *    INSERTED*
 1130    CONTINUE                                                   00416719    *    INSERTED*
C                                                                   00416720    *    INSERTED*
C --- SET UP REPORT 2 (SUMMARY OF ENTER/EXIT POINTS ON EXP/LRT/HOV) 00416721    *    INSERTED*
C                                                                   00416722    *    INSERTED*
         IF (GWYREP.EQ.2) GO TO 1175                                00416723    *    INSERTED*
         LO = EXPTR(IZ) + 1                                         00416724    *    INSERTED*
         LOHI = MAX0(LOHI,LO)                                       00416725    *    INSERTED*
         LI = EXPTR(I) + 1                                          00416726    *    INSERTED*
         LIHI = MAX0(LIHI,LI)                                       00416727    *    INSERTED*
C                                                                   00416728    *    INSERTED*
C - - - TALLY BOARDINGS AND ALIGHTINGS ON EXP/LRT ROUTE             00416729    *    INSERTED*
C                                                                   00416730    *    INSERTED*
         IF (TTYPE(I).EQ.0) GO TO 1170                              00416731    *    INSERTED*
         IF (TTYPE(I).GT.1) GO TO 1140                              00416732    *    INSERTED*
         IF (LTYPE(I).LT.4) GO TO 1170                              00416733    *    INSERTED*
         OUTALT(LI) = OUTALT(LI) + NTRTP                            00416734    *    INSERTED*
         OUTKAZ = OUTKAZ + NTRTP                                    00416735    *    INSERTED*
         GO TO 1170                                                 00416736    *    INSERTED*
 1140    IF (TTYPE(I).GT.2) GO TO 1150                              00416737    *    INSERTED*
         INBRD(LO) = INBRD(LO) + NTRTP                              00416738    *    INSERTED*
         INKAZ = INKAZ + NTRTP                                      00416739    *    INSERTED*
         GO TO 1170                                                 00416740    *    INSERTED*
 1150    IF (TTYPE(I).GT.3) GO TO 1160                              00416741    *    INSERTED*
         INBRD(LO) = INBRD(LO) + NTRTP                              00416742    *    INSERTED*
         INALT(LI) = INALT(LI) + NTRTP                              00416743    *    INSERTED*
         GO TO 1170                                                 00416744    *    INSERTED*
 1160    OUTBRD(LO) = OUTBRD(LO) + NTRTP                            00416745    *    INSERTED*
         OUTALT(LI) = OUTALT(LI) + NTRTP                            00416746    *    INSERTED*
C                                                                   00416747    *    INSERTED*
C - - - TALLY ENTRANCES TO HOV LANE, IF USED                        00416748    *    INSERTED*
C                                                                   00416749    *    INSERTED*
 1170    IF (HOV.NE.3.OR.HOVMK(I).NE.1) GO TO 1175                  00416750    *    INSERTED*
         HOVVEH = HOVVEH + NHOVDR                                   00416751    *    INSERTED*
         ONVEH(LO) = ONVEH(LO) + NHOVDR                             00416752    *    INSERTED*
         ONPER(LO) = ONPER(LO) + NHOVDR + NHOVPS                    00416753    *    INSERTED*
```

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      HOVPER = HOVPER + NHOVDR + NHOVPS                                  00416754   *   INSERTED*
C                                                                        00416755   *   INSERTED*
C --- SET UP REPORT 3 (SUMMARY OF VMT BY AQ DISTRICT AND FACILITY TYPE)   00416756   *   INSERTED*
C                                                                        00416757   *   INSERTED*
C - - - SUM VMT BY DISTRICT, IF DESIRED                                  00416758   *   INSERTED*
C                                                                        00416759   *   INSERTED*
 1175   IF (DOVMT.EQ.2) GO TO 1180                                       00416760   *   INSERTED*
        VMTI = NADR * INT(I,PVAR(28)) * FCHWYD                           00416761   *   INSERTED*
        JD = ZD(I)                                                       00416762   *   INSERTED*
        DO 1177 K=1,15                                                   00416763   *   INSERTED*
          VMTK(K) = VMTK(K) + VMTI*DSTPCT(IDST,JD,K)                     00416764   *   INSERTED*
 1177   CONTINUE                                                         00416765   *   INSERTED*
 1180 CONTINUE                                                           00416766   *   INSERTED*
      IF (IZ.NE.LIZ) GO TO 1184                                          00416767   *   INSERTED*
C                                                                        00416768   *   INSERTED*
C - - - LAST INTERNAL ZONE, ALLOCATE VMT TO FACILITY TYPES               00416769   *   INSERTED*
C                                                                        00416770   *   INSERTED*
      IF (DOVMT.EQ.2) GO TO 1181                                         00416771   *   INSERTED*
      DO 1182 K=1,6                                                      00416772   *   INSERTED*
        DO 1182 IDST=1,15                                                00416773   *   INSERTED*
          VMT(IDST,K) = VMTK(IDST)*FACPCT(IDST,K)                        00416774   *   INSERTED*
          VMTF(K) = VMTF(K) + VMT(IDST,K)                                00416775   *   INSERTED*
          VMTF(7) = VMTF(7) + VMT(IDST,K)                                00416776   *   INSERTED*
 1182 CONTINUE                                                           00416777   *   INSERTED*
 1181 DO 1183 I=1,4                                                      00416778   *   INSERTED*
        DO 1183 J=1,5                                                    00416779   *   INSERTED*
          TOTTRP(J) = TOTTRP(J) + TRPTOT(J,I)                            00416780   *   INSERTED*
 1183 CONTINUE                                                           00416781   *   INSERTED*
C                                                                        00416782   *   INSERTED*
C --- I-X TRIPS: INPUT VALUE EQUALS AUTO-DRIVER TRIPS                    00416783   *   INSERTED*
C                                                                        00416784   *   INSERTED*
 1184 IF (LIZ.EQ.ZONES) GO TO 1220                                       00416785   *   INSERTED*
      ZSTRT = LIZ + 1                                                    00416786   *   INSERTED*
      DO 1190 I=ZSTRT,ZONES                                              00416787   *   INSERTED*
        TRIP = INT(I,PVAR(26))                                           00416788   *   INSERTED*
        TE1(IZ,2) = TE1(IZ,2) + TRIP                                     00416789   *   INSERTED*
        TE1(I,5) = TE1(I,5) + TRIP                                       00416790   *   INSERTED*
        PERT1(IZ,1) = PERT1(IZ,1) + TRIP                                 00416791   *   INSERTED*
        PERT1(I,2) = PERT1(I,2) + TRIP                                   00416792   *   INSERTED*
        IF (HOV.NE.3) GO TO 1185                                         00416793   *   INSERTED*
        TROUT(I,4) = TRIP                                                00416794   *   INSERTED*
        TE3(IZ,2) = TE3(IZ,2) + TRIP                                     00416795   *   INSERTED*
        TE3(I,3) = TE3(I,3) + TRIP                                       00416796   *   INSERTED*
        PERT3(IZ,1) = PERT3(IZ,1) + TRIP                                 00416797   *   INSERTED*
        PERT3(I,2) = PERT3(I,2) + TRIP                                   00416798   *   INSERTED*
        GO TO 1190                                                       00416799   *   INSERTED*
 1185   TROUT(I,3) = TRIP                                                00416800   *   INSERTED*
 1190 CONTINUE                                                           00416801   *   INSERTED*
      GO TO 1220                                                         00416802   *   INSERTED*
C                                                                        00416803   *   INSERTED*
C --- X-I, X-X TRIPS: SAME                                               00416804   *   INSERTED*
C                                                                        00416805   *   INSERTED*
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      1200 DO 1210 I=1,ZONES                                        00416806    *     INSERTED*
             TRIP = INT(I,PVAR(26))                                 00416807    *     INSERTED*
             TE1(IZ,2) = TE1(IZ,2) + TRIP                           00416808    *     INSERTED*
             TE1(I,5) = TE1(I,5) + TRIP                             00416809    *     INSERTED*
             PERT1(IZ,1) = PERT1(IZ,1) + TRIP                       00416810    *     INSERTED*
             PERT1(I,2) = PERT1(I,2) + TRIP                         00416811    *     INSERTED*
             IF (HOV.NE.3) GO TO 1205                               00416812    *     INSERTED*
             TROUT(I,4) = TRIP                                      00416813    *     INSERTED*
             TE3(IZ,2) = TE3(IZ,2) + TRIP                           00416814    *     INSERTED*
             TE3(I,3) = TE3(I,3) + TRIP                             00416815    *     INSERTED*
             PERT3(IZ,1) = PERT3(IZ,1) + TRIP                       00416816    *     INSERTED*
             PERT3(I,2) = PERT3(I,2) + TRIP                         00416817    *     INSERTED*
             GO TO 1210                                             00416818    *     INSERTED*
      1205   TROUT(I,3) = TRIP                                      00416819    *     INSERTED*
      1210 CONTINUE                                                 00416820    *     INSERTED*
           GORDON = 1                                               00416821    *     INSERTED*
           IF (GORDON.EQ.2) GO TO 1221                              00416822    *     INSERTED*
      1220 RETURN 1                                                 00416823    *     INSERTED*
      1221 CONTINUE                                                 00416824    *     INSERTED*
     C                                                              00416825    *     INSERTED*
     C *** END OF MOD13D ***                                        00416826    *     INSERTED*
     C                                                              00416827    *     INSERTED*
./ NUMBER INSERT=YES,SEQ1=460000,NEW1=460031,INCR=1
     C*                                                            *00417000
     C*                                                            *00418000
     C*                                                            *00419000
     C*                                                            *00420000
     C*                                                            *00421000
     C**************************************************************00422000
           RETURN                                                   00423000
     C                                                              00424000
           ENTRY MOD13E(IZ,JZ,X,TABSO,TETAB,TEPERS,IRO,IRE,IRP,*)   00425000
     C                                                              00426000
           REAL*4    TETAB(3,5),TEPERS(5),IRO(5),IRE(5),IRP(5)      00427000
           REAL*4 X(NVAR),TABSO(TABOUT)                             00428000
     C**************************************************************00429000
     C*                                                            *00430000
     C*       ENTRY MOD13E IS USED TO APPLY MODELS ON AN INTERCHANGE *00431000
     C*       BASIS. IT IS ENTERED AS FOLLOWS:                     *00432000
     C*                                                            *00433000
     C*            1. ONCE FOR EACH HOUSEHOLD RECORD , IF INPUT.   *00434000
     C*                                                            *00435000
     C*            2. ONCE FOR EACH I-J PAIR IF INTERCHANGE AND TRIP *00436000
     C*               TABLE DATA IS INPUT WITHOUT HOUSEHOLD DATA.  *00437000
     C*                                                            *00438000
     C*            3. ONCE PER ZONE IF ONLY TRIP END DATA IS INPUT. *00439000
     C*                                                            *00440000
     C*-------------------------------------------------------------*00441000
     C*     MOD13E USER CODE IS INSERTED BETWEEN  442000 - 448000  *00442000
     C*                                                            *00443000
     C*                                                            *00444000
     C*                                                            *00445000
```

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C*                                                                      *
C*                                                                      *
C************************************************************************
      RETURN
C
      ENTRY MOD13F(X,*)
C************************************************************************
C*                                                                      *
C*         ENTRY MOD13F IS USED TO PRINT ANY ADDITIONAL ARRAYS WHICH    *
C*         MAY HAVE BEEN ACCUMULATED BY THE USER IN ENTRY POINTS        *
C*         MOD13D AND MOD13E. IT IS ENTERED ONCE AFTER ALL INPUT        *
C*         DATA HAS BEEN PROCESSED.                                     *
C*                                                                      *
C*----------------------------------------------------------------------*
C*      MOD13F USER CODE IS INSERTED BETWEEN  460000 - 466000           *
C                                                                          *    INSERTED*
C *** BEGIN MOD13F ***                                                     *    INSERTED*
C                                                                          *    INSERTED*
C --- WRITE OUT DESCRIPTION OF OUTPUT TRIP TABLES                          *    INSERTED*
C                                                                          *    INSERTED*
      WRITE (6,1270) TABOUT                                                *    INSERTED*
 1270 FORMAT ('1  TRIP TABLE MATRICES'//' THE FOLLOWING',I2,' TRIP TABLE   *    INSERTED*
     1S HAVE BEEN WRITTEN TO THE J9 FILE:'//4X,'1. TRANSIT TRIPS USING E   *    INSERTED*
     2XP/LRT SERVICE'/4X,'2. TRANSIT TRIPS NOT USING EXP/LRT SERVICE')     *    INSERTED*
      IF (HOV.NE.3) GO TO 1290                                             *    INSERTED*
      WRITE (6,1280)                                                       *    INSERTED*
 1280 FORMAT (4X,'3. AUTO-DRIVER TRIPS USING HOV LANE'/4X,'4. AUTO-DRIVE   *    INSERTED*
     1R TRIPS NOT USING HOV LANE'/4X,'5. AUTO-PASSENGER TRIPS USING HOV    *    INSERTED*
     2LANE'/4X,'6. AUTO-PASSENGER TRIPS NOT USING HOV LANE'/4X,'7. TOTAL   *    INSERTED*
     3 PERSON TRIPS')                                                      *    INSERTED*
      GO TO 1225                                                           *    INSERTED*
 1290 WRITE (6,1300)                                                       *    INSERTED*
 1300 FORMAT (4X,'3. AUTO-DRIVER TRIPS'/4X,'4. AUTO-PASSENGER TRIPS'/4X,   *    INSERTED*
     1'5. TOTAL PERSON TRIPS')                                             *    INSERTED*
C                                                                          *    INSERTED*
C --- PRINT REPORT 1                                                       *    INSERTED*
C                                                                          *    INSERTED*
 1225 WRITE (6,1230) (J,(TRPTOT(I,J),I=1,5),J=1,4),TOTTRP                  *    INSERTED*
 1230 FORMAT (1H1,16X,'SUMMARY REPORT 1'//8X,'SUMMARY OF TRIPS BY MODE A   *    INSERTED*
     1ND INCOME'/8X,'(NOTE: DOES NOT INCLUDE EXTERNALS)'//28X,'MODE'/      *    INSERTED*
     2//' INCOME      ONE      TWO      THREE     FOUR+   TRANSIT'//       *    INSERTED*
     34(//4X,I1,4X,5F8.0)/9X,5(2X,6(1H-))/9X,5F8.0)                        *    INSERTED*
C                                                                          *    INSERTED*
C --- PRINT REPORT 2, IF DESIRED                                           *    INSERTED*
C                                                                          *    INSERTED*
      IF (GWYREP.EQ.2) GO TO 1260                                          *    INSERTED*
      WRITE (6,1240) INKAZ,OUTKAZ,(I,INBRD(I),INALT(I),OUTBRD(I),          *    INSERTED*
     1                              OUTALT(I),I=1,LOHI)                    *    INSERTED*
 1240 FORMAT (1H1,19X,'SUMMARY REPORT 2'//6X,'ENTRANCE AND EXIT POINTS 0   *    INSERTED*
     1N EXP/LRT CORRIDOR'/16X,'(STRAIGHT LINE DISTANCE)'///'   MILE'/      *    INSERTED*
     2' FROM KEY INBOUND TRANSIT TRIPS  OUTBOUND TRANSIT TRIPS'//          *    INSERTED*
     3/' ACTIVITY'/'   ZONE',7X,'BOARD    ALIGHT',                         *    INSERTED*
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          49X,'BOARD   ALIGHT'/                                             00460038    *          INSERTED*
          5//'  O(KAZ)',12X,F9.0,5X,F9.0,                                   00460039    *          INSERTED*
          6100(/3X,I3,3X,2F10.0,5X,2F9.0))                                  00460040    *          INSERTED*
           IF (HOV.NE.3) GO TO 1260                                         00460041    *          INSERTED*
           WRITE (6,1250) HOVVEH,HOVPER,(I,ONVEH(I),ONPER(I),I=1,LOHI)      00460042    *          INSERTED*
      1250 FORMAT (//11X,'CARPOOL VEHICLE TRIPS   CARPOOL PERSON TRIPS'/    00460043    *          INSERTED*
          1//15X,'ENTER    EXIT',11X,'ENTER   EXIT'/                        00460044    *          INSERTED*
          2//'  O(KAZ)',11X,                                                00460045    *          INSERTED*
          3F9.0,13X,F10.0,100(/3X,I3,6X,F8.0,17X,F7.0))                     00460046    *          INSERTED*
    C                                                                       00460047    *          INSERTED*
    C--- PRINT REPORT 3, IF VMT CALCULATIONS WERE DONE                      00460048    *          INSERTED*
    C                                                                       00460049    *          INSERTED*
      1260 IF (DOVMT.EQ.1) WRITE(6,1265) (I,(VMT(I,J),J=1,6),VMTK(I),I=1,15),00460050    *          INSERTED*
          1 VMTF                                                            00460051    *          INSERTED*
      1265 FORMAT (1H1,35X,'SUMMARY REPORT 3'//20X,'SUMMARY OF VMT BY AQ DIST00460052    *          INSERTED*
          1RICT AND FACILITY TYPE'/20X,'(NOTE: INCLUDES ONLY INTERNAL-INTERNA00460053    *          INSERTED*
          2L WORK'/21X,'AUTO TRIPS.  IF THIS IS NOT A BASE RUN, THESE'/21X,'F00460054    *          INSERTED*
          3IGURES MUST BE COMPARED WITH REPORT 3 FROM'/21X,'BASE RUN TO GET E00460055    *          INSERTED*
          4STIMATED CHANGES IN VMT.)'///4X,'AQ',29X,'PRIMARY     MINOR'/' DIS00460056    *          INSERTED*
          5TRICT  INTERSTATE EXPRESSWAY  ARTERIAL  ARTERIAL  COLLECTOR    LOC00460057    *          INSERTED*
          6AL',7X,'TOTAL'/1H+,8(1H_),1X,2(1X,10(1H_)),2X,2(8(1H_),2X),9(1H_),00460058    *          INSERTED*
          74X,5(1H_),7X,5(1H_),15(//4X,I2,4X,7(1X,F10.0))/10X,7(3X,8(1H-))/ 00460059    *          INSERTED*
          810X,7(1X,F10.0))                                                 00460060    *          INSERTED*
    C                                                                       00460061    *          INSERTED*
    C ---- WRITE OUT EXPLANATION OF TRIP END SUMMARIES                      00460062    *          INSERTED*
    C                                                                       00460063    *          INSERTED*
      1310 WRITE (6,1320)                                                   00460064    *          INSERTED*
      1320 FORMAT ('1  TRIP END SUMMARIES'//' THE FOLLOWING TRIP END SUMMARIE00460065    *          INSERTED*
          1S WILL BE PRINTED BELOW:'//'  SUMMARY 1 -- TABLE 1 = TRANSIT TRIPS00460066    *          INSERTED*
          2'/15X,'TABLE 2 = AUTO-DRIVER TRIPS'/15X,'TABLE 3 = AUTO-PASSENGER 00460067    *          INSERTED*
          3TRIPS'/15X,'PERSON-TRIPS = TOTAL PERSON TRIPS'//'  SUMMARY 2 -- TA00460068    *          INSERTED*
          4BLE 1 = TRANSIT TRIPS USING EXP/LRT SERVICE'/15X,'TABLE 2 = TRANSI00460069    *          INSERTED*
          5T TRIPS NOT USING EXP/LRT SERVICE'/                              00460070    *          INSERTED*
          615X,'PERSON TRIPS = TOTAL TRANSIT TRIPS')                        00460071    *          INSERTED*
           IF (HOV.NE.3.OR.GWYREP.EQ.2) GO TO 1340                          00460072    *          INSERTED*
           WRITE (6,1330)                                                   00460073    *          INSERTED*
      1330 FORMAT(/'  SUMMARY 3 -- TABLE 1 = AUTO-DRIVER TRIPS USING HOV LANE00460074    *          INSERTED*
          1'/15X,'TABLE 2 = AUTO-DRIVER TRIPS NOT USING HOV LANE'/          00460075    *          INSERTED*
          215X,'PERSON TRIPS = TOTAL AUTO-DRIVER TRIPS'//'  SUMMARY 4 -- TABL00460076    *          INSERTED*
          3E 1 = AUTO-PASSENGER TRIPS USING HOV LANE'/15X,'TABLE 2 = AUTO-PAS00460077    *          INSERTED*
          4SENGER TRIPS NOT USING HOV LANE'/15X,'PERSON TRIPS = TOTAL AUTO-PA00460078    *          INSERTED*
          5SSENGER TRIPS')                                                  00460079    *          INSERTED*
      1340 CONTINUE                                                         00460080    *          INSERTED*
    C                                                                       00460081    *          INSERTED*
    C *** END OF MOD13F ***                                                 00460082    *          INSERTED*
    C                                                                       00460083    *          INSERTED*
./ ENDUP
    C*                                                                     *00461000
    C*                                                                     *00462000
    C*                                                                     *00463000
    C*                                                                     *00464000
    C*                                                                     *00465000
```

APPENDIX E

SCENARIO ANALYSIS TECHNIQUE

INTRODUCTION

The technique used to analyze the modal impacts of the transportation scenarios is an extension of the method used in Tables 16-19 in the main text. Incremental logit analysis is used in both cases to estimate the shifts in mode shares resulting from transportation system changes. Given a known original mode share, the absolute change in the system variable(s), and coefficients describing the relative sensitivity of travellers to each variable, new shares for each mode can be estimated.

The original mode share comes either from observed data, or a "base" application of the modal summary tables or the corridor sketch planning program. The modes of interest, of course, are transit and ridesharing (group auto), with drive alone being the remaining mode. The absolute change in the system variables is determined from the known existing variable values and an assumed percentage change from the existing base value. The percentage changes are related to the various scenarios: Constrained, Expected, and Uncontrained, as defined in a separate technical memorandum. The coefficients are derived from logit mode choice models calibrated for Seattle, Houston, New Orleans, and Minneapolis-St. Paul. They represent factors used to describe the effect of each variable on mode choice decisions.

This method, as applied in Tables 16-19 in the transit and carpool sensitivity analysis, deals with one mode at a time, and changes to one variable at a time. For the full scenario analysis, this technique has been expanded to include all three modes, and changes to several variables simultaneously.

CALCULATION

An interactive FORTRAN program was written for a microcomputer to implement the program. The source code for this program is attached at the end of this Appendix. A sample application (the printout from an interactive session) is shown in Figure 1.

The program first initializes several variables, prompts the user to input the original transit and ridesharing shares, then calculates the drive alone share. Then, the user is prompted to input the absolute changes in any of the system variables. The program converts the daily parking cost change to a "one-way" value, and calculates the change in highway operating cost based on the trip distance and change in gasoline cost. A 1980 value of 16.4 miles per gallon is used. Changes in the non-fuel part of auto operating cost are not included. In the case of the ridesharing mode, changes in cost are divided by 2.5 to reflect the change in cost <u>per person.</u>

Then, the relative disutility values (U) of the three modes are estimated by simply assuming an arbitrary value for the drive alone exponentiated disutility (exp (-U)). From that and the known original modal shares, the transit and ridesharing exponentiated disutilities can be calculated. Natural logarithms are applied to convert to actual disutility values.

Figure 1
EXAMPLE APPLICATION OF LOGIT SENSITIVITY PROGRAM

```
LOGIT SENSITIVITY PROGRAM -- INPUT KNOWN PERCENT TRANSIT
AND GROUP AUTO MODES, AND DESIRED CHANGES IN
SYSTEM VARIABLES -- PROGRAM WILL CALCULATE NEW MODE SHARES
PERCENTS MUST BE ENTERED AS PROPORTIONS (0.0-1.0)
AND MUST HAVE EXPLICIT DECIMAL POINTS


ENTER KNOWN TRANSIT PROPORTION:  0.10

ENTER KNOWN GROUP AUTO (RIDESHARING) PROPORTION:  0.40

INPUT CHANGES IN SYSTEM VARIABLES
IF THE VALUE DECREASES, ENTER AS A NEGATIVE NUMBER
ALWAYS USE EXPLICIT DECIMAL POINTS
IF NO CHANGE, JUST HIT ENTER


ENTER CHANGE IN TRANSIT RUN TIME (MIN.):  -5.0

ENTER TOTAL CHANGE IN TRANSIT WALK AND WAIT TIME:  0

ENTER CHANGE IN ONE-WAY TRANSIT FARE (CENTS):  -25.0

ENTER CHANGE IN HIGHWAY RUN TIME (MIN.):  -5.0

ENTER CHANGE IN REAL (1980 $) GAS COST (CENTS/GALLON):  30.0

ENTER CHANGE IN TOTAL DAILY PARKING COST (CENTS):  20.0

ENTER THE TOTAL HIGHWAY DISTANCE (MI.):  20.0




NEW TRANSIT PROPORTION =       .166
NEW DRIVE ALONE PROPORTION =   .405
NEW GROUP AUTO PROPORTION =    .429
NOTE: TOTALS MAY NOT ADD EXACTLY TO 1.0 DUE TO ROUNDING
TO DO ANOTHER CASE, TYPE 1...TO END, TYPE 0:  0
```

The disutility for each mode is then modified by the sum of the coefficients times their respective system variable changes. Table I lists the variables included in the program and their coefficients. The coefficient should be interpreted as the change in travel disutility resulting from a one unit change in the variable. These coefficients are positive because the entire disutility expression is multiplied by -1 prior to exponentiation. This yields the net effect of all the system changes on all the modes, relative to each other. Once new disutilities are calculated, the previous two steps are reversed: the disutilities are exponentiated and combined to yield the new modal shares. This process can be easily repeated for practically any combination of mode shares and system changes. The entire program executes in about 20 seconds.

Table I
SCENARIO ANALYSIS VARIABLES

System Variable	Units	Logit Coefficient
transit run (in-vehicle) time	minutes	0.031
transit out-of-vehicle time (walk and wait time)	minutes	0.044
transit fare (one-way)	cents	0.010
highway run time	minutes	0.031
auto operating cost[1/]	cents	0.010
daily parking cost	cents	0.010

Notes:

1/ Calculated based on highway distance and gasoline cost.

```
C
C  NEW LOGIT SENSITIVITY PROGRAM...LOGIT.FOR...BY WGA 4/21/82
C
C    THIS PROGRAM USES A MIX OF LOGIT SYSTEM COEFFICIENTS FROM
C     OTHER AREAS, AND A 1980 AUTO OPERATING COST MODEL TO
C     DETERMINE MODE SHIFTS FOR CHANGES IN THE ABSOLUTE
C     VALUES OF SYSTEM VARIABLES FOR TRANSIT AND HIGHWAY MODES.
C
      WRITE(1,10)
 10   FORMAT(' LOGIT SENSITIVITY PROGRAM -- INPUT KNOWN PERCENT
     1 TRANSIT'/' AND GROUP AUTO MODES, AND DESIRED CHANGES IN'/
     2 ' SYSTEM VARIABLES -- PROGRAM WILL CALCULATE NEW MODE',
     3 ' SHARES'/' PERCENTS MUST BE ENTERED AS PROPORTIONS',
     4 ' (0.0-1.0)'/' AND MUST HAVE EXPLICIT DECIMAL POINTS'//)
C
C  INITIALIZE SOME VARIABLES
C
  15  PTR = 0.0
      PGR = 0.0
      PDA = 0.0
      UTR = 0.0
      UGR = 0.0
      UDA = 0.0
      EUTR = 0.0
      EUGR = 0.0
      WRITE(1,20)
 20   FORMAT(' ENTER KNOWN TRANSIT PROPORTION:  ')
      READ(5,25) PTR
 25   FORMAT(F10.0)
      WRITE(1,30)
 30   FORMAT(' ENTER KNOWN GROUP AUTO (RIDESHARING) PROPORTION:  ')
      READ(5,25) PGR
      PDA = 1.0 - PGR - PTR
      IF (PDA.LE.0.0) STOP PDALEO
C
C  INITIALIZE SOME MORE VARIABLES
C
      TRNRUN = 0.0
      TRNOVT = 0.0
      FARE   = 0.0
      HWYRUN = 0.0
      HWYDST = 0.0
      HWYCST = 0.0
C
C  ENTER SYSTEM VARIABLE CHANGES
C
      WRITE(1,40)
 40   FORMAT(' INPUT CHANGES IN SYSTEM VARIABLES'/' IF THE VALUE',
     1 ' DECREASES, ENTER AS A NEGATIVE NUMBER'/' ALWAYS USE',
     2 ' EXPLICIT DECIMAL POINTS'/' IF NO CHANGE, JUST HIT ENTER'//)
      WRITE(1,50)
 50   FORMAT(' ENTER CHANGE IN TRANSIT RUN TIME (MIN.):  ')
      READ(5,25) TRNRUN
      WRITE(1,60)
 60   FORMAT(' ENTER TOTAL CHANGE IN TRANSIT WALK AND WAIT TIME:  ')
```

```
      READ(5,25) TRNOVT
      WRITE(1,70)
 70   FORMAT(' ENTER CHANGE IN ONE-WAY TRANSIT FARE (CENTS):  ')
      READ(5,25) FARE
      WRITE(1,80)
 80   FORMAT(' ENTER CHANGE IN HIGHWAY RUN TIME (MIN.):  ')
      READ(5,25) HWYRUN
      WRITE(1,90)
 90   FORMAT(' ENTER CHANGE IN REAL (1980 $) GAS COST (CENTS/',
     1 'GALLON):  ')
      READ(5,25) GASCST
      WRITE(1,100)
 100  FORMAT(' ENTER CHANGE IN TOTAL DAILY PARKING COST (CENTS):  ')
      READ(5,25) PRKCST
      PRKCST = 0.5 * PRKCST
      WRITE(1,110)
 110  FORMAT(' ENTER THE TOTAL HIGHWAY DISTANCE (MI.):  ')
      READ(5,25) HWYDST
C
C  CALCULATE CHANGE IN AUTO OPERATING COST
C    (ASSUME FUEL EFFICIENCY OF 16.4 MPG -- 1980)
C
      HWYCST = HWYDST * GASCST/16.4
C
C  CALCULATE MODAL DISUTILITY VALUES (UTILES)
C
C   ASSUME THAT U(DRIVE ALONE) = 2.0 AND DERIVE THE OTHERS
C
      EUDA = 2.0
      EUTOT = 2.0/PDA
      EUTR = PTR * EUTOT
      EUGR = PGR * EUTOT
C
C  UN-EXPONENTIATE
C
      IF (PTR.LT.0.01) GO TO 120
      UTR = -1.0 * ALOG(EUTR)
 120  UDA = -1.0 * ALOG(EUDA)
      UGR = -1.0 * ALOG(EUGR)
C
C  ADD CHANGES IN SYSTEM VARIABLES * COEFFICIENTS
C
C   COEFFICIENTS COME FROM SEATTLE, HOUSTON, MINNEAPOLIS, AND
C    NEW ORLEANS.  AVERAGE GROUP OCCUPANCY OF 2.5 IS ASSUMED.
C
      IF (PTR.LT.0.01) GO TO 125
      UTR = UTR + 0.031*TRNRUN + 0.044*TRNOVT + 0.010*FARE
 125  UDA = UDA + 0.031*HWYRUN + 0.010*(HWYCST + PRKCST)
      UGR = UGR + 0.031*HWYRUN + 0.010*(HWYCST + PRKCST)/2.5
C
C  CALCULATE NEW EXPONENTIATED UTILES
C
      IF (PTR.LT.0.01) GO TO 130
      EUTR = EXP(-1.0*UTR)
 130  EUDA = EXP(-1.0*UDA)
```

```
      EUGR = EXP(-1.0*UGR)
      EUTOT = EUTR + EUDA + EUGR
      IF (PTR.LT.0.01) GO TO 140
      PTR = EUTR/EUTOT
 140  PDA = EUDA/EUTOT
      PGR = EUGR/EUTOT
C
C  OUTPUT SECTION
C
      WRITE(1,200) PTR,PDA,PGR
 200  FORMAT(//////' NEW TRANSIT PROPORTION =      ',F6.3/
     1 ' NEW DRIVE ALONE PROPORTION = ',F6.3/
     2 ' NEW GROUP AUTO PROPORTION =  ',F6.3/
     3 ' NOTE: TOTALS MAY NOT ADD EXACTLY TO 1.0 DUE TO ROUNDING')
      WRITE(1,210)
 210  FORMAT(' TO DO ANOTHER CASE, TYPE 1...TO END, TYPE 0:  ')
      READ(5,215) I
 215  FORMAT(I1)
      IF (I.EQ.1) GO TO 15
      STOP  THEEND
      END
```