REPORT OF THE DEPARTMENT OF HIGHWAYS AND TRANSPORTATION ON THE

VIRGINIA COMMUTER STUDY

TO THE GOVERNOR AND THE GENERAL ASSEMBLY OF VIRGINIA

• Roanoke Case Study

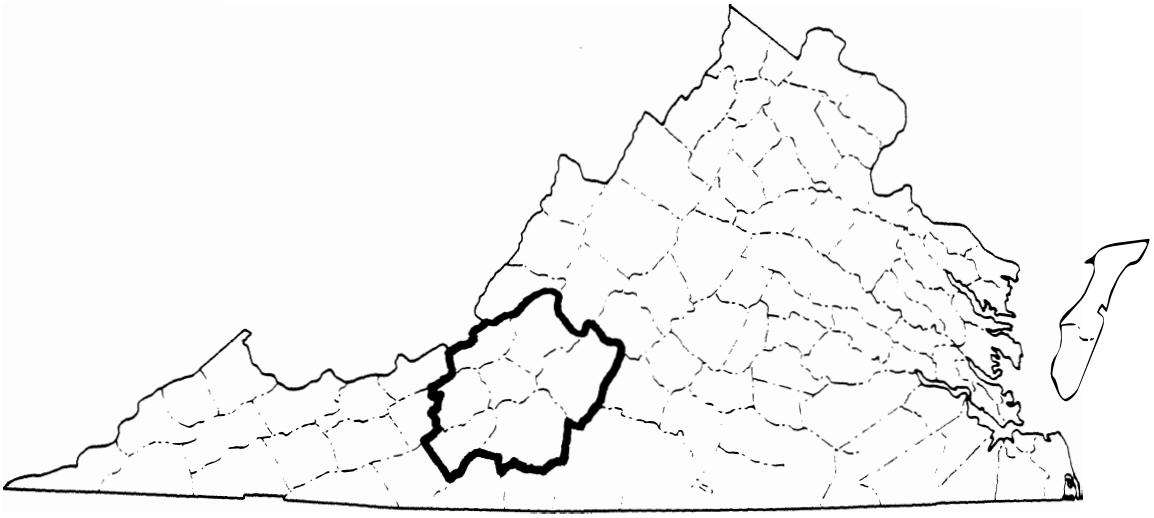
(See Also House Document 7)

HOUSE DOCUMENT NO. 7C

COMMONWEALTH OF VIRGINIA
RICHMOND
1983

VIRGINIA COMMUTER STUDY

An Analysis of Commuting Conditions in Three Case Study Areas



ROANOKE CASE STUDY

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

VIRGINIA COMMUTER STUDY

Phase 3 Report
An Analysis of Commuting Conditions in Three Case Study Areas

Roanoke

June 1982

Prepared for
The Virginia Department of
Highways and Transportation

Prepared by
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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 alter-

native 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 one of the three case studies in Phase 3. Other reports describe the analyses and results of Phase 1 (Commuting Problems, Issues, and Policy/Program Response) and Phase 2 (A Methodology for Evaluating Commuter Travel Options in Virginia Cities). An Executive Summary provides an overview of the entire study and highlights principal conclusions and recommendations.

The presentation of case study analyses and conclusions basically follows the principal steps of the planning methodology that is detailed in the Phase 2 report. The case studies have the dual objectives of identifying actions that can be taken to improve commuting in each area and demonstrating the use of the planning methodology in a variety of commuting environments. The second objective requires that each step of the analysis be documented in detail so that subsequent users of the methodology can achieve maximum benefit from application in the case studies. Thus, the report contains more extensive tables, sample calculations, and description of assumptions than would ordinarily be found in a typical project feasibility study.

While each case study report follows the general outline of the major steps in the planning methodology, there are important differences in the way in which material is presented and in the level and type of analysis for each case study. This results primarily from the vast differences in commuting conditions between a large urban region such as Northern Virginia, that is part of an even larger metropolitan area, and a smaller, free-standing urban area, such as Martinsville. The types and level of problems in two such contrasting areas obviously demand different planning and analytical techniques, and the resulting transportation solutions are likely to be quite different in form, cost, and impact.

Finally, some of the variation in the case study discussions is the result of different analysts working on each area. While there was extensive communication between the three principal analysts during the study, each was given considerable flexibility in adapting and applying the basic methodology to conditions in his respective study areas. This had the benefit of producing three fairly independent tests of the planning methodology, reflecting not only differences among study areas, but differences in interpretation of the methodology, as well.

CASE STUDY AREA DEFINITION

The Roanoke Case Study area is centered on the Roanoke Valley, encompassing the independent cities of Roanoke and Salem and Roanoke County. Also included in the study area are the counties of Botetourt, Bedford, Craig, Floyd, Franklin, and Montgomery and the independent cities of Bedford and Radford. Figure 2.1 shows the area considered in the Roanoke Case Study and the 1970 commuting patterns into the Roanoke Valley.

The Roanoke Valley had a 1980 employment base of 92,500 centered on manufacturing, transportation, wholesale and retail trade. Approximately sixty-five percent of employment in the Valley is located in the City of Roanoke. The City of Salem is estimated to have 1980 employment of almost 20,000 and about 17,500 jobs are located in Roanoke County. Figure 2.2 shows the location of firms in the Roanoke Valley employing more than 200 persons.

Employment opportunities in the surrounding counties are somewhat limited. In the 1970 Census, only Montgomery County and the City of Radford had a net influx of commuters. This situation appears to be the case today. In terms of employment reported in County Business Patterns[1/], the Roanoke Valley has a ratio of about one job for every two residents. The surrounding counties, being more rural and agricultural, had much lower job-to-resident ratios. Montgomery County and the City of Radford together have a ratio of about two jobs for every seven residents. Franklin County and Bedford County, each had a ratio of about one job to every five residents. The remaining counties (Botetourt, Floyd and Craig), each had a ratio of less than one job for every ten residents.

Despite the limited non-agricultural job opportunities outside the Roanoke Valley, it appears that the extent of in-commuting to the Valley is somewhat limited. As shown in Figure 2.1, in 1970 only about 12% of jobs in the Roanoke Valley were held by workers living outside the Valley. This may be due in part to the relative proximity of other major employment centers--Lynchburg to the east, Martinsville to the south and Montgomery County and Radford to the west. Of the surrounding counties, only Montgomery County has significant urban development.

While this study focuses on the long-distance commuter, the 1970 Census revealed that only 1% of the total jobs in the Roanoke Valley were held by persons living beyond the first ring of counties. As can be seen from Figure

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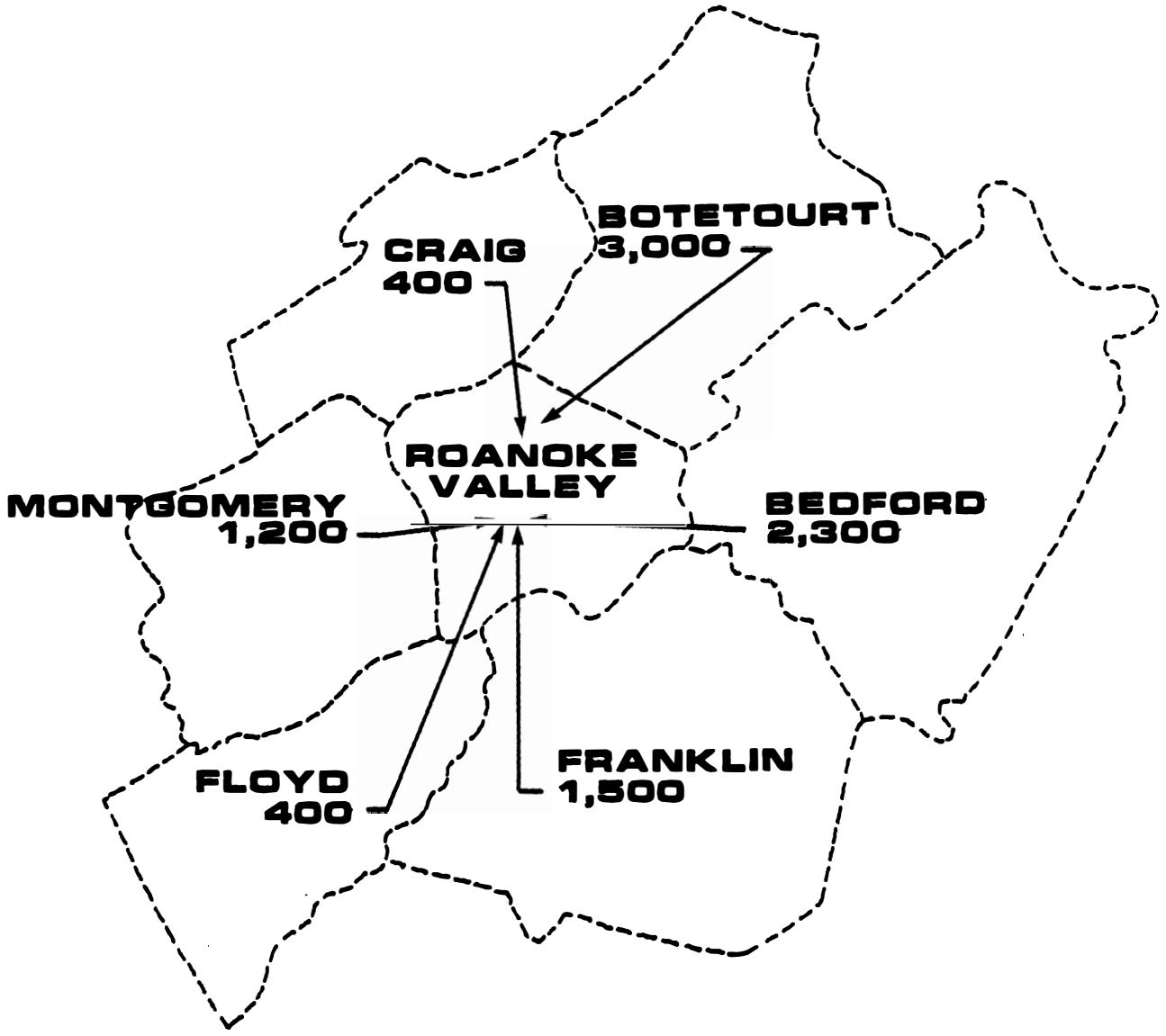
1/ County Business Patterns, 1979--Virginia, U.S. Department of the Commerce, Bureau of the Census. Note: The County Business Patterns publication of the Bureau of the Census excludes farmers, domestic service employees, self-employed persons, and government and railroad employees.



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 2.1
EXTERNAL COMMUTING TRAVEL TO ROANOKE VALLEY
(1970 CENSUS DATA)

ROANOKE CASE STUDY
Virginia Commuting Study

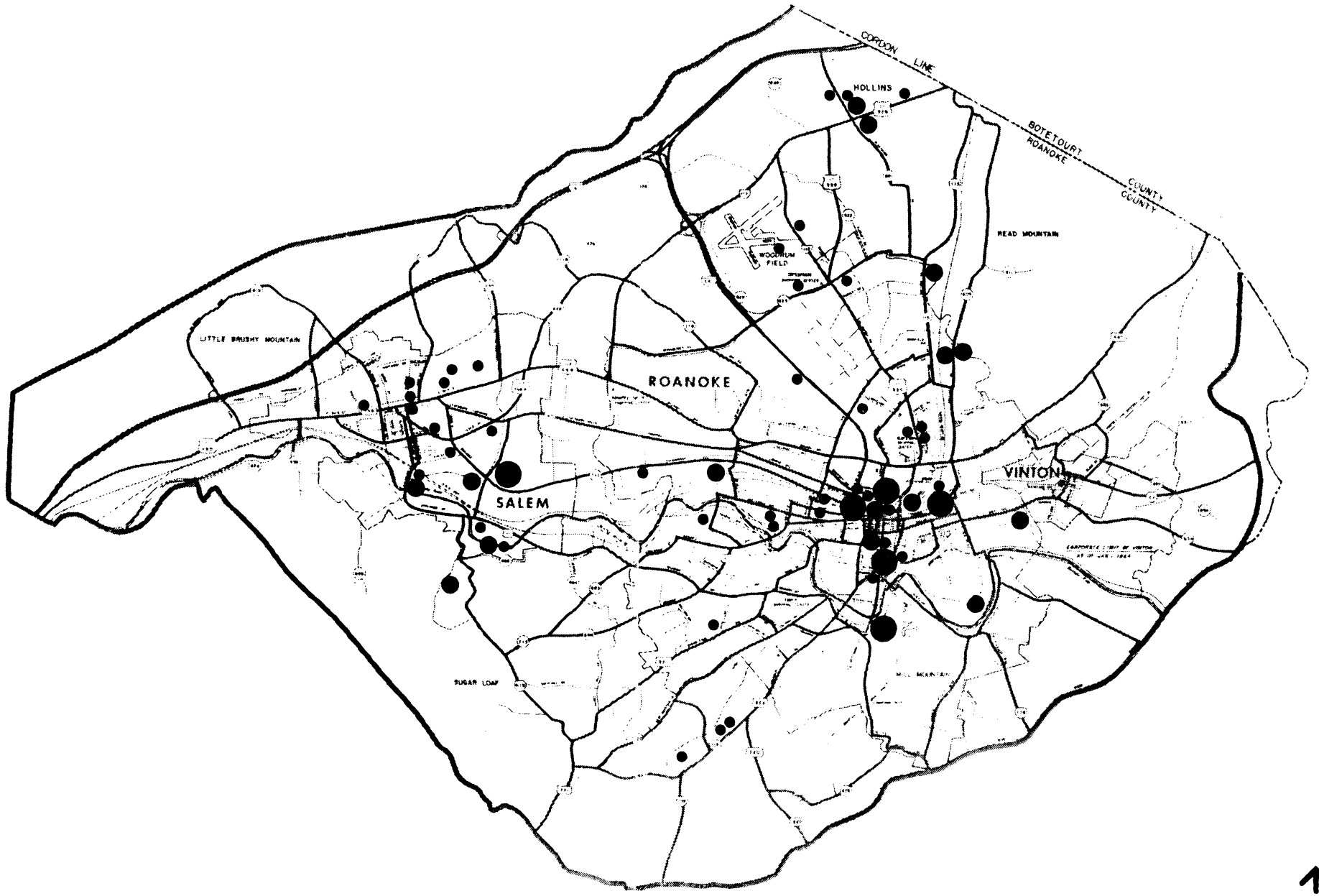


Figure 2.2
LOCATION OF FIRMS WITH 200 + EMPLOYEES
ROANOKE CASE STUDY
Virginia Commuting Study

NUMBER OF EMPLOYEES
- 200 - 499
- 500 - 999
- 1000 - +

2.1, Bedford and Botetourt counties are the primary contributors to in-commuting to the Roanoke Valley, with Franklin and Montgomery counties comprising the bulk of the remaining in-commuters.

Based on this analysis, the case study area was limited to the Roanoke Valley and the first ring of surrounding counties. This study area had a 1980 population of about 390,000 (of which just over fifty percent is in the Roanoke Valley) and encompasses a land area of over 3,400 square miles.

CORRIDOR DEFINITION

The first basic step in analyzing commuter travel problems and options is the identification of principal commute corridors. Four general criteria were used in identifying such corridors:

1. All major travel markets should be served by one or more corridors.
2. Corridors should have minimal overlap outside the central area.
3. One or more major highways should be included in each corridor.
4. The corridors should extend at least ten miles from the central area.

Where a number of alternative routings and corridor definitions are possible, some judgment must be exercised in order to ensure that the number of corridors identified for analysis purposes does not become unwieldy. Table 2.1 lists the nine commuter corridors identified for analysis as part of the Roanoke Case Study. Figure 2.3 locates these corridors within the study area.

The corridors link the nearby counties to employment opportunities within the Roanoke Valley and serve as the major commuter arterials into the Valley. Within the Valley, there is considerable use of the primary roadways for local circulation, and there is some overlapping of corridors. As each corridor enters the Valley, the principal roadway may change. For example, I-81 SW serves as the principal roadway between the Valley and population concentrations in Montgomery County. Within the Valley, Rte. 460 becomes the principal roadway into the City of Roanoke. All of the corridors except for Rte. 311 enter the City of Roanoke. The Rte. 311 Corridor merges with the I-81/Rte. 460 SW Corridor to link Craig County residents with the City of Roanoke.

Table 2.1
CORRIDOR DEFINITIONS FOR ROANOKE CASE STUDY

Rte 220 North -- Fincastle
I-81 (Rte. 11) Northeast -- Buchanan
Rte. 460 (Rte. 221) Northeast -- Bedford
Rte. 24 East -- Chamblissburg
Rte. 116 South -- Burnt Chimney
Rte. 220 South -- Rocky Mount
Rte. 221 South -- Copper Hill
I-81 (Rte. 460 and 11) Southwest -- Christiansburg
Rte. 311 North -- New Castle

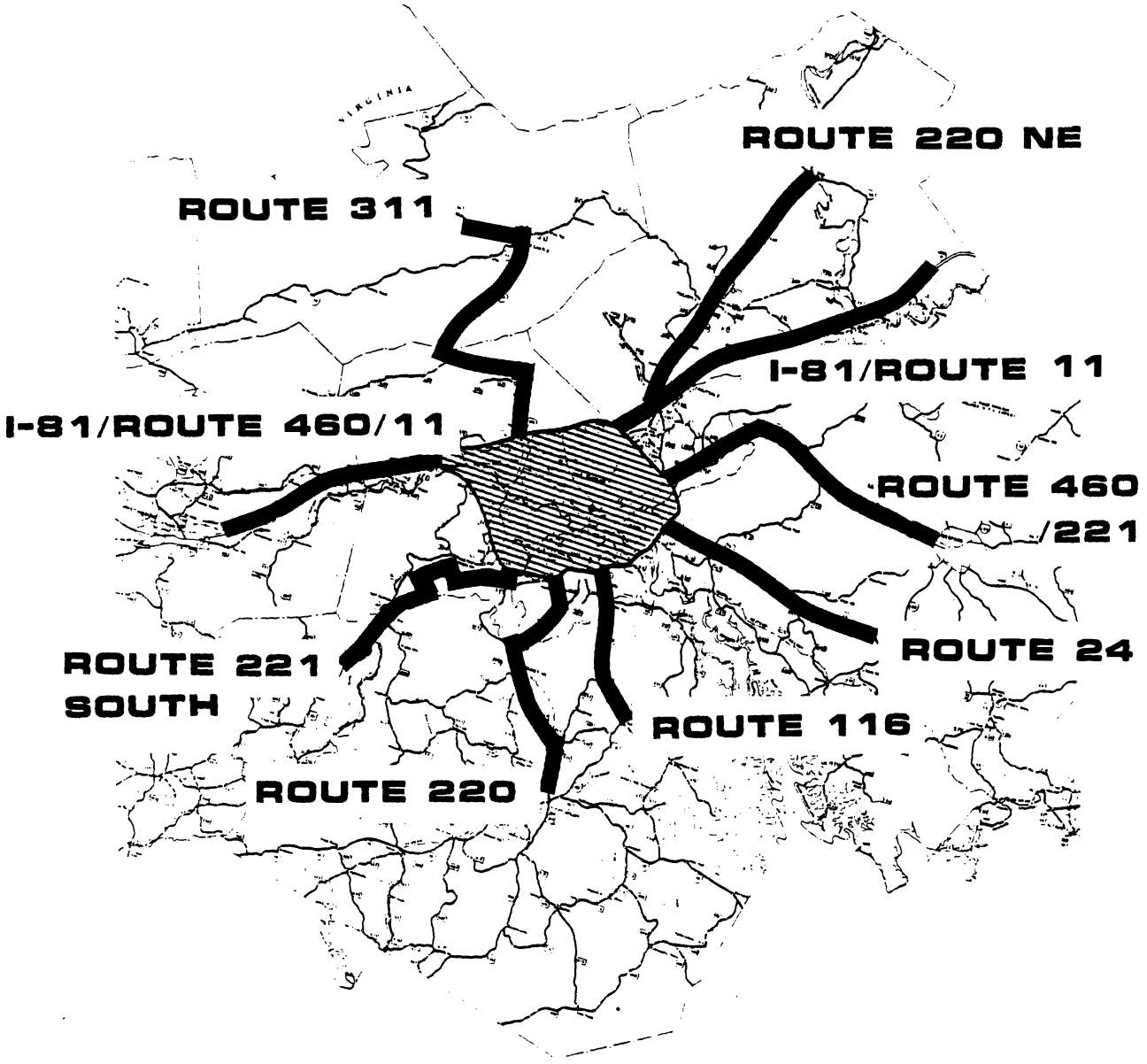


Figure 2.3
MAJOR TRAVEL CORRIDORS

ROANOKE CASE STUDY
Virginia Commuting Study

PLANS AND PROPOSALS

As part of the data collection effort, proposals developed by VDH&T, the Fifth PDC, Valley Metro, and others concerning transportation in the Roanoke Valley were reviewed. With a few exceptions, the current proposals are not expected to significantly alter the commuting picture in the Roanoke Valley. This section summarizes current proposals for the Roanoke Valley covering the areas of highways, transit and ridesharing.

Planned improvements to the Roanoke Valley highway system are shown in Figure 2.4. Except for the expansion of Route 460 in Salem and Route 117, these improvements will not substantially impact the conditions faced by long-distance commuters. Figure 2.5 shows the planned improvements in the study area (outside of the Roanoke Valley) as identified by VDH&T in its statewide planning effort. Elimination of the deficiencies on Route 311 N, Route 221 N, Route 604 N, and Route 116 S should improve commuting conditions but will do little to reduce the twin problems of auto dependence and cost facing long-distance commuters.

Transit in the Roanoke Valley is currently oriented to the transit dependent population within the Valley and does not exist as an alternative to many commuters. One bright spot has been the success of an experimental Downtown Circulator/Shuttle Service operated by Valley Metro. The shuttle service operates weekdays from 7:30 a.m. to 6:30 p.m. at a twelve minute frequency connecting free parking at the Roanoke Civic Center with the Roanoke Business District. Removal of surface parking and increased parking fees associated with downtown redevelopment have created a natural market for this service. It is expected that this service will be continued after the demonstration period, offering some alternative to workers in the Roanoke CBD. Beyond the downtown shuttle, it is unlikely that transit will be able to play a more significant role in the commute to work. A recent study of Park and Ride Service potential conducted for the Fifth Planning District Commission saw little demand for such service[1/] but recommended consideration be given to implementing a ridesharing assistance program in the Roanoke Valley.

Currently, there is no ridesharing assistance program in the Roanoke Valley, except for low-key efforts by individual employers. The recommendations arising from the Park-and-Ride Study point to the potential of an areawide program with the Greater Roanoke Transit Company as the implementing agency. Certain actions which are generally supportive of ridesharing are currently at various stages of planning and implementation. The development

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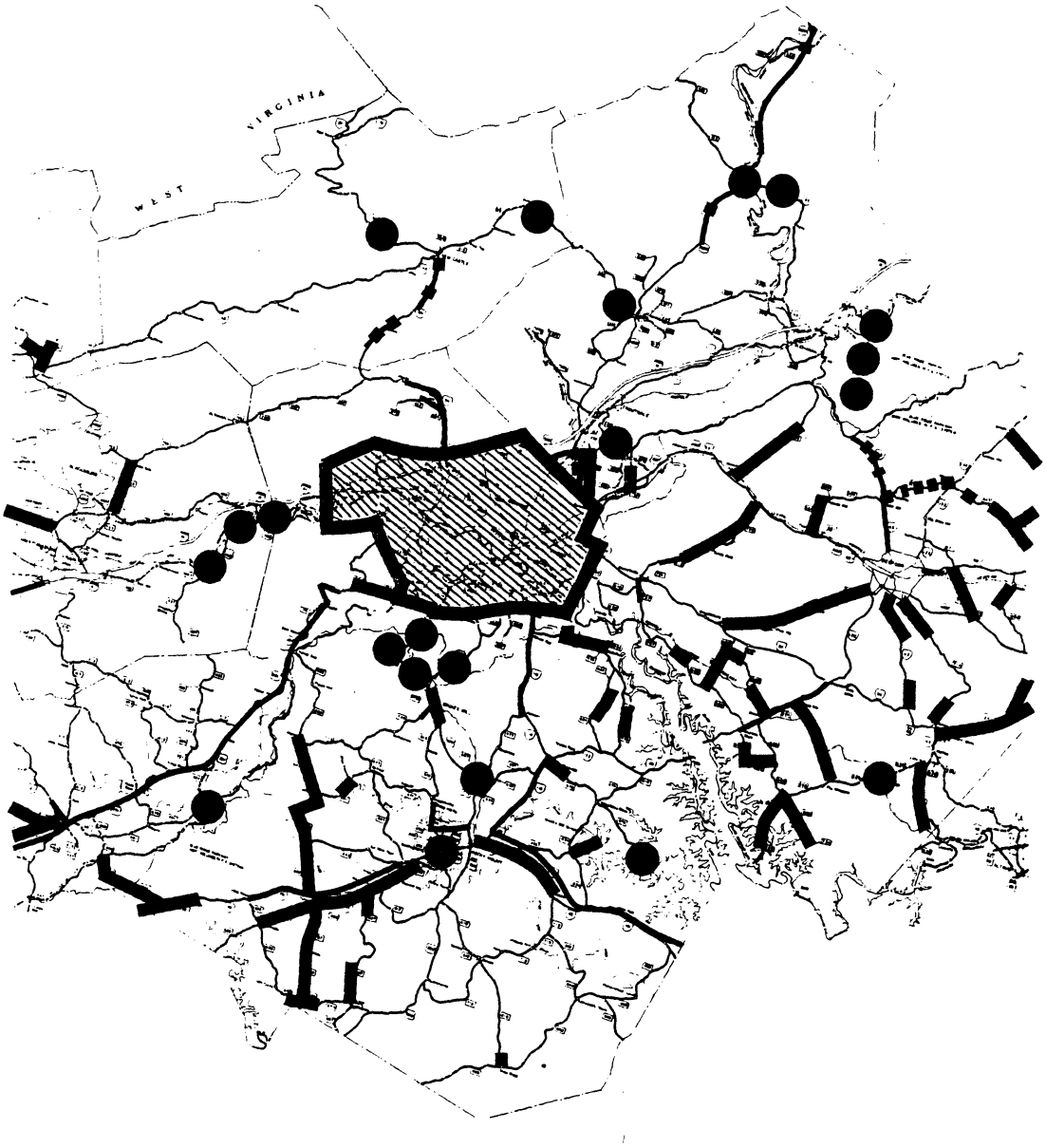
1/ The study recommended the establishment, on a trial basis, of a joint-use park-and-ride facility at the intersection of Route 460 and 311 to be served by an existing bus route.

Figure 2.4
PLANNED ROADWAY IMPROVEMENTS ROANOKE VALLEY TRANSPORTATION IMPROVEMENT PROGRAM
ROANOKE CASE STUDY
Virginia Commuting Study



NORTH

Figure 2.5

PLANNED ROADWAY IMPROVEMENTS
VDH & T'S STATEWIDE PLANNING EFFORT

ROANOKE CASE STUDY
Viriginia Commuting Study

PRESENT DAY RECOMMENDATIONS
EXISTING LOCATION
TSM; BRIDGE REPLACEMENT; SPOT IMPROVEMENT
FUTURE RECOMMENDATIONS

of a downtown transportation terminal with some parking spaces set aside for carpools will foster the ridesharing environment. Additionally, the pool staging lot planned by VDH&T (I-81 at Route 11) and the lot recommended by the Park-and-Ride Study will further help the development of ridesharing as an alternate to driving alone. At present there is no comprehensive ridesharing matching service in the area.

PROBLEMS AND ISSUES

Commuters in the Roanoke Valley Area face problems which revolve primarily around two issues: the lack of alternatives to the single-occupant auto and the travel cost associated with that dependence.

For persons commuting to the Roanoke Valley, the primary travel options consist of the single-occupant auto and informal ridesharing arrangements. No public transit service is available from points outside the Roanoke Valley. There is, however, inter-city bus service provided by private carriers in all of the corridors shown in Figure 2.3 except the Route 116 S corridor. While at first glance this may seem a viable option for long-distance commuters, the scheduled services are oriented to non-work trips by inter-city travelers and are not compatible with daily commute patterns.

The reliance on the private auto is further encouraged by the lack of any organized ridesharing assistance effort directed toward commuters to the Roanoke Valley. The New River PDC and the Greater Lynchburg Transit Company have instituted ridesharing programs covering Montgomery and Bedford Counties, respectively, but these efforts do not cover the Roanoke Valley.

Heavy reliance on the single-occupant auto for commuting to the Roanoke Valley has impacted the level of service on area roadways and congested certain locations during peak periods. As part of its statewide planning work, VDH&T recently identified current and anticipated future roadway deficiencies in the Roanoke area. Deficiencies in this case relate to inadequate capacity and/or sub-standard design characteristics that result in poor operating characteristics. Only the Rte. 311 N and the Rte. 221 S corridors were identified as being in large part deficient. Rte. 311 is a minor commute corridor in terms of travel volumes, but unlike Rte. 221 N and other corridors, has no alternative roadway available.

Within the Roanoke Valley, congestion is largely limited to the Roanoke and Salem CBDs and other spot locations. Congestion in the Roanoke Valley is not extensive and is generally of short duration during the peak periods. The lack of alternatives to the private automobile can be expected to intensify the frequency and extent of such congestion, and thus, increase roadway deficiencies in the future.

For commuters residing in the Roanoke Valley, conditions are not substantially different in terms of modal alternatives. Public transit is available in the Roanoke Valley with Valley Metro (the Greater Roanoke Transit Company) being the primary service provider However, public transit in the Roanoke Valley is not viewed as a viable option by many local residents. The system of ten fixed routes and the basic half-hour service frequency during peak periods results in use of the service primarily by those without an available auto--the so-called transit captive. A recent transit marketing study conducted for the Fifth PDC indicated that approximately 81% of the weekday transit riders were captive (see Figure 2.6).

In 1965, transit served 4% of all person trips in the Roanoke Valley. Since then, transit usage has not kept pace with overall growth in travel, and it is probable that the current modal share for transit is significantly less than 4%. Figure 2.7 shows the pattern of weekday transit trips (in 1978) in the Roanoke Valley of which about 59% are work trips. While Figure 2.7 does not reflect the service being provided to the City of Salem since 1978, it does document the predominant short, local nature of most transit trips with the Roanoke CBD as the major focal point.

As previously stated there is currently no areawide ridesharing assistance in the Roanoke Valley. A few major employers, such as Allstate, Norfolk and Western, and Dominion Bankshares, have attempted at various times to facilitate ridesharing among their employees. Generally, the efforts were low-key and the response very limited. Contributing to this apparent low interest in ridesharing is the fact that travel congestion during peak periods in Roanoke Valley is not severe. Area roadways operate at level of service C or better, except for brief periods of congestion.

Additionally, the availability of free or low cost parking, even in the CBD, tends to reinforce the preference of individuals to drive-alone. As part of a Park-and-Ride Study for the Fifth PDC, a survey of parking downtown found an approximate 4.5% surplus over estimated demand. A limited survey of downtown firms suggests about 12.5% of employees are provided free parking, about 10.5% are provided reduced rate parking (at $8 to $9 per month), and the remaining 77% of employees working downtown pay the market rate ($11 to $22 per month) for parking. These figures suggest an average monthly parking fee of about $13.60 for all employees in the CBD or an average daily rate of only $0.68. This fact has been suggested as a major contributing factor to the low auto occupancy rates observed in the Roanoke Valley.

In spite of the low, downtown, parking charges an experimental downtown circulator/transit shuttle serving low cost parking at the Roanoke Civic Center has enjoyed a measure of success attesting to the concern of area residents over the cost of commuting. As a result of downtown redevelopment plans, the supply of parking is in a state of flux and a temporary shortage is expected to result. After the parking situation reaches equilibrium, it is likely that parking charges in the CBD will increase as a result of a number of surface lots being eliminated. This expected change may offer an opportunity to develop ridesharing alternatives for CBD workers.

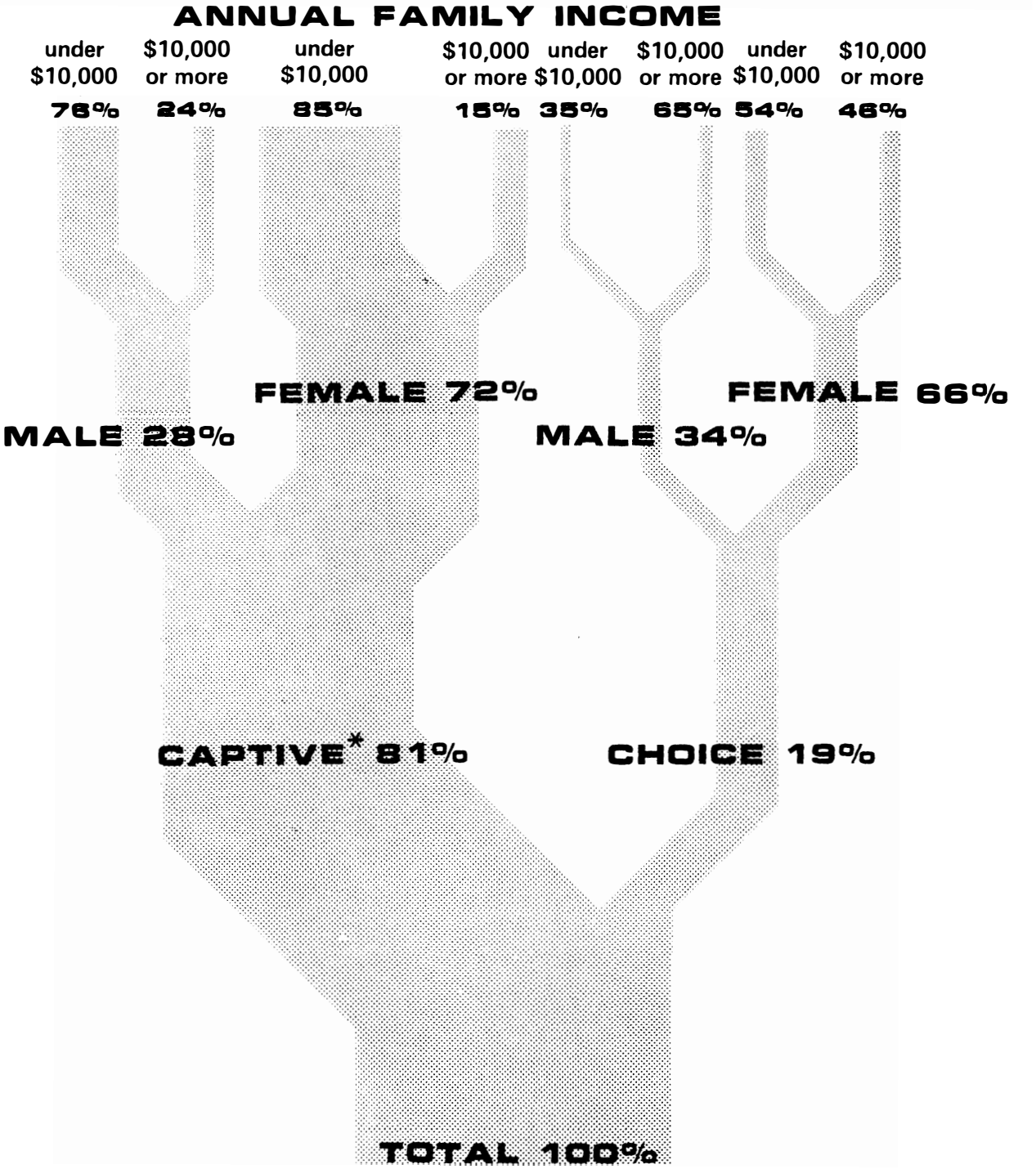
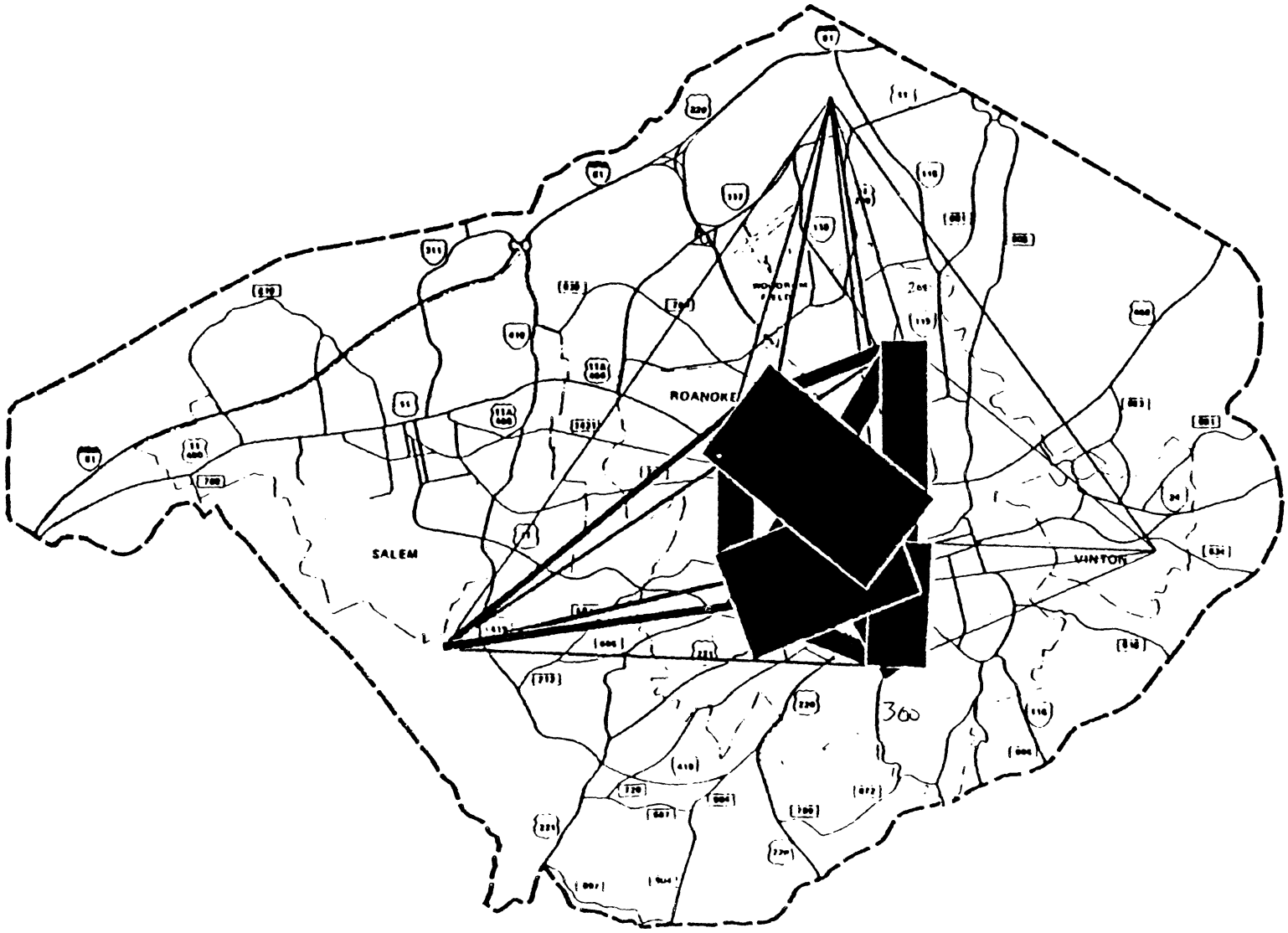


Figure 2.6
CHARACTERISTICS OF CAPTIVE AND CHOICE TRANSIT RIDERS — WEEKDAY

ROANOKE CASE STUDY
Virginia Commuting Study

*CAPTIVE IS DEFINED AS NOT HAVING AN AUTOMOBILE AVAILABLE

SOURCE: TRANSIT MARKET STUDY, SIMPSON & CURTIN FIFTH, PDC, 1978



NORTH

Figure 2.7
WEEKDAY TRANSIT TRIPS

ROANOKE CASE STUDY
Virginia Commuting Study

50 100 150
DAILY TRANSIT TRIPS
(INBOUND ONLY)

SOURCE: TRANSIT MARKETING STUDY,
SIMPSON & CURTIN FIFTH PDC, 1978

The costs of commuting in the Roanoke Valley are in large part determined by the necessity of a second auto for many workers and the price of gasoline. Because there are no significant alternatives to the automobile for work travel in the Roanoke Valley, most households find it necessary to have two (or more) autos. One auto is typically left at home for shopping, personal business, and other trip purposes. The other auto is used by the primary worker (more often than not, driving alone) for the work trip. This represents a significant financial commitment when one considers the maintenance, insurance, fuel, and other costs associated with ownership of a second auto.

The American Automobile Association estimates the annual cost of owning an automobile to be about $3,000. Even for a used car, the annual cost could easily exceed $1,000. While $1,000 annually may not be considered an excessive amount to pay for basic transportation, for many households this represents a poor investment since the auto is idle for significant portions of the typical work day. Further, this cost is largely avoidable if decent transit service or ridesharing alternatives are available. It is this cost and the unstable nature of gasoline prices which is a major problem to commuters in the Roanoke Valley.

DATA BASE

A number of data items are used in the application of the screening criteria and modal summary tables. This section identifies the data sources used and the development of information required by the methodology. Following definition of the commute corridors, an effort was made to collect each of the data items used in the analysis.

The study area includes seven counties, four independent cities, and parts of four different planning district commissions. The Roanoke Valley is also classified as a standard Metropolitan Statistical Area (SMSA), and therefore, information collected by the Bureau of the Census is available at a more disaggregate level than is the case for smaller urban areas. Thus, while the multiple jurisdictions and area classifications provide many data sources, they offer little information on long-distance commuting patterns. While the 1980 Census data on travel promises to eliminate this deficiency, that information is not yet available. The major data sources on travel characteristics in the Roanoke Valley are identified in Table 2.2.

Primarily due to the size of the case study area, there was little or no data available on the length of commuting trips. While the travel demand estimates maintained by the VDH&T were available, the mechanism of handling work trips originating outside the Roanoke Valley does not provide a complete trip length distribution pattern. Lacking any better information, a default trip length distribution from the Methodology Report was used in the corridor analysis.

Table 2.2
MAJOR DATA SOURCES ON TRAVEL PATTERNS AND CHARACTERISTICS
ROANOKE CASE STUDY

1980 Census of Population and Housing, Advance Reports -- U.S. Department of Commerce, Bureau of the Census

1970 Census of Population and Housing -- U.S. Department of Commerce, Bureau of the Census

Roanoke Valley Area Thoroughfare Plan, 1976 -- Virginia Department of Highways and Transportation

Roanoke Valley Area Transportation Plan, 1975-1995 -- Virginia Department of Highways and Transportation

MPO Establishment List For the Roanoke SMSA, 1978 -- obtained from Virginia Department of Highways and Transportation

County Business Patterns, Virginia 1979 -- U.S. Department of Commerce, Bureau of the Census

1977 Per Capitia Income in the United States -- U.S. Department of Commerce, Bureau of the Census

Roanoke Valley Area Socioeconomic Data 1979 and 1995 -- Virginia Department of Highways and Transportation

Roanoke Valley Area Data Maintenance Report, 1980 -- Fifth Planning District Commission

Park and Ride Feasibility Study, 1981 -- Fifth Planning District Commission

Transit Marketing Study, 1978 -- Fifth Planning District Commission

Statewide Transportation Facilities Inventory ..., 1981 -- Virginia Department of Highways and Transportation

Roanoke Valley Regional Area Traffic Volume Counties, 1981 -- Virginia Department of Highways and Transportation

Norfolk and Western Employee Residence by Zip Code, 1981 -- Norfolk and Western Railway Company

Summary Report, Comprehensive Plan -- Roanoke County, Virginia

United Transportation Work Program, FY 1982 -- Roanoke Valley Area

Transportation Improvement Plan FY 1981 -- Roanoke Valley Area

In the Methodology Report, procedures are identified for initially assessing the potential viability of the major modal options (Modal Screening Criteria). This inital assessment is made on the basis of four items--corridor volumes, CBD employment, residential density, and corridor length. Those modal options identified as potentially successful are analyzed in more detail using the Modal Summary Tables from the Methodology Report. Application of the modal summary tables requires the use of distributions covering: household income, employment concentrations, type of employment, and work trip length. While default distributions are available for each of the above data items, the use of local data, if available, is strongly advised. Below, the data sources and assumptions used in calculating in the required items are identified.

Corridor Volumes. One-way, peak direction, peak hour person trip volumes are used in the screening criteria. This information was derived by factoring 24-hour vehicle and transit trips to approximate one-way, peak hour, peak direction person trips. The factors used were: 10% (24-hour vehicle trips to peak hour vehicle trips), 60% (peak direction volume in the peak hour), 1.2 (average auto occupancy), and 12.6% (peak direction, peak hour factor for 24-hour transit trips). 1981 traffic counts for the Roanoke Valley conducted by VDH&T and a recent transit marketing study for the Fifth PDC were used as base counts for factoring.

CBD Employment. CBD employment is used in the initial screening of transit options to determine which modes should be further analyzed using the modal summary tables. The Roanoke CBD was defined as Traffic Analysis Zones (TAZs) 1 and 2 of the VDH&T zone system. Employment by TAZ was available from the planning data maintained by the Fifth PDC. Additionally, VDH&T supplied a list (and mapping) of firms with 50 or more employees which could be used in more detailed ridesharing analysis.

Residential Density. Residential density in terms of dwelling units per residential area is used in the screening criteria to assess modal applicability. This information is also used in some of the modal analysis tables. The information necessary to derive this measure was obtained from the Fifth PDC planning data base. Information on residential density outside the Roanoke Valley was not available, but did not affect the application of the methodology.

Corridor Length. Corridor length is used in the modal screening criteria as an additional check on the potential viability of the transit options. If travel volumes or residential densities are not maintained over some reasonable distance, it is probable that insufficient trips would be attracted to justify that mode. For the ridesharing modes, corridor length is interpreted as the minimum trip length at which the individual ridesharing modes are likely to be successful.

Household Income. Household income stratified by high, medium, and low ranges is used in the application of the modal summary tables. Income distribution can be on an aggregate basis (e.g., SMSA) or a disaggregate basis (TAZ). For the Roanoke Case Study, 1970 income distributions at the city

and county level were updated to approximate 1980 distributions using the ratio of 1970 and 1977 per capita income to deflate the range values.

Employment Concentration. The distribution of area employees by firm size is used in the application of the modal summary tables. This information was obtained from two independent sources. The Census publication, County Business Patterns, 1979-Virginia was used to establish firm size distributions for Roanoke County, the City of Roanoke, and the City of Salem. The listing of establishments with 50 or more employees supplied by VDH&T was used to establish the firm size distribution for the Roanoke CBD.

Type of Employment. Classification of the workforce into white collar, retail, and blue collar workers is used in the application of the modal summary tables. The Roanoke Valley Thoroughfare Plan represents the latest available source for this data. Using the projections for 1985, distributions were established for the Roanoke CBD and areawide. While the projections were made in 1969, they represent only a modest change from observations made in 1965 and were judged to be an improvement over the use of default data.

Work Trip Length. This is an important data item in the application of both the screening criteria and the modal summary tables. Regional trip length data was limited to that implicit in the travel matrices provided by the VDH&T. A problem in working with this data is that all trips produced externally are "loaded" at stations on the edge of the Roanoke Valley highway network, thereby providing no information on the total length of these trips. While this is the typical means of handling external trip productions, this method does not produce a trip length distribution usable for this study. As a result the default work trip length distribution was used.

INITIAL SCREENING OF MODAL OPTIONS

The initial screening of modal options is an important step in the case study methodology. Its primary purpose is to identify those travel options which most probably would not be viable for the area being analyzed. The screening criteria are not intended to be an absolute measure of a mode's potential but rather an aid to the analyst in deciding whether to apply the modal summary tables for a particular mode.

The screening criteria encompass four interrelated measures--corridor volume, residential density, employment, and corridor length. Corridor volume (one-way, peak hour, peak direction person trips) is important at both the maximum load point and at the end of the minimum facility length (corridor length). Corridor residential density (in dwelling units per acre) is assessed for the minimum facility length. Employment is not directly related to the other measures but serves as a gauge of the "critical mass" at the destination

end that is required to support a modal option. The following paragraphs summarize the results of applying the screening criteria to the Roanoke study area.

Table 2.3 summarizes the values used in the application of the screening criteria to the corridors in the study area. In terms of peak hour, peak direction person trips, only the I-81/581 Northeast and Rte. 220 South corridors have volumes sufficient to consider any of the express transit modes. Both corridors exceed the minimum person trip volume criteria for express bus. The minimum facility length for express bus is given as five miles in the Methodology Report. The person trip volume at that point should also be considered as a further indication of the potential market. In both of the corridors meeting the peak load point volume criteria, the volume at five miles from the CBD is approximately half of that at the maximum load point. The rate of traffic decay over distance is not unusually high and it would appear that based on the volume criteria, neither corridor should be rejected for consideration of express bus service.

Net residential density in the Roanoke Valley is shown in Figure 2.8. Of the two corridors which meet the minimum volume criteria for express bus, neither corridor has a residential density of 3 dwelling units per acre (du/acre). The I-581 corridor comes closest at 2.65 du/acre, but as the corridor follows I-81 North, the residential density further decreases. The residential density for the Rte. 220 South corridor is less than half that required to consider express bus service. Of those corridors which meet the residential density requirement, the I-81/Rte. 460 SW corridor has the highest person trip volume. The rate of traffic decay from the maximum load point to a point five miles from the CBD is also substantially less than that of the I-581 N and Rte. 220 S corridors. However, even at the maximum load point, the person trip volume for the I-81/Rte. 460 SW corridor is about 40% less than that necessary for consideration of express bus service.

CBD employment was obtained from the planning and land-use data base maintained by the Fifth Planning District Commission. The latest available estimate of CBD employment (encompassing VDH&T Traffic Analysis Zones 1 and 2) was 13,191 for 1980. This figure is well below the employment base required for consideration of express transit services and tends to reinforce the conclusions of the volume criteria.

The corridor length criteria from the screening tables is actually applied as part of the residential density and corridor volume criteria and hence requires no further analysis.

Based on the application of the screening criteria, it is clear that none of the express transit modes are likely to be viable in the Roanoke Valley. While certain corridors meet the volume criteria or the residential density criteria for express bus, no corridor meets both. Additionally, the limited employment in the Roanoke CBD is far below that suggested for express bus, further arguing against the applicability of express bus service. The application of the Screening Criteria for Modal Options clearly and convincingly suggest

Table 2.3
SCREENING CRITERIA VALUES BY CORRIDOR

Corridor	Corridor Volume[1/] At Maximum Load Point	5-Mile Radius	At Residential Density	Net CBD Employment	Corridor Length
Rte. 220/11 North	1500	1200	1.68	13,200	>10 miles
I-81/581 Northeast[2/]	3400	1700	2.65	13,200	>10 miles
Rte. 460/221 Northeast	2200	1300	1.86	13,200	>10 miles
Rte. 24 East	1850	750	3.36	13,200	>10 miles
Rte. 116 Southeast	500	300	N/A[3/]	13,200	>10 miles
Rte. 220 South	3150	1500	1.47	13,200	>10 miles
Rte. 221 South	1000	900	3.84	13,200	>10 miles
I-81/Rte.460 Southeast	1800	1550	3.50	13,200	>10 miles
Rte. 311 North [4/]	550	550	1.27	13,200	>10 miles

1/ Peak hour, peak direction person trips.

2/ Volumes are for I-581; I-581 serves both I-81 SW and I-81 N corridors, volume for I-81 N is 1300 at maximum load point.

3/ Not Available

4/ Volumes are for Rte. 311 at junction with Rte. 419; corridor does not extend into the City of Roanoke.

Figure 2.8
NET RESIDENTIAL DENSITY
ROANOKE CASE STUDY
Virgini[redacted]muting Study

DWELLING UNITS PER ACRE
0 - 2.9
3 - 5.9
6 - +
5 MILE CONTOUR

that the modal options for the Roanoke Valley should be limited to the ridesharing modes (carpool, vanpool and buspool).

APPLICATION OF MODAL SUMMARY TABLES

Based on application of the screening criteria, the modal options analyzed would normally be limited to Carpool, Vanpool, and Buspool. In this case study, Express Bus will be included in the analysis as a check of the consistency between the screening criteria and the modal summary tables. This step would not be included in the normal application of the methodology.

Within the Roanoke Valley, four destinations were identified for analysis. These destinations were: Roanoke County, the City of Salem, the City of Roanoke, and the Roanoke CBD. For each of these destinations total employment, and distributions for employment concentration and type of employment were developed using the data sources identified earlier. These distributions are documented in Table 2.4.

The best available information on work trip patterns for the study area is the 1970 census tabulation of work/residence location. A supplemental source is the 1981 residence location of Norfolk and Western employees by zip code. A third source of travel patterns is the travel demand information maintained by VDH&T (available for years 1965 and 1995). A comparison of these data sources revealed substantial agreement between the Census and VDH&T information and a wide divergence between the N&W zip code information and the other sources. Based on this review, it was judged that the N&W data was not representative of total work travel patterns in the Roanoke Valley and that the 1970 Census information represented the most appropriate base data. This information had the advantage over the VDH&T data of identifying the specific origin of long-distance trips from outside the transportation study area, making it possible to use income data available at the county level. The 1970 commuter pattern identified by the Bureau of the Census is given in Table 2.5.

Table 2.6 shows the estimated 1980 commuter patterns. Basically, the 1970 travel pattern was adjusted to reflect 1980 employment in the Roanoke Valley and growth in the number of households throughout the case study area between 1970 and 1980. A FRATAR type matrix updating procedure was used with 1980 employment in the Roanoke Valley and growth in households (by county) as controlling variables.

The identification of trip origins allows the use of county-specific income information in conjunction with the destination-specific data identified in Table 2.4. In order to maintain the ability to present results by corridor, an allocation of trip origins to commute corridors was required. An allocation of trips by origin county to various corridors was obtained by attempting to

Table 2.4
1980 WORK TRIP DESTINATION CHARACTERISTICS

	Roanoke County	City of Salem	City of Roanoke	Roanoke CBD
No. of Employees	16,609	19,848	56,054 1/	13,191
Worksite Size (%)				
1-100 employees	59.2	51.0	52.4	62.6
100-500 employees	27.9	26.3	25.9	14.7
500-1000 employees	12.9	12.5	9.0	11.0
1000+ employees	--	10.2	12.7	11.7
Type of Employment (%)				
White Collar	49.8	49.8	49.8	59.7
Blue Collar	50.2	50.2	50.2	40.3

1/ This total includes employees working in the CBD.

Table 2.5
1970 IN-COMMUTING TO ROANOKE VALLEY[1/]

Trip Origin	City of Salem	City of Roanoke	Roanoke County	Roanoke Valley Totals
Bedford County	80	1,517	625	2,222
Bedford City	12	62	13	87
Botetourt County	266	1,437	1,252	2,955
Craig County	43	25	354	422
Floyd County	72	208	110	390
Franklin County	50	762	693	1,505
Montgomery County	212	308	668	1,188
Radford City	12	22	26	60
Elsewhere	103	473	247	798
Total In-commuters	850	4,814	3,988	9,627

1/ Number of employees, based on the 1970 Census, Work-Residence Location.

Table 2.6
ESTIMATED 1980 IN-COMMUTING TO ROANOKE VALLEY[1/]

	City of Salem	City of Roanoke	Roanoke County	Roanoke Valley Totals
Bedford County	174	2,066	959	3,199
Bedford City	20	67	15	102
Botetourt County	502	1,688	1,657	3,847
Craig County	74	27	428	529
Floyd County	126	228	136	490
Franklin County	102	961	986	2,049
Montgomery County	410	371	906	1,687
Radford City	18	23	29	70
Elsewhere	184	502	312	998
Total In-commuters	1,610	5,933	5,428	12,971

1/ Number of employees, based on 1970 commuting patterns, household and employment growth in the case study area.

match the 1965 work trip volumes at external stations (from the Roanoke Valley Area Thoroughfare Plan) with the 1970 commute information from the Census. The resulting allocations and 1980 employee trip totals by corridor are given in Table 2.7.

Income distribution for each political jurisdiction was based on 1970 income as reported by the Bureau of the Census and growth in per capita income (by jurisdiction) between 1970 and 1977. The growth in per capita income was used to adjust the cutoff points used in calculating income distribution by jurisdiction. The results of this procedure are shown in Table 2.8.

In using the default trip length distribution some adjustments were made on the basis of the specific origin and destination patterns. Specifically, the default distribution was truncated to approximate the distributions resulting from travel between particular origins and destinations. For instance, travel distances between Montgomery County and the City of Roanoke exceed five miles in all cases. Therefore, the trip length distribution used for that particular origin/destination pair would range from 6 to 25+ miles. Similarly, travel within the City of Salem would not exceed five miles.

At this point, all of the information required for application of the methodology has been developed. The market size and corridors used for various origin and destination pairs have been defined, as have the income characteristics (at the origin end of the trip) and the employment concentration and type at the destination end. The next step is the actual application of the modal summary tables from the Methodology Report for Carpool, Vanpool and Express Bus (Tables 2.9, 2.10, and 2.11) to the identified travel markets.

In applying the modal summary tables, a series of adjustment factors are calculated based on the income, employment concentration, type of employment, and work trip length characteristics of the case study area. For example, the proportional adjustment factors for carpool in a medium-sized urban area are 1.244, 0.829, and 0.993 for low, medium, and high income levels, respectively (see Table 2.9). The distribution of household incomes for Bedford County was calculated to be 0.27, 0.57, and 0.16 for low, medium, and high income levels, respectively. The income adjustment factor for carpools originating in Bedford County would be calculated as:
1.244 * 0.27 + 0.829 * 0.57 + 0.993 * 0.16 = 0.96729 or 0.967

Similar calculations are made to determine the adjustment factors for employment concentration, type of employment, and work trip length. These calculations are required for each origin/destination pair.

Tables 2A.1, 2A.2, and 2A.3 in the appendix of this report document the adjustment factors for Carpool, Vanpool/Buspool and Express Bus. These adjustment factors are calculated independently of the market size and are used to adjust the basic market share for each mode. The carpool income adjustment factor for trips originating in Bedford County was calculated to be 0.967. Similarly, for Bedford County trips destined to the Roanoke CBD, the following adjustment factors would apply--Firm Size (0.915), Employment Type (0.966) and Work Trip Length (1.35). These adjustment factors would be

Table 2.7
1980 ALLOCATION OF EMPLOYEE TRIPS TO CORRIDORS

Corridor	Origin County	Destination City of Salem	Destination City of Roanoke	Destination Roanoke County	Corridor Total
Rte. 220 N	Botetourt (38%) 1/	191	641	630	1462
I-81 NE	Botetourt (37%)	186	624	613	1423
Rte. 460 NE	Botetourt (25%) Bedford (66%)	254	1830	1057	3141
Rte. 24 E	Bedford (34%)	66	725	331	1122
Rte. 116 S	Franklin (20%)	21	192	197	410
Rte. 220 S	Franklin (70%)	71	673	690	1434
Rte. 221 S	Franklin (10%) Floyd (100%)	136	324	235	695
I-81 SW	Montgomery (100%)	428	394	935	1757
Rte. 311 N	Craig (100%)	74	27	428	529

1/ Allocation based on comparison of 1965 trip patterns and 1970 Census information.

Table 2.8
1980 INCOME DISTRIBUTIONS FOR THE ROANOKE CASE STUDY[1/]

	Bedford	Botetourt	Craig	Floyd	Franklin	Montgomery	Roanoke	City of Roanoke	City of Salem
LOW	.27	.23	.33	.39	.32	.26	.12	.28	.15
MIDDLE	.57	.50	.58	.51	.54	.53	.51	.54	.56
HIGH	.16	.27	.09	.10	.14	.21	.37	.18	.29
1977 Per Capita Income	$4555	$5089	$4090	$4378	$4264	$4843	$6536	$5590	$5816

[1/] Approximate distribution based on 1970 Census and 1977 Per Capita Income Estimates.

Table 2.9
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
Socioeconomic Section	Proportional Adjustment Factors		
Residential Density			
Low (less than 3 d.u./acre)			
Medium (3-6 d.u./acre)			
High (over 6 d.u./acre)			
Household Income			
Low		1.244	
Medium		.829	
High		.993	
Employment Concentration			
1-100 employees		.674	
101-500 employees		1.004	
500-1,000 employees		1.004	
1,000 + employees		2.009	
Type of Employment			
Office (White Collar)		1.069	
Retail		1.069	
Blue Collar		.813	
Work Trip Length			
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 2.10
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
Socioeconomic Section	Proportional Adjustment Factors		
Residential Density			
Low (less than 3 d.u./acre)			
Medium (3-6 d.u./acre)			
High (over 6 d.u./acre)			
Household Income			
Low			
Medium			
High			
Employment Concentration			
1-100 employees		.382	
101-500 employees		2.041	
500-1,000 employees		1.967	
1,000 + employees		.765	
Type of Employment			
Office (White Collar)		1.136	
Retail		1.136	
Blue Collar		.632	
Work Trip Length			
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	Low	Normal	High
Vanpool Encouragement[1/]			
Owner operated	1.00	1.00	1.00
Promotion/information	1.00	2.11	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 2.11
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
Socioeconomic Section	Proportional Adjustment Factors		
Residential Density			
Low (less than 3 d.u./acre)			
Medium (3-6 d.u./acre)			
High (over 6 d.u./acre)			
Household Income			
Low		.863	
Medium		1.062	
High		1.072	
Employment Concentration			
1-100 employees			
101-500 employees			
500-1,000 employees			
1,000 + employees			
Type of Employment			
Office (White Collar)		1.119	
Retail		1.119	
Blue Collar		.678	
Work Trip Length			
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.

combined with the basic carpool mode share (19% or 0.19) to derive the specific mode share applicable to work trips from Bedford County to the Roanoke CBD. This O/D specific mode share is calculated as:
(Basic Mode Share * Income Adj. * Firm Size Adj. * Employment Type Adj. * Work Trip Length Adj.)
0.19 * 0.967 * 0.915 * 0.966 * 1.35 = .219 or 21.9%

Tables 2.12, 2.13, 2.14, and 2.15 document the calculated mode shares and modal usage estimates for each travel destination. Note that the "normal" mode share has been used in all cases since there was no tangible evidence that the "low" or the "high" mode shares were more appropriate.

Results And Conclusions

In summarizing the results of the modal analysis on a corridor basis, a series of logical checks were made. First, if the absolute number of person trips estimated for vanpools between a particular origin-destination pair was below the minimum vanpool occupancy (7 persons), those person trips were deleted from the vanpool share and added to the carpool share. The reasoning behind this adjustment is that if vanpooling is not available in a specific O-D market, another ridesharing alternative (carpooling) would be attractive to potential vanpoolers. This adjustment is consistent with the additive nature of the ridesharing modal estimates.

Second, a similar check was made against the carpool estimate and any O-D market with less than 2 carpool person trips (the minimum carpool occupancy) was considered as drive alone trips.

Third, the vanpool minimum occupancy check was applied again as trips were allocated to corridors. That is, if the total vanpool share between a specific origin and destination was estimated to be 10 person trips and these trips were equally split between two travel corridors, neither corridor-specific travel market would have sufficient vanpool person trips to meet the minimum vanpool occupancy. This adjustment reflects a general hypothesis that vanpools are available only to trips sharing the same origin and destination. This hypothesis seems appropriate considering the county/city definition of origins and destinations.

Fourth, using the same reasoning, a check against the minimum carpool occupancy by contractor was made. A similar minimum occupancy check for express bus service was not applied since all trips were, by definition, to a common destination (the Roanoke CBD), and it was felt that use of private autos as a local access mode to bus service would allow individuals to take advantage of corridor-based express service.

Table 2.16 summarizes by corridor the results of the current year modal analysis and the daily, one-way person work trips entering the Roanoke Valley. Table 2.17 presents similar results for work trips entering the City of Roanoke. The person trips were rounded to the nearest whole number.

Table 2.12
1980 MARKET ANALYSIS SUMMARY SHEET--ROANOKE COUNTY DESTINATIONS

Commuter Market/Mode	Bedford	Botetourt	Craig	Floyd	Franklin	Montgomery	Roanoke	City of Roanoke	City of Salem	Subtotal
Market Size one-way work trips 1/	828	1,408	364	116	838	795	5,324	3,680	765	14,118
Carpool (%)	14.0	14.0	14.2	14.5	14.2	14.0	12.5	11.9	11.5	12.7
person trips	116	197	52	17	119	112	663	436	88	1,800
Bus/Vanpool (%)	1.9	1.9	1.9	1.9	1.9	1.9	1.2	1.2	1.0	1.4
person trips	15	26	7	2	16	15	64	44	8	197
Express Bus (%) person trips	Not Analyzed									
Total Ridesharing (%)	15.8	15.8	16.2	16.4	16.1	16.0	13.7	13.0	12.5	14.1
person trips	131	223	59	19	135	127	727	480	96	1,997
Total Transit (%) person trips	Not Analyzed									

1/ daily one-way person work trips.

Table 2.13
1980 MARKET ANALYSIS SUMMARY SHEET--CITY OF SALEM DESTINATIONS

Commuter Market/Mode	Bedford	Botetourt	Craig	Floyd	Franklin	Montgomery	Roanoke	City of Roanoke	City of Salem	Subtotal
Market Size one-way work trips[1/]	165	427	63	107	87	364	6,074	4,179	5,405	16,871
Carpool (%)	26.1	26.1	22.2	22.8	26.6	22.0	13.3	13.8	10.4	13.3
person trips	43	112	14	24	23	80	806	576	561	2,239
Bus/Vanpool (%)	5.1	5.1	3.4	3.4	5.1	3.4	1.1	1.1	0.4	1.1
person trips	8	22	2	4	4	12	63	44	23	182
Express Bus (%) person trips	Not Analyzed									
Total Ridesharing (%)	30.9	31.4	25.4	26.2	31.0	25.3	14.3	14.8	10.8	14.4
person trips	51	134	16	28	27	92	869	620	584	2,421
Total Transit (%) person trips	Not Analyzed									

1/ daily one-way person, work trips.

Table 2.14
1980 MARKET ANALYSIS SUMMARY SHEET--CITY OF ROANOKE DESTINATIONS (EXCLUDES CBD)

Commuter Market/Mode	Bedford	Botetourt	Craig	Floyd	Franklin	Montgomery	Roanoke	City of Roanoke	City of Salem	Subtotal
Market Size one-way work trips 1/	1,379	1,091	18	147	621	255	10,571	20,738	1,613	36,433
Carpool (%)	22.4	22.4	27.1	27.8	22.8	26.8	13.0	13.5	13.0	14.3
person trips	308	244	5	41	141	68	1,377	2,805	210	5,199
Bus/Vanpool (%)	2.6	2.6	3.9	3.9	2.6	3.9	0.6	0.6	0.6	0.8
person trips	35	28	1	6	16	16	67	132	10	305
Express Bus (%) person trips	Not Available									
Total Ridesharing (%)	24.9	24.9	33.3	32.0	25.3	30.6	13.7	14.2	13.6	15.1
person trips	343	272	6	47	157	78	1,444	2,937	220	5,504
Total Transit (%) person trips	Not Available									

1/ daily, one-way person, work trips

Table 2.15
1980 MARKET ANALYSIS SUMMARY SHEET--ROANOKE CBD DESTINATIONS

Commuter Market/Mode	Bedford	Botetourt	Craig	Floyd	Franklin	Montgomery	Roanoke	City of Roanoke	City of Salem	Subtotal
Market Size one-way work trips 1/	434	343	5	47	196	80	3,245	6,367	496	11,213
Carpool (%)	21.9	22.0	26.5	31.9	26.6	30.7	13.3	13.3	12.8	14.3
person trips	95	75	1	15	52	25	432	844	63	1,602
Bus/Vanpool (%)	2.3	2.3	3.5	4.4	3.5	4.4	0.7	0.6	0.6	0.8
person trips	10	8	--	2	7	4	23	36	3	93
Express Bus (%)	16.6	16.7	15.4	15.2	15.4	15.6	11.0	10.1	10.4	11.0
person trips	72	57	1	7	30	12	357	642	51	1,229
Total Ridesharing (%)	24.2	24.2	20.0	36.2	30.1	36.3	14.0	13.4	13.3	15.1
person trips	105	83	1	17	59	29	455	880	66	1,695
Total Transit (%)	16.6	16.7	15.4	15.2	15.4	15.6	11.0	10.1	10.4	11.0
person trips	72	57	1	7	30	12	357	642	51	1,229

1/ daily, one-way person work trips.

Table 2.16
1980 PERSON WORK TRIPS ENTERING THE ROANOKE VALLEY[1/]

Corridor	Drive Alone	Carpool	Vanpool	Express Bus
Rte. 220 N	944	247	29	22
I-81 NE	921	240	28	21
Rte. 460 NE	2016	543	47	62
Rte. 24 E	723	196	12	24
Rte. 116 S	271	71	--	6
Rte. 220 S	928	249	22	21
Rte. 221 S	434	147	--	10
I-81 SW	1156	289	37	12
Rte. 311 N	368	74	7	1

1/ daily one-way person work trips entering the Roanoke Valley.

Table 2.17
1980 PERSON WORK TRIPS ENTERING THE CITY OF ROANOKE[1/]

Corridor	Drive Alone	Carpool	Vanpool	Express Bus
Rte. 220/11 N	2773	502	25	95
I-81/581 NE	1526	302	17	56
Rte. 460 NE	1643	433	37	78
Rte. 24 E	1910	370	20	69
Rte. 116 S	492	100	--	17
Rte. 221 S	2050	404	21	72
Rte. 220 S	1982	369	10	65
I-81/460 SW	4197	730	41	135

1/ daily one-way person work trips entering the City of Roanoke

Without further analysis it is apparent that the potential of express bus service is very limited. Although, the total number of transit trips approaches 600 daily one-way trips or 15 vehicle trips, these trips are dispersed over eight corridors and a 24-hour time period. Even without converting these figures to peak hour volumes, one can see that it would be inadvisable to attempt such a limited service. This conclusion is in accord with that reached in the application of the initial screening criteria. Given this conclusion as to the infeasibility of express bus service, the estimated transit trips were distributed to the remaining non-transit modes (drive-alone, carpool and vanpool) in proportion to their estimated usage. This adjustment reflects expected usage assuming express bus service is not available.

In order to determine the appropriateness of supplemental TSM actions and evaluate the extent of ridesharing (assuming no express bus service) the results of the modal analysis were converted to peak-hour, peak-direction trips. This was done by applying a peaking factor of 0.36 to the estimated daily one-way person trips by mode. Tables 2.18 and 2.19 present the estimated peak hour, peak direction person trips by mode entering the Roanoke Valley and the City of Roanoke respectively.

Approximately 17% of the person work trips entering the City of Roanoke during the peak hour are estimated to use a ridesharing mode (carpool or vanpool). The primary ridesharing mode is the carpool, accounting for about 95% of the ridesharing person trips. Use of vanpool for the trip to work is expected to be minimal (less than 1% of work trips entering the city). These findings are generally consistent with observations of travel patterns in the Roanoke Valley.

Approximately twelve hundred person work trips are estimated to enter the city during the peak hour using carpools. The carpool trips are fairly evenly distributed over the eight commute corridors into the city with the heaviest concentration being in the I-81/Rte. 460 SW Corridor. The Rte. 460 NE Corridor is estimated as having the highest percentage of person trips in a ridesharing mode (22%); this is probably due to the high proportion of trips in this corridor originating outside the Roanoke Valley. As would be expected, the percentage of ridesharing trips is higher at the Roanoke Valley cordon line (22.5%) than it is at the City of Roanoke cordon line (17%).

Validation

Unfortunately, there is no observed data available for the Roanoke Valley which can be used to check the accuracy of the estimates produced by the modal summary tables. The trends indicated by the modal estimates generally seem reasonable for a medium-sized area where parking is not expensive and congestion is not widespread. Average vehicle occupancies associated with the modal estimates can be derived by dividing the modal person trip estimate by the average occupancy of the appropriate mode (carpool = 2.5, vanpool = 12). The average vehicle occupancy implied by the modal estimates are: 1.11 for work trips entering the City of Roanoke and

Table 2.18
1980 PEAK HOUR PERSON TRIPS ENTERING THE ROANOKE VALLEY[1/]

Corridor	Drive Alone	Carpool	Vanpool	Total
Rte. 220 N	346	91	11	448
I-81 N	337	88	10	435
Rte. 460 NE	743	200	17	960
Rte. 24 E	267	72	7	346
Rte. 116 S	99	26	--	125
Rte. 221 S	340	91	8	439
Rte. 220 S	159	54	--	213
I-81 SW	420	105	13	538
Rte. 311 N	133	27	7	167
Total	2,844	754	73	3,671

1/ one-way, peak hour, person work trips.

Table 2.19
1980 PEAK HOUR PERSON TRIPS ENTERING THE CITY OF ROANOKE[1/]

Corridor	Drive Alone	Carpool	Vanpool	Total
Rte. 220/11 N	1,027	186	9	1,222
I-81/581 NE	566	112	7	685
Rte. 460 NE	613	162	14	789
Rte. 24 E	708	137	7	852
Rte. 116 S	182	37	--	219
Rte. 220 S	759	150	8	917
Rte. 221 S	733	136	7	876
I-81/Rte. 460 SW	1,552	270	15	1,827
Total	6,140	1,190	67	7,397

1/ One-way peak hour work trips

1.16 for work trips entering the Roanoke Valley. In the 1970 census, the means of transportation is given for workers in the Roanoke SMSA. The average vehicle occupancy for work trips in the SMSA is estimated as 1.19. It should be noted that the 1970 Census information is based on pre-oil crisis conditions, one would expect the average vehicle occupancy to have increased somewhat since then. By comparison, the estimate produced by the modal summary tables would appear low.

MODAL ALTERNATIVES

Based on the analysis of the major modal options, the ridesharing modes appear to hold the most promise for the alleviation of long-distance commuting problems. Table 2.18 presents the expected modal usage assuming no express bus service and no largescale ridesharing assistance efforts are undertaken by employers or governmental entities. Of the Supplemental TSM Actions identified in Table 13 of the Methodology Report, the estimated ridesharing volumes are insufficient to warrant any of the capital intensive options except for pool staging lots (see Table 14 of the Methodology Report).

The available alternatives consist of a variety of individual elements which are generally supportive of ridesharing efforts. Perhaps the most important of these individual elements is the formation of a Ridesharing Matching Program. It is in large measure the availability of a matching program which acts as a catlyst in the realization of the benefits of other supportive actions.

Two such supportive actions have been previously investigated for the Roanoke Valley. One element is the development of a multimodal transportation center in the CBD providing free parking for 105 high-occupancy vehicles. The other element is the construction of one or more pool staging lots serving vehicles entering the Roanoke Valley. The impact of the free parking for HOVs in the CBD can be estimated using the sensitivity tables provided in the Methodology Report. No mechanism is available for estimating the impact of pool staging lots.

Table 2.20 identifies the alternative programs analyzed for the Roanoke Case Study. The first alternative consists of a Level Two Ridesharing program, the Free HOV parking in the CBD and pool staging lots. The Alternative Two substitutes a Level Three Ridesharing Program for the Level Two program of the first alternative. The free parking in the CBD and the pool staging lots are retained. The third alternative consists only of a Level Four Ridesharing Program. Pool staging lots and HOV parking cost incentives are included by definition in a Level Four program and these require no separate analysis. A Level One Ridesharing program is not included among the alternatives analyzed. The reasoning behind this exclusion is that the Level One program is basically intended as a minimal cost program designed to maintain public

Table 2.20
ALTERNATIVE RIDESHARING PROGRAM

Null Alternative --	This alternative basically consists of maintaining the status quo; that is no ridesharing advertising/assistance program is adopted. The implementation of the proposed Multi-Modal Transportation Center in the CBD with 105 spaces reserved for HOVs is assumed as is the construction of a limited number of pool staging lots. These actions while generally supportive of ridesharing are not expected to materially affect mode usage.
Alternative One --	A Level Two Ridesharing Assistance Program would be implemented as described in the Methodology Report. Areawide matching services are made available and approximately 11% of area workers are exposed to vanpool promotion effects through their employers (see text for details). The pool staging lots and 105 HOV parking spaces in the CBD described in the Null Alternative are also included on this program.
Alternative Two --	A Level Three Ridesharing Assistance Program is assumed implemented for the Roanoke Valley in place of the Level Two program of Alternative One. The level of exposure through employers for vanpool programs is assumed to be 36% of employment in the Valley. This increased (over Alternative One) exposure rate is expected to result from the active promotion inherent in a Level Three Program and the general emphasis on large employers.
Alternative Three --	In this alternative, a Level Four Ridesharing Assistance Program is implemented in addition to the pool staging lots and free HOV parking spaces identified in the Null Alternative. The employee exposure rate is assumed to remain at 36% of all workers. Additional HOV incentives such as vehicle leasing guarantees, free and/or reserved HOV parking, etc. are assumed adopted by some area employers.

awareness of ridesharing and prevent erosion of ridesharing usage. As such, the observable impacts cannot be estimated by the available techniques.

In estimating the impacts of the alternative Ridesharing programs, mode share adjustment factors corresponding to each program level are available for both the carpool and vanpool modes. Because the vanpool adjustment factors are site-specific (as opposed to the areawide carpool factors), assumptions are required regarding the level of participation by area employers. Although limited information is available on employer participation rates, some general, logical assumptions can be made to derive on areawide adjustment factor for vanpools.

For a Level Two program, it was assumed that only employers of 100 or more persons would be interested in the vanpool portion of the program. These employers account for approximately 45% of employment in the Roanoke Valley. Of those persons employed by a firm of 100+ persons, it was further assumed that only 25% of these employees would have vanpool information made available to them by their employers. These assumptions are equivalent to an exposure rate of 11.25%. That is, of all workers in the Roanoke Valley about 11.25% would work for employers choosing to provide vanpool information. This was calculated as the fraction of employees in firms employing 100+ (0.45) multiplied by the workforce represented by 100+ employers choosing to participate (0.25). The remaining 88.75% of the workforce would not be exposed to site-specific vanpool encouragement activities, and therefore, the site-specific vanpool adjustment factor for a Level Two program would not be applied to that group. The vanpool mode share of the group exposed to a site-specific vanpool program would be multiplied by the adjustment factor associated with a Level Two Ridesharing program (2.105). The net effect would be an areawide adjustment factor of 1.124 for a Level Two Program (1*0.8875 + 2.105*0.1125).

For the Level Three and Level Four Ridesharing programs, the participation rate was assumed to increase to the point where 80% of employees in firms of 100+ would have vanpool matching/lease administration assistance provided by their employers. This is equivalent to an exposure rate of 36% (of Valley employees). The reasons for the substantial increase in the participation rate is the active promotion associated with Levels Three and Four and the emphasis on large employers. Using the same basic computations as for a Level Two Program, the areawide adjustment factors associated with a Level Three Ridesharing program would be 1.777 and for a Level Four program, 2.658.

The impact of free parking for HOVs in the CBD is normally calculated using the sensitivity tables provided in the Methodology Report. As documented earlier in this report, the average daily parking cost paid by employees in the CBD is approximately $0.68. The provision of free parking for HOVs would, therefore, reduce the out-of-pocket cost for a one-way HOV trip by an average of 34 cents. Given the initial ridesharing utilization and the decrease in one-way trip cost for HOVs, the new ridesharing mode share is obtained from the sensitivity tables. However, the current proposal provides

only 105 parking spares for HOVs, and expected HOV demand exceeds the available spaces. As a result, the availability of free parking for 105 High Occupancy Vehicles will not materially affect mode shares. It would only be effective in increasing mode share if the options were available on a more widespread basis. Such an incentive is included in the Level Four Ridesharing Program.

Results Of The Modal Alternatives

On an areawide basis, the impacts of the alternative Ridesharing Assistance Programs were rather limited. Table 2.21 shows the estimated mode shifts which would result from the various alternatives. The most effective program in inducing mode shifts is Alternative Three. Even under this program, the drive-alone mode share is reduced less than 5%. The shift in the drive-alone mode share in Alternative One is negligible and in Alternative Two, less than 2%. In specific corridors, the decrease in the drive-alone mode share with Alternative Three reaches about 10% in the Route 220 N, I-81 and the I-81 SW corridors. The extent of the shift in mode share for individual corridors is roughly in proportion to the proportion of ridesharing trips in the Null Alternative.

Similarly, the change in average vehicle occupancy is also slight. Areawide, the average vehicle occupancy does not change perceivably under Alternative One, and even under Alternative Three, the change can hardly be considered substantial. While the changes in the drive-alone mode share and the average vehicle occupancy are not particularly encouraging, these statistics do not provide a complete picture of the impacts. Table 2.22 details the modal volumes expected to result from the alternative programs. The estimated reduction in drive-alone work trips ranges from about 60 in Alternative One to more than 1,000 in Alternative Three. The number of persons using ridesharing modes increases a little more than one percent in Alternative One, approximately nine percent in Alternative Two, and a very substantial twenty-seven percent in Alternative Three.

In term of peak hour vehicles on area roadways, the impact of Alternative Three is also quite substantial. The number of vehicles used for work purposes during the peak hour would be reduced by over 800 vehicles under Alternative Three. Alternative One would reduce the number of peak hour vehicle trips by about 50 and Alternative Two by about 300. In the various corridors entering the Roanoke area, the percentage of work vehicle trips removed from the roadway is negligible in Alternative One (0.5%), as high as 2.6% for Alternative Two, and almost 7% for Alternative Three (all percentages are for the Rte. 220N Corridor). Further analysis of the impacts of these program alternatives is documented in the Impact Analysis section following the analysis of future travel conditions.

Table 2.21
1980 IMPACT ON MODE SHARE OF THE RIDESHARING ALTERNATIVES[1/]

	Null Alternative			Alternative One			Alternative Two			Alternative Three		
Corridor	Drive Alone	Carpool	Vanpool	Drive Alone	Carpool	Vanpool	Drive Alone	Carpool	Vanpool	Drive Alone	Carpool	Vanpool
Rte. 220 N	77.4	20.2	2.4	77.0	20.3	2.7	74.6	21.2	4.3	69.7	23.9	6.4
I-81 N	77.5	20.2	2.4	77.0	20.3	2.7	74.6	21.2	4.3	69.7	23.9	6.4
Rte. 460 NE	77.4	20.8	1.8	77.0	20.9	2.0	75.0	21.8	3.2	70.6	24.6	4.8
Rte. 24 E	77.7	21.1	1.3	77.3	21.2	1.5	75.6	22.1	2.3	71.6	24.9	3.5
Rte. 116 SE	79.2	20.8	--	79.1	20.9	--	78.2	21.8	--	75.4	24.6	--
Rte. 221 S	77.4	20.8	1.8	77.0	20.9	2.0	75.0	21.8	3.2	70.6	24.6	4.8
Rte. 220 S	74.7	25.3	--	74.5	25.5	--	73.5	26.5	--	70.1	29.9	--
I-81 SW	78.0	19.5	2.5	77.6	19.6	2.8	75.1	20.4	4.4	70.3	23.0	6.6
Rte. 311 N	82.0	16.5	1.6	81.6	16.6	1.8	79.9	17.3	2.8	76.2	19.5	4.3
Internal Trips	86.1	13.1	0.8	85.9	13.2	0.9	89.8	13.7	1.4	82.4	15.5	2.0
Areawide Shares	85.0	14.1	0.9	84.8	14.2	1.0	83.6	14.8	1.6	80.9	16.7	2.5
Average Vehicle Occupancy		1.10			1.10			1.12			1.14	

1/ Mode share for person work trips entering or internal to the Roanoke Valley.

Table 2.22
1980 MODAL USAGE IMPACTS OF THE RIDESHARING ALTERNATIVES[1/]

Corridor	Null Alternative			Alternative One			Alternative Two			Alternative Three		
	Drive Alone	Carpool	Vanpool	Drive Alone	Carpool	Vanpool	Drive Alone	Carpool	Vanpool	Drive Alone	Carpool	Vanpool
Rte. 220 N	346	91	11	344	92	12	333	95	20	311	108	29
I-81 N	337	88	10	335	89	11	325	92	18	304	104	27
Rte. 460 NE	743	200	17	740	201	19	720	210	30	679	236	45
Rte. 24 E	267	72	7	265	73	8	259	75	12	242	85	19
Rte. 116 SE	99	26	--	99	26	--	98	27	--	94	31	--
Rte. 221 S	340	91	8	338	92	9	330	95	14	310	108	21
Rte. 220 S	159	54	--	159	54	--	156	57	--	149	64	--
I-81 SW	420	105	13	417	106	15	405	110	23	379	124	35
Rte. 311 N	133	27	7	132	27	8	127	28	12	116	32	19
Internal Trips	21,216	3,241	188	21,170	3,263	212	20,914	3,396	335	20,315	3,830	500
Areawide Totals	24,060	3,995	261	23,999	4,023	294	23,667	4,185	464	22,899	4,722	695
Change In Person Trips[2/]				(61)	28	33	(393)	190	203	(1,161)	727	434

1/ One-way, peak hour, person work trips entering or internal to the Roanoke Valley.

2/ Parenthesis indicate a decrease compared to the Null Alternative.

FUTURE TRAVEL CONDITIONS

The primary sources of information on future year travel in the Roanoke Valley are the travel demand estimates and socioeconomic projections developed by VDH&T. This information is maintained as a series of computer files keyed to a system of traffic analysis zones representing the Roanoke Valley. These traffic analysis zones (TAZs) are shown graphically in Figure 2.9. Origins and destinations outside the Roanoke Valley are represented by a number of external stations at the point where traffic would enter or leave the Roanoke Valley.

The total of 205 TAZs and external stations in the VDH&T zone system for the Roanoke Area represents a level of detail inappropriate for direct application of the modal analysis tables. In order to summarize the VDH&T travel estimates, a series of traffic districts were defined. These districts are simply a grouping of individual TAZs for ease of manipulation and analysis. The first step in the definition of traffic districts was a comparison of TAZs and the Census tracts used in the 1970 Census. It was thought that development of districts on the basis of tract boundaries would allow use of the Census income information at a more disaggregrate level. Figure 2.10 shows the correspondence between tract boundaries and the Roanoke Valley zone system. District boundaries were developed on the basis of tract boundaries with appropriate adjustments made to reflect the boundaries of political jurisdictions within the Roanoke Valley. External stations were grouped in a manner corresponding to the corridor definitions used earlier. Figure 2.11 shows the 44 districts used to summarize the VDH&T travel estimates. Districts 37 through 44 represent external stations for each major corridor.

Travel Demand Estimates

The primary data items available from VDH&T for the Roanoke Valley appropriate for use in the future year analysis were: 1995 vehicle trip matrix (all purposes), 1995 work trip productions and attractions by TAZ, and 1995 socioeconomic data by TAZ. The first step in the future year analysis was the development of a work trip matrix. This was accomplished using the UTPS programs UMATRIX and UMCON to eliminate trips with external destinations and to scale the 205-zone vehicle trip matrix to zonal-level work productions and attractions. The program USQUEX was used to summarize the travel estimates on a district basis. Tables 2A.4 and 2A.5 in the appendix of this report show the original 1995 trip matrix (for all purposes) and the estimated 1995 work trip matrix, repectively (both at the district level).

This information is not directly comparable to the 1980 travel patterns as summarized in Table 2.7, in that Table 2.7 presents daily employee trips, while this information is quantified in terms of daily vehicle work trips. In

Figure 2.9
TRAFFIC ANALYSIS ZONE SYSTEM FOR THE ROANOKE VALLEY

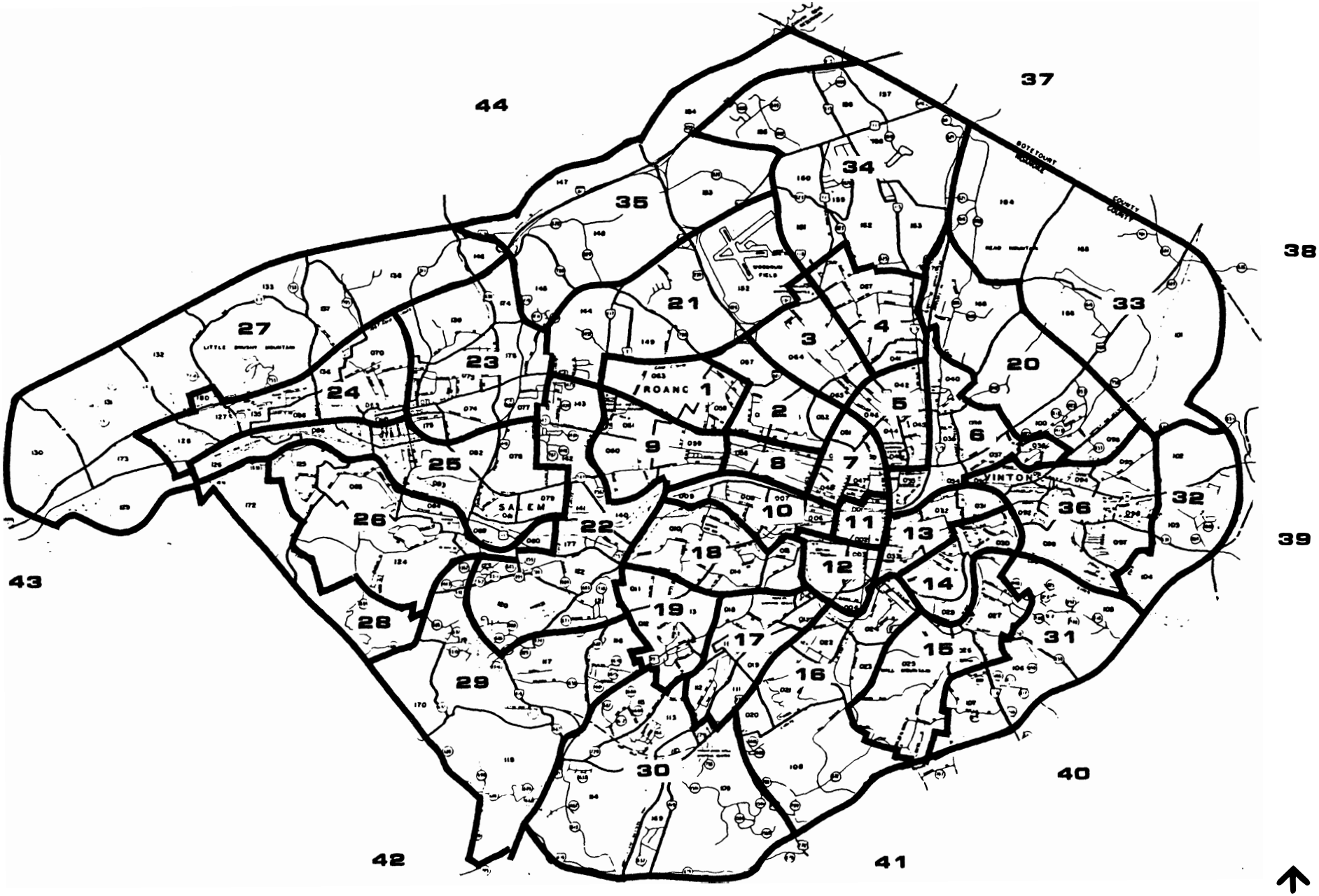


Figure 2.11
DISTRICT DEFINITION FOR CASE STUDY ANALYSIS

ROANOKE CASE STUDY
Virginia Commuting Study

Figure 2.10
1970 CENSUS TRACT-TRAFFIC ZONE CORRESPONDENCE
ROANOKE CASE STUDY
Virgi[redacted]muting Study

order to ensure that the analysis of future year travel is directly comparable to the 1980 year analysis, several adjustments are necessary. For the current year analysis, employment was multiplied by 1.7 to get daily, two-way, person work trips (accounting for absenteeism). Applying this methodology to the 1995 employment base, the resulting estimate of daily, two-way, person work trips would be 223,601 (131,530*1.7). This compares to the VDH&T estimate of 175,100 daily, two-way, vehicle work trips. This suggests an adjustment factor of 1.277 (223,601/175,100) to convert VDH&T vehicle trips to person-trips. As with the 1980 person trip volumes, a factor of 0.5 is used to convert two-way to one-way person work trips. Table 2.23 presents the estimated daily, one-way, person work-trips by corridor in the Roanoke Valley.

Analysis of Travel Patterns

Between 1980 and 1995, significant changes are expected in the Roanoke Valley. Overall, employment in the Roanoke Valley is expected to increase approximately 42% from 92,511 in 1980 to 131,530 in 1995. Employment in the City of Roanoke is projected to grow almost 60% in the 15-year period. Employment in the Roanoke CBD also is projected to grow at a very healthy rate (about 49%), but below that of the city in general. Employment growth in the rest of the Roanoke Valley to expected to be relatively modest at about 23% for the City of Salem and 14% for Roanoke County.

In-commuting to the Roanoke Valley is expected to almost double. However, external origins are projected to be only about 18 percent of total work productions (up from about 13% in 1980). While the City of Roanoke is expected to account for the bulk of employment growth in the Valley, the growth in work productions (i.e., population) is more evenly distributed. Roanoke County work trip productions are expected to grow 52%, while the Cities of Salem and Roanoke experience increases of 34% and 23%, respectively.

Within the general trends stated above, some abnormalities were identified in comparing the trip patterns estimated for the two target years. For example, a strict comparison of 1980 versus 1995 estimated work trips internal to the City of Salem would show a decline in absolute numbers, while trips from Salem to the City of Roanoke are estimated to be substantially higher in 1995 than in 1980. The probable cause of this apparent inconsistency is the use of two very different methodologies to develop trip patterns for 1980 and 1995. While these irregularities should not be dismissed, their existance does not invalidate the general analysis conducted herein.

Table 2.23
ESTIMATED 1995 PERSON WORK TRIPS TO THE ROANOKE VALLEY[1/]

Corridor	Destination			Corridor Total
	City of Salem	City of Roanoke	Roanoke County	
Rte. 220 N I-81 NE	767	3,810	831	5,408
Rte. 460 N	137	1,362	196	1,695
Rte. 24 E	172	1,276	269	1,717
Rte. 116 S	89	715	111	915
Rte. 220 S	325	2,871	549	3,745
Route 221 S	162	925	208	1,295
I-81 SW	1,505	2,687	556	4,748
Rte. 331 N	195	501	87	783

1/ Daily, one-way, person work trips

1995 Socioeconomic Distributions

The various distributions used in the modal analysis were adopted from those used in the current year (1980) analysis. Because no new information was available on firm size and employment type distributions, the 1980 distributions were used without alteration. While no further information was available on income distribution, the future year analysis was conducted on a corridor-specific basis for external trips, voiding the direct use of the county specific income distributions used for 1980. Income distributions associated with each travel corridor were derived by using the apportioning process previously identified for travel (see Table 2.7). For example, it was determined that approximately 27% of the traffic using Rte. 460 NE to enter the Valley originated in Botetourt County, and the remaining 73% had origins in Bedford County. Therefore, the income distribution associated with the Rte. 460 NE corridor was calculated as 27% of the Botetourt County income, plus 73% of the Bedford County income. The 1995 distribution of households by income range resulting from these calculations is given in Table 2.24.

Initially, it was anticipated that income distributions would be developed for each of the 36 traffic districts within the Roanoke Valley, based on the information available in the 1970 Census. However, it was later decided that the use of 1970 information to represent 1995 conditions at that level of detail would be inappropriate. As a result, the current income distributions for the cities of Salem and Roanoke and for Roanoke County were used for the future year analysis.

Application of Modal Summary Tables

The modal summary tables were applied to future year travel in the same manner as was done for the current year analysis. Tables 2A.6, 2A.7, and 2A.8 in the appendix summarize the adjustment factors calculated for each travel market by mode. Tables 2.25, 2.26, 2.27, and 2.28 represent the direct application of the market adjustment factors to each origin-destination pair. The mode share and estimated daily person trips represent expected demand, assuming the modal option is available to the entire travel segment. In some cases, the resulting estimate of modal trips is clearly below the minimum occupancy for that mode. An example of this occurance is the estimated four vanpool person-trips between the Rte. 460 NE corridor and Roanoke County destinations. In such instances, the vanpool option is not viable and the estimated vanpool trips are included in the carpool estimate, as the next "best" mode for ridesharing. Thus, total ridesharing remains constant and the minimum vehicle occupancy by mode respected. This adjustment is similar to that applied to the 1980 modal estimates.

Table 2.24
INCOME DISTRIBUTION BY CORRIDOR[1/]

	Rte. 220 N/ I-81 NE	Rte. 460 NE	Rte. 24 E	Rte. 116 E	Rte. 220 S	Rte. 221 S	I-81 SW	Rte. 311 N
Low	.23	.25	.27	.32	.32	.36	.26	.33
Medium	.50	.54	.57	.54	.54	.52	.53	.58
High	.27	.21	.16	.14	.14	.12	.21	.09

1/ Applies only to trips originating outside of the Roanoke Valley

Table 2.25
1995 MARKET ANALYSIS SUMMARY SHEET--ROANOKE COUNTY DESTINATIONS

Commuter Market/Mode	Rte. 220 N/ I-81 NE	Rte. 460 NE	Rte. 24 E	Rte. 116 S	Rte. 220 S	Rte. 221 S	I-81 SW	Rte. 311 N	Roanoke County	City of Roanoke	City of Salem	Subtotal
Market Size one-way work trips[1/]	831	196	269	111	549	208	556	87	8,188	5,799	1,589	18,383
Carpool (%)	14.0	14.0	14.0	14.2	14.2	14.4	14.0	14.2	12.5	11.7	11.3	12.4
person-trips	116	27	36	16	78	30	78	12	1,020	681	180	2,274
Van/Buspool (%)	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.2	1.0	1.0	1.2
person-trips	15	4	5	2	10	4	10	2	98	61	17	228
Express Bus (%) person-trips	Not Analyzed											
Total Ridesharing (%)	15.8	15.8	15.2	16.2	16.0	16.3	15.8	16.1	13.7	12.8	12.4	13.6
person-trips	131	31	41	18	88	34	88	14	1,118	742	197	2,502
Total Transit (%) person-trips	Not Analyzed											

1/ Daily, one-way, person work trips

Table 2.26
MARKET ANALYSIS SUMMARY SHEET--CITY OF SALEM DESTINATIONS

Commuter Market/Mode	Rte. 220 N/ I-81 NE	Rte. 460 NE	Rte. 24 E	Rte. 116 S	Rte. 220 S	Rte. 221 S	I-81 SW	Rte. 311 N	Roanoke County	City of Roanoke	City of Salem	Subtotal
Market Size one-way work trips 1/	767	137	172	89	325	162	1,505	195	6,008	5,294	4,504	19,158
Carpool (%)	26.1	26.1	26.1	26.6	26.6	22.6	22.0	22.2	13.3	13.8	10.4	14.6
person-trips 1/	200	36	45	24	86	37	331	43	798	730	468	2,798
Van/Buspool (%)	5.1	5.1	5.1	5.1	5.1	3.4	3.4	3.4	1.1	1.1	0.4	1.5
person-trips	39	7	9	5	17	5	51	7	63	56	19	278
Express Bus (%) person-trips	Not Analyzed											
Total Ridesharing (%)	31.2	31.4	31.4	32.6	31.7	25.9	25.4	25.6	14.3	14.8	10.8	16.1
person-trips	239	43	54	29	103	42	382	50	861	786	487	3,076
Total Transit (%) person-trips	Not Analyzed											

1/ Daily, one-way, person work trips

Table 2.27
MARKET ANALYSIS SUMMARY SHEET--CITY OF ROANOKE DESTINATIONS (EXCLUDES CBD)

Commuter Market/Mode	Rte. 220 N/ I-81 NE	Rte. 460 NE	Rte. 24 E	Rte. 116 S	Rte. 220 S	Rte. 221 S	I-81 SW	Rte. 311 N	Roanoke County	City of Roanoke	City of Salem	Subtotal
Market Size one-way work trips[1/]	3,092	1,071	993	552	2,202	724	2,159	407	19,491	25,277	4,085	60,053
Carpool (%)	22.4	22.4	22.4	22.8	22.8	23.1	26.8	27.1	13.0	13.5	13.0	15.1
person-trips[1/]	693	239	222	126	502	167	578	110	2,539	3,419	532	9,127
Van/Buspool (%)	2.6	2.6	2.6	2.6	2.6	2.6	3.9	3.9	0.6	0.6	0.6	1.0
person-trips	79	27	25	14	58	19	84	16	124	160	26	630
Express Bus (%) person-trips	Not Analyzed											
Total Ridesharing (%)	25.0	24.8	24.9	25.4	25.3	25.7	30.7	31.0	13.7	14.2	13.7	16.2
person-trips	772	266	247	140	558	186	662	126	2,663	3,579	558	9,757
Total Transit (%) person-trips	Not Analyzed											

1/ Daily, one-way, person work trips

Table 2.28
MARKET ANALYSIS SUMMARY SHEET--ROANOKE CBD DESTINATIONS

Commuter Market/Mode	Rte. 220 N/ I-81 NE	Rte. 460 NE	Rte. 24 E	Rte. 116 S	Rte. 220 S	Rte. 221 S	I-81 SW	Rte. 311 N	Roanoke County	City of Roanoke	City of Salem	Subtotal
Market Size one-way work trips[1/]	718	291	283	163	669	201	528	94	4,445	5,976	835	14,203
Carpool (%)	22.0	21.9	21.9	22.3	22.3	22.6	30.7	26.5	13.9	13.3	12.8	15.6
person-trips[1/]	158	64	62	36	149	45	162	25	619	793	107	2,220
Van/Buspool (%)	2.3	2.3	2.3	2.3	2.3	2.3	4.4	3.5	0.7	0.6	0.6	1.1
person-trips	16	7	6	4	15	5	23	3	32	36	5	152
Express Bus (%)	16.7	16.6	16.6	16.4	16.4	16.3	15.6	15.4	11.0	10.1	10.4	11.7
person-trips	120	48	47	27	110	33	82	14	490	603	86	1660
Total Ridesharing (%)	24.2	24.4	24.0	24.5	24.5	24.9	35.0	29.8	14.6	13.9	13.4	16.7
person-trips	174	71	68	40	164	50	185	28	651	829	112	2,372
Total Transit (%)	16.7	16.6	16.6	16.4	16.4	16.3	15.6	15.4	11.0	10.1	10.4	11.7
person-trips	120	48	47	27	110	33	82	14	490	603	86	1660

1/ Daily, one-way, person work trips

Conclusions

Tables 2.29 and 2.30 present the results of the modal analysis in terms of daily person work trips (by mode) entering the Roanoke Valley and the City of Roanoke. As was the case for the current year analysis, it is readily evident that express bus will not be a viable commuting option. The estimated daily usage in the peak corridor (I-81 SW into the City of Roanoke) is significantly below the peak hour usage required to justify service. A major factor in limiting demand for express bus service appears to be the modest level of downtown employment. While employment in the CBD is projected to grow at a faster rate than total employment in the Valley, the expected 1995 CBD employment (19,680) is still 20% less than the minimum suggested in the initial screening criteria.

Overall, only minor shifts in mode usage are expected to occur between 1980 and 1995. The proportion of persons ridesharing (carpool and vanpool) is expected to increase about 8% for trips entering the City of Roanoke. The percentage of work trips using transit is expected to decline somewhat for trips entering the City of Roanoke. In absolute numbers, approximately 1,000 work trips daily would enter the City of Roanoke using express bus service, if it were available in all corridors.

In spite of the limited mode shifts expected, the volume of ridesharing vehicle trips entering the Roanoke Valley and the City of Roanoke is expected to more than double. This is due primarily to growth in commuting to the City of Roanoke. Table 2.31 and 2.32 summarize the expected peak hour, person, work trips by mode entering the Roanoke Valley and the City of Roanoke, assuming no express transit service. Approximately 2,800 person trips (or 8%) of the peak hour, person, work trips entering the City of Roanoke are expected to use a ridesharing mode. As was the case in the current year analysis, the estimated modal volumes (in person trips) do not meet any of the warrants for supplemental TSM actions, except for pool staging lots. As a result, the additional options are largely limited to the institutional actions reported in Table 13 of the Methodology Report.

1995 Modal Alternatives

As was the case in the 1980 analysis, feasible alternatives in 1995 are likely to be various ridesharing assistance programs, pool staging lots, and preferential HOV parking in the Roanoke CBD. Those options were originally identified in a previous section of this report and are reproduced as Table 2.33. The previous derivation of the adjustment factors associated with the alternative "Ridesharing Program Levels" is also applicable to this analysis, since the current basic distribution of employees by worksite size is assumed to apply in 1995. The impact on ridesharing activity of the 105 spaces to be reserved for HOVs in the CBD and the proposed pool staging lots cannot be measured separately from the general ridesharing incentives in the Level Two and Level Three programs. The impact of a more widespread HOV parking

Table 2.29
ESTIMATED 1995 PERSON WORK TRIPS ENTERING THE ROANOKE VALLEY[1/]

Corridor	Drive Alone	Carpool	Vanpool	Express Bus
Rte. 220 N/ I-81 NE	3972	1167	149	120
Rte. 460 NE	1236	370	41	48
Rte. 24 E	1260	376	34	47
Rte. 116 S	661	213	14	27
Rte. 220 S	2722	815	98	110
Rte. 221 S	950	293	19	33
I-81 SW	3349	1149	168	82
Rte. 311 N	551	195	23	14

1/ Daily, one-way, person work trips

Table 2.30
ESTIMATED 1995 PERSON WORK TRIPS ENTERING THE CITY OF ROANOKE[1/]

Corridor	Drive Alone	Carpool	Vanpool	Express Bus
I-81/I-581 N	9176	1864	143	273
Rte. 460 NE	1955	456	34	71
Rte. 24 E	3587	711	42	110
Rte. 116 S	1243	223	14	43
Rte. 220 S	5052	1126	90	181
Rte. 221 S	3940	734	39	111
I-81 SW	9322	2018	177	268

1/ Daily, one-way, person work trips.

Table 2.31
ESTIMATED 1995 PEAK HOUR, PERSON, WORK TRIPS ENTERING THE ROANOKE VALLEY

Corridor	Drive Alone	Carpool	Vanpool	Total
Rte. 220 N/ I-81 NE	1462	430	55	1947
Rte. 460 NE	458	137	15	610
Rte. 24 E	466	139	13	618
Rte. 116 S	244	79	7	330
Rte. 221 S	1011	302	36	1349
Rte. 220 S	351	108	7	466
I-81 SW	1227	421	62	1710
Rte. 311 N	202	71	9	281
Total	5421	1687	203	7311

Table 2.32
ESTIMATED 1995 PEAK HOUR, PERSON, WORK TRIPS ENTERING THE CITY OF ROANOKE

Corridor	Drive Alone	Carpool	Vanpool	Total
I-81/I-581 N	3384	687	53	4124
Rte. 460 NE	724	169	13	906
Rte. 24 E	1324	262	16	1602
Rte. 116 S	460	83	7	550
Rte. 220 S	1871	417	33	2321
Rte. 221 S	1452	270	14	1736
I-81 SW	3434	743	65	4242
Total	12649	2631	201	15481

Table 2.33
ALTERNATIVE RIDESHARING PROGRAMS

Null Alternative --	This alternative basically consists of maintaining the status quo; that is no ridesharing advertising/assistance program is adopted. The implementation of the proposed Multi-Modal Transportation Center in the CBD with 105 spaces reserved for HOVs is assumed as is the construction of a limited number of pool staging lots. These actions while generally supportive of ridesharing are not expected to materially affect mode usage.
Alternative One --	A Level Two Ridesharing Assistance Program would be implemented as described in the Methodology Report. Areawide matching services are made available and approximately 11% of area workers are exposed to vanpool promotion effects through their employers (see text for details). The pool staging lots and 105 HOV parking spaces in the CBD described in the Null Alternative are also included on this program.
Alternative Two --	A Level Three Ridesharing Assistance Program is assumed implemented for the Roanoke Valley in place of the Level Two program of Alternative One. The level of exposure through employers for vanpool programs is assumed to be 36% of employment in the Valley. This increased (over Alternative One) exposure rate is expected to result from the active promotion inherent in a Level Three Program and the general emphasis on large employers.
Alternative Three --	In this alternative, a Level Four Ridesharing Assistance Program is implemented in addition to the pool staging lots and free HOV parking spaces identified in the Null Alternative. The employee exposure rate is assumed to remain at 36% of all workers. Additional HOV incentives such as vehicle leasing guarantees, free and/or reserved HOV parking, etc. are assumed adopted by some area employers.

policy is included in the adjustment factor for a Level Four Ridesharing Program.

The results of the alternative ridesharing programs are presented in Tables 2.34 and 2.35. The Null Alternative represents the base case conditions presented in Table 2.32. Table 2.34 estimates one-way, peak period, person work trip modal shares by corridor entering the Roanoke Valley and work trips internal to the Valley. Table 2.35 estimates person trip volumes by mode for the null and program alternatives. As can be seen from these tables, the impact of program alternatives on the drive-alone mode share and average vehicle occupancy is quite modest. The drive-alone mode share is reduced by only about 6% in the most effective program, and average vehicle occupancy is increased less than 5%.

However, the impact in terms of person trips is more substantial. The reduction in drive-alone person trips ranges from just over 100 in Alternative One to almost 1,900 in Alternative Three. The reduction in peak hour vehicles ranges from about 80 in Alternative One to almost 1,400 in Alternative Three. Alternative Two would remove about 500 peak hour vehicles from the area roadways.

The impact on travel in corridors is even more significant in terms of percentages. In the well-traveled I-81/Rte. 460 SW corridor, the drive-alone mode share would be reduced approximately 15% with Alternative Three. Under the same alternative, average vehicle occupancy would increase about 11% to about 1.36 persons per vehicle. About 140 peak hour vehicles (or 10% of the corridor vehicle work trips) would be removed from the roadway with Alternative Three. Alternatives One and Two would remove about 0.6% and 4.0% (respectively) of the peak hour work vehicle trips in the I-81/Rt. 460 SW corridor. Further analysis of the program alternatives is presented in the Impact Assessment section of this report.

Operating and Capital Costs

Primary public costs for the three alternatives are related to implementation of the ridesharing assistance program around which each alternative is centered. Table 2.36 from the Methdology Report, details the cost of each level of ridesharing assistance. Alternative One assumes the implementation of a Level Two Ridesharing Program (see Table 2.33). This alternative would involve direct public costs of about $35,000 for implementation in the Roanoke Valley. One full-time staff person is assumed and support services are obtained from the implementing agency.

Alternative Two assumes one full-time and one half-time position to implement a Level Three Ridesharing Program. In addition to the increased staffing over a Level Two Program, additional resources are allocated for promotion and computer matching of ridesharing applications. The total cost for Alternative Two would be approximately $60,000 annually.

Table 2.34
1995 IMPACT ON MODE SHARES OF THE RIDESHARING ALTERNATIVES[1/]

Corridor	Null Alternative			Alternative One			Alternative Two			Alternative Three		
	Drive Alone	Carpool	Vanpool	Drive Alone	Carpool	Vanpool	Drive Alone	Carpool	Vanpool	Drive Alone	Carpool	Vanpool
Rte. 220N/ I-81 NE	75.1	22.1	2.8[b/]	74.6	22.2	3.2	71.8	23.2	5.0	66.4	26.1	7.5
Rte. 460	75.0	22.4	2.6	74.6	22.6	2.8	72.0	23.6	4.4	66.9	26.6	6.6
Rte. 24	78.7	19.1	2.2	78.2	19.3	2.5	76.2	19.9	3.9	71.5	22.6	5.9
Rte. 116	73.9	23.9	2.1	73.3	24.2	2.4	71.2	25.2	3.6	66.1	28.2	5.8
Rte. 221	74.9	22.4	2.7	74.5	22.5	3.0	71.8	23.4	4.7	66.4	26.5	7.1
Rte. 220	75.3	23.2	1.5	74.9	23.4	1.7	73.2	24.2	2.6	68.5	27.5	4.1
I-81	71.8	24.6	3.6	71.1	24.8	4.1	67.8	25.8	6.4	61.2	29.1	9.6
Rte. 311	71.9	25.3	2.8	71.5	25.3	3.2	68.7	26.3	5.0	62.6	29.9	7.5
Internal	85.7	13.5	0.8	85.5	13.6	0.9	84.5	14.1	1.4	82.0	15.9	2.1
Areawide Shares	83.7	15.2	1.2	83.4	15.3	1.3	82.1	15.9	2.0	79.0	17.9	3.1
Implied Average Vehicle Occupancy		1.11			1.12			1.13			1.16	

a/ Mode share for peak hour person work trips entering and internal to the Roanoke Valley.

b/ May not add to 100% due to rounding.

Table 2.35
1995 MODAL USAGE IMPACTS OF THE RIDESHARING ALTERNATIVES[a/]

Corridor	Null Alternative			Alternative One			Alternative Two			Alternative Three		
	Drive Alone	Carpool	Vanpool	Drive Alone	Carpool	Vanpool	Drive Alone	Carpool	Vanpool	Drive Alone	Carpool	Vanpool
Rte. 220N/ I-81 NE	1462	430	55	1452	433	62	1398	451	98	1293	508	146
Rte. 460	458	137	15	455	138	17	439	144	27	408	162	40
Rte. 24	466	113	13	463	114	15	451	118	23	423	134	35
Rte. 116	244	79	7	242	80	8	235	83	12	218	93	19
Rte. 221	1011	302	36	1005	304	40	969	316	64	896	357	96
Rte. 220	351	108	7	349	109	8	341	113	12	319	128	19
I-81	1227	421	62	1216	424	70	1159	441	110	1047	498	165
Rte. 311	202	71	8	201	71	9	193	74	14	176	84	21
Internal	28,239	4438	260	28,176	4469	292	27,824	4651	462	27,000	5246	691
Areawide Totals	33,660	6099	463	33,559	6142	521	33,009	6391	822	31,780	7210	1232
Change In Person Trips [b/]				(101)	43	58	(651)	292	359	(1880)	1111	769

a/ One-way, peak hour, person work trips entering and internal to the Roanoke Valley.

b/ Parenthesis indicate a decrease compared to the Null Alternative.

Table 2.36
TYPICAL COSTS AND STAFFING ASSOCIATED WITH RIDESHARING PROGRAMS[1/]

	Total Cost	Personnel	Promotion	Computer	Other	Full Time Staff	Part Time Staff
LEVEL ONE							
Small Urban Area	$ 10,000	$ 6,000	$ 2,000		$ 2,000	0	1
Medium Urban Area	12,000	8,000	2,000		2,000	0	1
Large Urban Area	15,000	10,000	3,000		2,000	0	1
LEVEL TWO							
Small Urban Area	$ 25,000	$ 16,000	$ 4,000	$	$ 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
LEVEL THREE							
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
LEVEL FOUR							
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

1/ All costs are in 1980 constant dollars.

Alternative Three involves the implementation of a Level Four Ridesharing Program. Included in the program costs are three full-time positions and expenses for computer processing, promotion, and other miscellaneous program costs. The total public cost of Alternative Four would be $100,000 annually.

In estimating the public cost for each alternative, the cost of actions assumed in the Null Alternative have been excluded. Not included in the cost of any of the alternatives are non-public expenses incurred by major employers in providing ridesharing incentives, such as free parking to their employees. Similarly, the costs of the pool staging lot planned by VDH&T, the Multi-Modal Transportation Terminal, and the downtown transit shuttle are not included in the cost of any of the ridesharing alternatives. Note that all costs presented -- program costs as well as fuel and auto operating costs -- are on a 1980 constant dollar basis.

IMPACT ASSESSMENT

This section documents impacts of alternative ridesharing assistance programs upon 1980 and 1995 travel conditions. Specific impacts considered in this assessment include: number of ridesharing trips, program cost, vehicle-miles of travel (VMT), fuel usage, air pollution, and user costs.

Methodology and Assumptions

In developing the estimate of impacts, the commuter participation figures were derived from the modal shares documented in the Modal Analysis section. Tables 2.21 and 2.22 detail the estimated 1980 ridesharing mode share under each alternative. Table 2.34 and 2.35 provide similar estimates for 1995. These tables detail the peak hour mode share for carpool and vanpool, and the change in peak hour person trips by mode. Areawide mode shares were applied to the daily, one-way, person, work trip estimates to determine daily usage by mode. These daily figures were converted to annual usage based on 250 commuting days per year. The cost of each alternative, as estimated in the preceding section, was divided by the change in annual ridesharing trips (carpool plus vanpool) to estimate the cost per new ridesharing trip (annually).

In order to estimate impacts on VMT, fuel consumption, air pollution, and user costs, a stratification of vehicle trips by distance and mode (drive-alone, carpool, and vanpool) is required. The default trip length distribution for medium-sized urban areas was used in the application of the modal summary tables and also served as the basis for deriving the above stratification. Daily, one-way, person, work trips were assigned to the distance stratification used in the default trip length distribution.

Given the areawide mode shares, it was possible to estimate mode shares for each distance stratification by using the trip length adjustment factor (by mode) for each distance stratification. For example, the 1980 carpool mode share was estimated as 14.1% areawide. The Modal Summary Sheet for carpools provides the following work trip length adjustment factors:

0-5 miles	0.662
5-10 miles	1.104
10-15 miles	1.153
15-20 miles	1.809
20-25 miles	1.877
25+ miles	1.993

Combining these two pieces of information yields the estimated carpool share by distance. The 0-5 mile carpool is calculated as (14.1% * 0.662) or 9.47%. Similarly, the carpool share for 5-10 miles would be (14.1% * 1.104) or 15.7%. This process was repeated for each distance stratification for both carpools and vanpools. Applying the estimated mode share to the person work trips estimated for that stratification resulted in an estimate of carpool person trips and vanpool person trips for each distance stratification. The difference between total person work trips and carpool plus vanpool person work trips was assigned to drive-alone trips within each distance stratification.

The number of vehicle trips, by mode for each distance stratification was determined by dividing modal trips by the appropriate average occupancy figure (drive-alone = 1, carpool = 2.5 and vanpool = 12). Because vanpools typically do not operate trips less than five miles in length, any vanpool vehicle trips estimated for the 0-5 mile stratification were reallocated to the other distance stratifications. The reasoning behind this adjustment is that while vanpools occasionally serve workers residing five miles or less from their place of employment, the deviations required to pick-up seven or more persons are sufficiently great to make a vanpool vehicle trip of less than five miles generally infeasible.

Table 2.37 presents estimated vehicle trips stratified by distance and by mode for the 1980 base case (Null Alternative) and the ridesharing program alternatives. The application of the above process to 1995 travel estimates yields the vehicle trip length distributions shown in Table 2.38. Estimates of vehicle-miles of travel (VMT) for each alternative were made by multiplying the number of vehicle trips by the mid-point of each distance range. A figure of 35 miles was used as the average trip length for the 25+ mile category.

In order to check the reasonableness of the VMT estimates, average vehicle trip lengths were calculated for the individual travel modes. The average, one-way, work trip length for vehicles destined to the Roanoke Valley was estimated to be 7.6 miles in 1980. The average vehicle work trip length for drive-alone, carpool, and vanpool was estimated as 7.35 miles, 11.2 miles, and 21.5 miles, respectively.

Table 2.37
1980 DAILY ONE-WAY VEHICLE TRIPS BY COMMUTE DISTANCE[1/]

		Commute Distance						
		0-5 miles	5-10 miles	10-15 miles	15-20 miles	20-25 miles	25+ miles	Total
Null Alternative	Drive Alone	36,014	16,463	5,846	4,105	1,721	2,690	66,839
	Carpool	1,501	1,223	459	562	249	441	4,435
	Vanpool	--	14	9	8	5	23	58
Alternative One	Drive Alone	35,930	15,424	5,832	4,096	1,716	2,684	66,682
	Carpool	1,511	1,232	463	565	251	444	4,466
	Vanpool	--	16	10	9	6	25	66
Alternative Two	Drive Alone	35,421	16,192	5,750	4,037	1,692	2,646	65,738
	Carpool	1,575	1,284	482	589	262	463	4,655
	Vanpool	--	26	16	14	9	40	105
Alternative Three	Drive Alone	34,243	15,653	5,559	3,903	1,636	2,558	63,552
	Carpool	1,776	1,448	543	664	295	522	5,248
	Vanpool	--	40	26	22	15	61	164

1/ Vehicle work trips destined for the Roanoke Valley.

Table 2.38
1995 DAILY ONE-WAY VEHICLE TRIPS BY COMMUTE DISTANCE[1/]

		Commute Distance						
		0-5 miles	5-10 miles	10-15 miles	15-20 miles	20-25 miles	25+ miles	Total
Null Alternative	Drive Alone	50,369	23,025	8,176	5,742	2,406	3,762	93,480
	Carpool	2,298	1,873	703	859	382	675	6,790
	Vanpool	--	27	17	15	10	43	112
Alternative One	Drive Alone	50,239	22,965	8,156	5,726	2,400	3,752	93,238
	Carpool	2,315	1,887	709	865	385	681	6,842
	Vanpool	--	30	19	16	11	46	122
Alternative Two	Drive Alone	49,456	22,607	8,028	5,637	2,363	3,694	91,785
	Carpool	2,406	1,961	737	899	400	707	7,110
	Vanpool	--	45	29	24	17	70	186
Alternative Three	Drive Alone	47,588	21,755	7,725	5,424	2,273	3,554	88,319
	Carpool	2,709	2,209	829	1,012	450	796	8,005
	Vanpool	--	70	45	39	26	109	289

1/ Vehicle work trips destined for the Roanoke Valley.

Estimates of daily, one-way work trips were multiplied by two to get round-trip distance and multiplied by 250 to produce annual VMT. Fuel consumption estimates were based on 16.4 miles per gallon in 1980 and 22.5 miles per gallon in 1995. The assumptions used in calculating auto pollutant emissions were: for 1980: HC 4 grams/mile, CO 44 grams/mile, and NO_x 5 grams/mile; for 1995: HC 1.4 grams/mile, CO 15 grams/mile, and NO_x 1.9 grams/mile. An average automobile operating cost of 11.3¢ per mile (in constant dollars) was assumed for both 1980 and 1995. The auto operating cost for 1995 reflects the assumption that increased fuel efficiency will be offset by increases in the real price of gasoline and auto ownership.

1980 Impact Assessment

Table 2.39 summarizes the expected impacts of the ridesharing alternatives upon 1980 travel conditions. The values listed under the Null Alternative are the base values assuming no ridesharing assistance program is implemented. The values listed under Alternative One, Two, and Three are the changes from the base values, which would result if that alternative were implemented.

Alternative One would increase peak hour ridesharing by about sixty person trips (carpool and vanpool). On an annual basis, this represents approximately 73,000 new ridesharing trips and a reduction of about 337,000 vehicle-miles of travel. This reduction in VMT implies a decrease in fuel consumption of more than 20,000 gallons annually and reductions of 1,350 kg of HC, 14,850 kg of CO and 1,700 kg of NO_x annually. The program cost of $35,000 or $0.48 per induced rideshare trip is balanced by a reduction in user costs of about $38,000 annually.

Alternative Two would save users an estimated $263,000 annually at a public cost of $60,000 or about $0.11 per induced trip. While the increase in peak hour ridesharing trips (390) is hardly impressive, the number of new ridesharing trips (550,400 annually) and the reduction of more than two million vehicle-miles of travel are substantial. Fuel savings would amount to about 142,000 gallons annually and reductions of 9,300 kg, 102,600 kg and 11,600 kg of HC, CO and NO_x emissions, respectively. The reduction in VMT-related impacts amounts to slightly less than a 1% reduction in the base figures and ridesharing trips are expected to increase about 9%. These figures represent an approximate seven fold increase over the expected impacts of Alternative One.

Alternative Three is expected to decrease VMT by more than two percent (6,435,000) compared to the base case and increase ridesharing by almost 28%. This shift to ridesharing modes would result in user savings of almost $750,000 at a public cost of $100,000. The cost per induced trip would be about 6¢ annually. The increase in peak hour ridesharing trips (1,160) represents about 800 vehicles removed from area roadways during the peak hour. The reduction in pollutant emissions annually would be over 340,000 kilograms of pollutants (total - HC, CO and NO_x). Fuel consumed for commuting purposes would be reduced about 390,000 gallons annually. In

Table 2.39
1980 IMPACT SUMMARY[1/]

Impact Measure	Null Alternative	Alternative One	Alternative Two	Alternative Three
Annual Rideshare Trips	5,898,000	73,000	550,400	1,651,400
One-Way, Peak Hour Trips	4,260	60	390	1,160
Mode Share	15%	15.2%	16.4%	19.2%
Project Cost	--	$ 35,000	$ 60,000	$ 100,000
Cost per Trip	--	$ 0.48	$ 0.11	$ 0.06
Vehicle Miles of Travel	271,052,000	-337,500	-2,332,500	-6,435,000
Fuel Used (gallons)	16,528,000	-20,600	-142,200	-392,400
Air Pollution (kg) HC	1,084,200	-1,350	-9,350	-25,750
CO	11,926,250	-14,850	-102,650	-283,150
NO_x	1,355,250	-1,700	-11,650	-32,200
User Cost	$30,628,000	-$38,200	-$263,600	-$727,200

1/ Impacts given for Alternatives One, Two, and Three represent the increase, or decrease, from base conditions given under the Null Alternative. All values are on an annual basis (except peak-hour trips) for ridesharing person trips and costs are in 1980 constant dollars.

Alternative Three, VMT-related impacts are about 2.75 times that of Alternative Two and about 19 times that of Alternative One. Ridesharing participation approximately triples from Alternative Two to Alternative Three and would be about 22 times greater in Alternative Three than in Alternative One.

1995 Impact Assessment

Table 2.40 summarizes the expected impacts of the three ridesharing alternatives in 1995. Also presented in Table 2.40 under the Null Alternative are the base values for each impact category, which assume no ridesharing assistance program implemented in 1995. Listed under Alternative One, Two, and Three are the changes expected in the base condition values, if that alternative is implemented. By way of comparison, the volume of ridesharing trips in 1995 (base case) is approximately 55% greater than the 1980 base case condition. Base case VMT and user cost figures are about 41% more in 1995 than in 1980. The absolute volume of pollutant emissions in 1995 is estimated at less than half that of 1980 despite the increase in VMT. This reduction is due to the significantly lower emission rates assumed in 1995. The expected increase in fuel efficiency partially offsets the VMT increase so that base fuel consumption rises less than 3% between 1980 and 1995.

Alternative One results in approximately a one-percent increase in carpool and vanpool person trips (annually) over 1995 base case conditions. This represents about 100 new ridesharing trips during the peak hour and over 100,000 new ridesharing trips annually. The annual program cost of $35,000 ($0.34 per new trip) is more than offset by $56,000 annually in user cost savings. Annual VMT is reduced about 1% (495,000) and results in savings of 22,000 gallons of fuel and a 9,000 kilograms reduction in pollutant emissions.

Alternative Two would result in 650 new peak hour ridesharing trips; this is approximately a 10% increase in peak hour ridesharing. Overall, the ridesharing mode share would be almost 18%, representing about 838,000 new ridesharing trips annually. Annual VMT would be reduced by 3,655,000 (about 1%), more than seven times the reduction achieved with Alternative One. The expected reduction in pollutant emissions is 5,100 kg of HC, 54,800 kg of CO and 6,900 kg of NO_x. Fuel consumption would be reduced about 162,400 gallons annually, and user cost savings ($413,000) would be almost seven times the annual program cost ($60,000). The annual cost per ridesharing trip induced would be about 7¢ (about one-fifth the cost of Alternative One).

Alternative Three would produce a 28% increase in the number of annual ridesharing trips (compared to base conditions). This is 25 times the induced trips resulting from Alternative One and about 3 times that of Alternative Two. During the peak hour, about 1,880 new ridesharing trips would be expected. The program cost of $100,000 amounts to an average annual expenditure of about 4¢ per new ridesharing trip. User cost savings under this alternative would amount to over one million dollars annually. Alternative Three would result in VMT-related impacts about 2.7% lower than base

Table 2.40
1995 IMPACT SUMMARY[1/]

Impact Measure	Null Alternative	Alternative One	Alternative Two	Alternative Three
Annual Rideshare Trips	9,167,500	102,000	838,500	2,571,500
One-Way, Peak Hour Trips	6,560	100	650	1,880
Mode Share	16.4%	16.6%	17.9%	21.0%
Project Cost	--	$ 35,000	$ 60,000	$ 100,000
Cost per Trip	--	$ 0.34	$ 0.07	$ 0.04
Vehicle Miles of Travel	382,175,000	-495,000	-3,655,000	-10,315,500
Fuel Used (gallons)	16,985,000	-22,000	-162,400	-458,500
Air Pollution (kg) HC	535,000	-700	-5,100	-14,400
CO	5,732,600	-7,400	-54,800	-154,700
NO_x	726,100	-940	-6,900	-19,600
User Cost	$43,186,000	-$56,000	-$413,000	-$1,165,000

1/ Impacts given for Alternatives One, Two, and Three represent the increase, or decrease, from the base conditions given under the Null Alternative. All values are on an annual basis (except peak-hour trips) for ridesharing person trips and costs are in 1980 constant dollars.

case conditions. The reduction in fuel consumption of 458,000 gallons annually is approximately 2.8 times that of Alternative Two and about 21 times that of Alternative One. Reduction in pollutant emissions would approach 190,000 kg annually under Alternative Three.

Summary

From the results presented in Tables 2.39 and 2.40, it is clear that Alternative Three would produce the most substantial impacts. Alternative Three out performs the other alternatives in all of the impact measures. It is also evident that there are declining economies of scale. While Alternative Three is the most cost effective program, the change in cost-effectiveness from Alternative Two to Alternative Three is not nearly as great as from Alternative One to Alternative Two.

In the social aggregate, each of the alternatives would appear beneficial. Even under the least effective, Alternative One, the direct monetary benefit (to users) exceeds the monetary cost to society. Additionally, other public objectives (i.e., fuel conservation, reduction in air pollutants, and better use of existing facilities) would benefit from the adoption of a ridesharing assistance program. As such, the pertinent question appears to be not whether a ridesharing program should be adopted, but which program is best suited to the needs and desires of the Roanoke Valley. This question is addressed in the following section.

SCENARIO ANALYSIS

The previous sections presented analyses of commuter travel options for the years 1980 and 1995 based on conditions not dramatically different from today's. Transportation system operating characteristics in terms of travel time, fuel cost, and total auto operating costs were assumed to be relatively stable between 1980 and 1995. However, given the present uncertainty regarding national transportation funding and the price (and availability) of gasoline, it is useful to perform another level of analysis to quantify in general terms the impact of possible alternative futures.

The method of analysis used to gauge the impact of these futures is to define alternative transportation conditions as might result from the scenarios hypothesized elsewhere in the study and to relate these changed conditions to commuter mode shifts. The purpose of this analysis is to anticipate the response of commuters to such changes and to determine the resulting implications for alternative commuter options as described in the previous section.

Three scenarios of the future have been defined. They describe alternative conditions of fuel cost, highway service levels, and transit services levels, as might result from political, institutional and economic developments. Table 2.41 quantifies the hypothesized conditions associated with the constrained, expected, and unconstrained scenarios.

In conducting the scenario evaluation for the Roanoke Valley, three trip lengths and associated characteristics were chosen as representative of commuting behavior in the Valley. Table 2.42 details the characteristics of the representative trips selected. One-way trip lengths of 5, 12, and 22 miles were selected as typical commuting distances for those employed in the Roanoke Valley. Travel times were developed from information contained in the Park-and-Ride Feasibility Study and reflect the different highway travel conditions faced by short-, medium-, and long-distance commuters. The 1995 base gasoline cost of $1.65 per gallon (1980 dollars) includes all taxes. As before, the increased fleet fuel economy in 1995 is assumed to offset the real increase in gasoline cost resulting in no change from 1980 in average automobile operating cost. Because public transit service in the Roanoke Valley is used predominately by transit captives and is not used as a primary commuting alternative, no analysis of this mode was attempted.

The procedure used to estimate modal shifts resulting from the change in travel conditions is called incremental logit analysis. This technique, also known as pivot point analysis, estimates the modal share which would result from an absolute change in the system variables, given the original mode share.

The basic mode shares for the typical trip lengths were developed as part of the 1995 modal analysis presented in the preceding section. The absolute change in gasoline cost and highway travel time were obtained by applying the percentage change identified in Table 2.41 to the appropriate descriptor variable. With these two pieces of information, the incremental logit formulation is employed to estimate the resulting mode share. This use of incremental logit analysis is detailed in the appendix of the Methodology Report. The results of the scenario analysis are presented in Table 2.43.

Constrained Scenario

In the constrained scenario, the increase in the price of gasoline (50%) and the deterioration in highway level of service is expected to increase ridesharing substantially. Short trips with a base drive-alone share of about 90% would be least sensitive to these changes. The proportion of ridesharing among this group would increase about 10%. Medium-distance commuters would increase ridesharing approximately 23% and long-distance commuters by about 36%.

Despite the fact that the percentage change in travel time and travel cost is the same for each of the representative trips, different sensitivities to these changes are observed. Logically, this is what should be expected. For short

Table 2.41

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.

Table 2.42
REPRESENTATIVE TRIP CHARACTERISTICS

Characteristic	Length of Representative Trip		
	Short	Medium	Long
Typical Origin	Salem	Catawba	Fincastle
Distance (miles)[1/]	5	12	22
Highway Travel Time (minutes)	14	22	30
Average Operating Speed	21	33	44
Average Gasoline Consumption (gallons)[2/]	0.22	0.53	0.98
Average Auto Operating Cost (cents)[3/]	56.5	135.6	248.6

1/ One-way trips destined to Roanoke CBD.

2/ Based on 22.5 mpg; although fuel economy and operating cost varies with operating speed, this effect was judged insignificant in the context of sketch planning.

3/ Based on an average of 11.3¢/mile in 1980 constant dollars.

Table 2.43
IMPACT OF SCENARIOS ON 1995 MODAL SHARES

Scenario	Mode	Mode Share for Representative Trip		
		Short	Medium	Long
Base Condition[1/]				
	Drive Alone	.897	.806	.695
	Ridesharing	.103	.194	.305
Constrained				
	Drive Alone	.886	.761	.584
	Ridesharing	.114	.239	.416
Expected				
	Drive Alone	.895	.798	.674
	Ridesharing	.105	.202	.326
Unconstrained				
	Drive Alone	.901	.822	.734
	Ridesharing	.099	.178	.266

1/ Based on typical 1995 mode shares presented in Table 2.38.

trips, the time and distance deviation necessary to pick up an additional passenger remains a significant deterrant to ridesharing in spite of the possible overall cost savings. Long-distance commuters would be most sensitive to the transportation supply changes. In this scenario, the greater economy of ridesharing over driving alone could be expected to elicit the greatest response from this group.

The constrained scenario would significantly enhance the impact of ridesharing programs in general, and these programs would be particularly beneficial to medium- and long-distance commuters.

Expected Scenario

In the expected scenario, modest increases in fuel cost and highway travel times would occur. This scenario is the closest of the three scenarios to the assumed base conditions, and as one might anticipate, produces the least change in the modal shares. However, even the relatively small changes in travel time and fuel cost would enhance the attractiveness of ridesharing.

The proportion of ridesharing trips would increase for each of the representative trip lengths. As in the constrained scenario, short trips would be least sensitive to the changes in transportation characteristics and ridesharing would increase less than 2%. Medium-distance work trips would experience about a 4% increase in ridesharing, roughly double that of short trips. Even for long-distance trips, the percent increase in ridesharing is hardly substantial at just under 7%.

Because short- and medium-distance trips comprise the great majority of work trips in the Roanoke Valley, areawide ridesharing would be expected to increase less than 5% under this scenario. The effectiveness of ridesharing assistance programs in the Roanoke Valley would generally be enhanced under the conditions associated with the expected scenario.

Unconstrained Scenario

This scenario is the most optimistic of the three in portraying the travel conditions likely to be faced by commuters in the future. In addition to a 5% decrease in peak-hour travel times, this scenario assumes a 20% decrease in the real price of gasoline (i.e., $1.32/gallon instead of $1.65/gallon).

With such favorable highway travel conditions, ridesharing would be expected to decline among all travel markets. The percentage decline would be greatest for long-distance commuters (12.8%), although the level of ridesharing remains high at 26.6%. Ridesharing among medium-distance commuters would decrease a little over 8%, and the decrease among short-distance commutes would be less than 4%.

Because the sensitivity of commuters to changes in travel conditions varies with the level of ridesharing, this scenario would be most detrimental to the benefits expected under an intense program, such as a Level Four ridesharing program.

Summary

Although no probabilities were assigned to the scenarios, the analysis presented above strongly suggests that ridesharing will continue to be the most viable alternative for long-distance commuters to the Roanoke Valley. Further, these results project an increasing role for ridesharing in the Roanoke Valley for all but the unconstrained scenario.

While this analysis was limited to those modes deemed viable as a result of the earlier modal analysis, it is unlikely that express transit service would become significantly more attractive under any of the scenarios. Referring to Table 2.41, the conditions which are generally most favorable to growth in transit patronage (the constrained scenario) are accompanied by a significant deterioration in transit service levels. Judging from the results of the more extensive scenario analysis for the Northern Virginia case study, the net effect would be an overall reduction in the attractiveness of transit service.

The results of the analysis presented above tend to reinforce the conclusions reached in the Modal Alternatives section--ridesharing is now, and will continue to be, the most appropriate modal option for long-distance commuters.

IMPLEMENTATION

Recommended Actions

Based on the preceding analyses, it is evident that significant benefits for the Roanoke Valley can be obtained by the implementation of a ridesharing program. The most appropriate program for the Roanoke Valley is the Level Three Ridesharing Assistance Program. This program would be expected to achieve substantial reductions in user costs, VMT, fuel consumption, and pollutant emissions at a modest public cost. A Level Three Program would be significantly more cost-effective and produce more desirable impacts than the lesser cost alternative, a Level Two Program. While not as cost-effective as a Level Four Program, the Level Three Program does take advantage of the economies of scale, while avoiding the larger staffing and financial commitments.

One slight change in the structure of the Level Three Program may be appropriate for circumstances in the Roanoke Valley. As part of the $60,000 budget for a Level Three Program, approximately $9,000 annually in computer processing expense is anticipated. Assuming a minimum two-year program commitment, it may be advisable to purchase a micro-computer to be used for the matching of ridesharing applications (if such equipment is not already available to GRTC). Not only would the expense associated with this purchase be significantly less than the anticipated cost of purchased services, the micro-computer could also be used extensively in the GRTC's transit operations. While such a purchase would appear sound financially, it may be appropriate to delay its consideration until the true level of ridesharing applications and computer expenses can be determined. A minimum of one year would be necessary for the computer processing cost to stabilize, and at that point or at the time of an overall program evaluation, the possible purchase of a micro-computer should be evaluated.

In addition to an organized ridesharing assistance effort, there are complementary measures which should be considered. The provision of pool staging lots in the Roanoke area would complement the ridesharing program and is deserving of consideration. The conclusions reached in the recent Park and Ride Feasibility Study sponsored by the Fifth PDC and VDH&T appear sound, and steps should be taken for a staged implementation of these recommendations. Additionally, current plans for construction of a downtown intermodal terminal with 105 spaces reserved for carpools and continuation of the downtown shuttle would be supportive of areawide ridesharing efforts. It would also be desirable that downtown employers, in particular, be encouraged to provide free or reduced-rate, reserved parking for carpools and vanpools. As the surplus parking downtown diminishes, this may be a valuable promotional tool for ridesharing and a significant employee benefit.

Implementation of a ridesharing program should reflect a commitment by public agencies in the Roanoke Valley. The estimated impacts of a ridesharing program as presented in this report represent expected results at program maturity. The period between implementation of a ridesharing program and full realization of benefits can be expected to be at least two years; thus, a ridesharing program should be more than a one-year experiment.

Perhaps the most critical aspect of implementing a ridesharing program is finding the right individual(s) for the job. Because so much of ridesharing assistance is marketing/promotion, the ability and persuasiveness of the individual running the program are key factors in its effectiveness. As observed by a recent TRB Conference on Ridesharing Needs and Requirements, because the position of ridesharing coordinator reflects a relatively new field, there exists no standard set of qualifications to be used in evaluating candidates. This is a significant problem with serious implications for the success of the program. Consideration should be given to establishing staff salaries at a level to attract well-qualified individuals.

Implementation Responsibilities

The Greater Roanoke Transit Company (GRTC) should be the implementing agency of the proposed ridesharing program. Arguing in favor of GRTC as the implementing agency is the fact that the GRTC is both commuter service-oriented and an existing transportation implementing agency. Further, as a result of their recent marketing program, the GRTC is known to major employers in the Valley and these contacts could be of particular value in the proposed ridesharing program. It should be pointed out that the staff positions described in the outline for a Level Three Program should be additions to GRTC staff, rather than additional duties for existing staff.

One question which requires clarification is whether GRTC's service charter would limit the ridesharing service area to the City of Roanoke and the Town of Vinton. A member of Valley Metro's staff has suggested no limitation would exist, if funds were derived from a source other than the City of Roanoke. This question should be evaluated in more detail.

Funding Sources

Funding for the implementation of the proposed program should be sought from the VDH&T Public Transportation, Promotion, Operational Studies and Ridesharing Support program. Under this program, VDH&T can provide up to 80% of approved ridesharing programs. The local share of program cost (20%) would amount to about $12,000 annually. It is suggested that the Fifth Planning District Commission be responsible for obtaining the local funding from the member counties and cities. These funds would be transferred to the GRTC, specifically earmarked for the ridesharing program. Because of its role as a regional agency, the Fifth PDC is in a more advantageous position than the GRTC in seeking broad, local financial support. It is desirable that additional funds specifically for the Ridesharing Program be solicited from local governments.

An alternative funding source which is not recommended is the state program for Experimental Public Transportation Projects. While this program will finance up to 95% of the program cost, funding is limited to a period of twelve months. This period would most probably not be sufficient to fully develop the ridesharing program, and other funding would be required for program continuation. Futher, the use of funds from a continuing source and the development of local funding support serves to reinforce the permanent aspect of the program. This funding arrangement also serves to involve local governments and should enhance program effectiveness.

Monitoring

As with most projects, the development of a monitoring program should be part of the implementation process. It is suggested that the initial monitoring program be keyed to a two-year program. Prior to implementation of the program, the current level of ridesharing in the Roanoke Valley should be assessed. This can be accomplished through vehicle occupancy checks on major arterials during the peak period, and surveys of employees working in the CBD and at selected major employers. This information can be used to establish initial program goals and can be used later to assess program impacts.

In addition to a periodic assessment of the outward signs of program effectiveness, certain internal effectiveness measures should be maintained on a quarterly basis. Among the desired measures are: number of participating firms (employees as a percentage of the work force), number of applications submitted by employees of participating firms, number of total applications submitted, number of applications matched, and number of matches actually ridesharing. This information will be particularly valuable in evaluating the program and insetting internal goals and priorities. The collection of this information should not, however, become an end in itself and should consume no more than 5% to 10% of staff time (less than a week each quarter). This information will also be extremely valuable to the VDH&T in evaluating alternative program structures and in providing assistance to local ridesharing programs.

After the program has been operational for eighteen months to two years, the original surveys should be repeated to fully determine its effectiveness. Based on this assessment, a decision should be reached jointly between the GRTC and the Fifth PDC as to the future of the ridesharing effort.

CONCLUSIONS

This case study was undertaken to accomplish two objectives: (1) to test and refine the planning methodology presented earlier in the Methodology Report, and (2) to assess the potential of commuter modal alternative in the Roanoke Valley. The Roanoke Case Study verified the basic applicability of the methodology to a medium-sized urban area, and provided refinements to the methodology. The case study identified ridesharing as the most feasible commuter modal option for the Roanoke Valley, and confirmed the limited potential for public transit in serving long-distance commuter travel. The following section expands upon these basic conclusions.

Methodology

- The methodology can be a valuable tool in assessing the viability of a wide range of commuter options at relatively low cost.

- Modal screening criteria and warrants for supplemental TSM actions can be effectively used in gauging the appropriateness of a variety of modal options and supportive actions.

- Commuter response to alternative programs can be estimated with sufficient accuracy to establish general feasibility and infer implementation priorities.

- The methodology can successfully interface with standard computer-based travel data (i.e., as from a regional transportation study) as well as being applied to circumstances where such data is lacking.

- The methodology tended to under-estimate current ridesharing in the Roanoke Valley. The results of the Northern Virginia and Martinsville Case Studies suggest this problem may be due to the use of default values, lacking study area-specific trip length data.

- The sensitivity tasks and incremental logit aspects of the methodology are also capable of estimating traveler response to transportation systems changes (fuel cost, parking cost, highway level of service), although some additional improvement in gauging the influence of existing travel circumstances (parking cost and highway level of service) on modal demand would be useful.

Commuting Actions

- Ridesharing assistance and encouragement can produce substantial benefits to both the residents of, and commuters to, the Roanoke Valley.

- In addressing the problems of long-distance commuting to the Roanoke Valley, ridesharing is clearly the most feasible and appropriate action.

- In the Roanoke Valley, ridesharing is also the most practical alternative for short- to medium-distance commuters.

- While ridesharing is the most appropriate modal option for area commuters, the generally high level of service of the highway system and low parking charges constrain ridesharing from achieving its full potential.

- The potential of express bus service for medium- and long-distance commuting is very limited, and even under the constrained scenario, express bus service is not likely to be a major commuting alternative.

SUMMARY

The principal conclusion derived from the case study analyses is that, regardless of urban area size or characteristics, ridesharing modes (carpooling, vanpooling, and buspooling) offer virtually the only feasible modal alternatives to the single-occupant (i.e., drive alone) auto for long-distance commuters. This conclusion applies generally to work trips 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 10 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, bus) for trips longer than 10 miles.

The high costs of transit service (bus or rail), coupled with the modest volumes of long-distance commuters in most 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 the corridors. Public transportation plays an essential role in meeting the demands of shorter commuting trips, primarily within medium-sized and large urban areas. The Northern Virginia case study has underscored this fact through its assessment of Metrorail's positive impact on commuting conditions in that area.

Fortunately for the commuters and taxpayers 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.

However, a major question associated with ridesharing in the future is whether further substantial shifts to that mode can be attained, 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 to ridesharing of 12% in Martinsville to a maximum shift of 6% in Northern Virginia.

Although small as a percentage of total commuting, these modal shifts are not insignificant in their impacts in reducing vehicle-miles of travel, pollution emissions, and gasoline consumption, because they are drawing strongly from the longer work trips. Moreover, they are additions to an already strong base of ridesharing. For example, about 30% of all workers in the Martinsville area are already ridesharing.

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 will be difficult to serve with conventional transit, and local congestion around these sites is likely to grow. Ridesharing programs focused upon major employers may be a critical element in future transportation planning for such areas.

In summary, while the absolute shift in modal share of commuter travel to ridesharing may be modest even under an active promotional program, the state should pursue a strong ridesharing program because (1) it is very cost-effective as a mode of travel in terms of public costs 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, replacement of major factor in holding down congestion, pollution emissions, and energy consumption, and (3) it is the only feasible modal alternative for most long-distance commuters.

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APPENDIX

ROANOKE CASE STUDY

TABLE 2A.1
1980 CARPOOL MARKET ADJUSTMENT FACTORS

Adjustment Factor	Trip Origin Bedford	Botetourt	Craig	Floyd	Franklin	Montgomery	Roanoke	City of Roanoke	City of Salem
For: Income	0.967	0.969	0.981	1.007	0.985	0.971	0.939	0.975	0.939
Roanoke County Destinations									
Distance	1.00	1.00	1.00	1.00	1.00	1.00	0.918	0.844	0.844
Firm Size	0.809								
Employment Type	0.940								
City of Salem Destinations									
Distance	1.61	1.61	1.35	1.35	1.61	1.35	0.844	0.844	0.66
Firm Size	0.938								
Employment Type	0.940								
City of Roanoke Destinations									
Distance	1.35	1.35	1.61	1.61	1.35	1.61	0.81	0.81	0.81
Firm Size	0.959								
Employment Type	0.940								
Roanoke CBD Destinations									
Distance	1.35	1.35	1.61	1.884	1.61	1.884	0.844	0.81	0.81
Firm Size	0.915								
Employment Type	0.966								

TABLE 2A.2
1980 VANPOOL/BUSPOOL MARKET ADJUSTMENT FACTORS

Adjustment Factor	Trip Origin Bedford	Botetourt	Craig	Floyd	Franklin	Montgomery	Roanoke	City of Roanoke	City of Salem
For: Income	No Adjustment Factor								
	Roanoke County Destinations								
Distance	1.00	1.00	1.00	1.00	1.00	1.00	0.645	0.645	0.565
Firm Size	1.049								
Employment Type	0.883								
	City of Salem Destinations								
Distance	2.747	2.747	1.804	1.804	2.747	1.804	.565	0.565	0.227
Firm Size	1.056								
Employment Type	0.883								
	City of Roanoke Destinations								
Distance	1.804	1.804	2.747	2.747	1.804	2.747	0.448	0.448	0.448
Firm Size	1.003								
Employment Type	0.883								
	Roanoke CBD Destinations								
Distance	1.804	1.804	2.747	3.462	2.747	3.462	0.565	0.448	0.448
Firm Size	0.845								
Employment Type	0.933								

Table 2A.3
1980 EXPRESS BUS MARKET ADJUSTMENT FACTORS

Adjustment Factor	Trip Origin Bedford	Botetourt	Craig	Floyd	Franklin	Montgomery	Roanoke	City of Roanoke	City of Salem
For: Income	1.01	1.019	0.997	0.985	1.00	1.012	1.042	1.008	1.035
Roanoke County Destinations									
Distance	Not Analyzed								
Firm Size									
Employment Type									
City of Salem Destinations									
Distance	Not Analyzed								
Firm Size									
Employment Type									
City of Roanoke Destinations									
Distance	Not Analyzed								
Firm Size									
Employment Type									
Roanoke CBD Destinations									
Distance	1.452	1.452	1.365	1.365	1.365	1.365	0.936	0.886	0.886
Firm Size	No Adjustment Factor								
Employment Type	0.941								

Table 2A.4

ESTIMATED 1995 DISTRICT TO DISTRICT VEHICLE TRIPS (24-HOUR, ALL PURPOSES)

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EST. DATA SET J1 TABLE 1

I/J	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	139	133	609	281	273	170	129	209	636	425	564	188	134	111	39	126	252	244	75
2	136	108	493	277	315	188	146	219	495	366	618	205	143	116	41	140	268	231	73
3	597	475	2212	2297	1324	558	388	333	871	581	1345	493	410	327	147	460	577	568	196
4	278	278	2332	825	1157	577	313	274	604	506	1212	411	336	289	107	315	530	387	127
5	272	314	1345	1152	892	797	514	395	653	664	2109	727	664	513	224	658	819	636	269
6	168	192	571	584	804	415	318	214	378	393	1253	467	510	442	188	434	506	403	185
7	130	152	392	312	545	318	109	140	361	420	1078	351	238	183	75	243	331	331	112
8	213	218	324	278	378	215	142	0	563	449	809	268	176	137	60	191	262	352	119
9	642	502	905	605	667	395	374	480	1334	1242	1426	524	353	280	128	383	528	954	334
10	420	365	597	502	671	399	418	459	1177	462	2522	899	378	320	177	543	733	1542	498
11	568	625	1279	1198	2067	1267	1052	820	1428	2399	1453	3053	1623	1413	687	1996	2030	2546	916
12	186	202	489	409	735	471	361	275	524	903	3010	167	643	469	355	1162	1318	930	397
13	137	144	415	328	650	512	256	177	345	378	1636	635	58	701	246	553	718	401	194
14	110	114	320	286	504	445	186	140	275	303	1450	461	708	366	374	427	540	314	156
15	36	43	144	108	223	190	74	60	127	177	685	361	239	381	178	302	436	151	73
16	126	144	471	315	656	441	244	191	379	537	1985	1169	557	437	309	1046	2029	743	398
17	249	272	578	537	825	507	333	263	523	743	1828	1340	728	553	440	2086	2174	2202	1354
18	236	224	561	391	630	409	334	353	932	1546	2665	928	379	309	152	731	2223	1502	1126
19	77	72	198	126	264	182	114	122	235	511	910	399	192	158	71	402	1352	1140	140
20	340	358	958	1033	1434	1229	460	383	603	552	1523	694	766	694	415	768	825	745	359
21	469	273	1433	869	604	327	207	285	1306	532	994	340	259	215	87	276	494	380	138
22	299	167	618	298	437	297	205	297	1541	816	1352	493	255	222	86	407	1303	1222	597
23	281	120	513	265	246	163	120	183	950	360	557	185	122	110	47	150	326	394	176
24	265	125	460	268	234	170	114	168	938	353	557	206	130	126	55	223	473	624	277
25	635	300	915	584	500	315	254	377	2101	768	1124	449	273	248	142	513	932	1626	755
26	217	99	416	194	207	155	98	149	866	362	622	254	135	119	60	264	692	919	411
27	147	74	398	196	203	153	81	110	534	242	474	166	115	108	46	150	368	332	141
28	33	14	72	31	41	31	16	24	147	58	114	37	21	22	8	34	95	77	35
29	197	131	481	275	511	396	207	203	841	848	1647	718	381	328	130	794	2711	1490	950
30	224	235	683	517	951	643	355	295	667	840	2534	1353	755	608	333	1821	3761	1359	1044
31	36	39	151	103	231	192	72	62	123	172	658	322	237	350	275	247	388	136	61
32	36	38	147	113	242	208	72	58	123	131	486	149	188	216	66	119	206	98	42
33	71	79	366	294	517	403	140	117	237	237	788	245	229	223	79	186	360	164	63
34	618	491	4313	2863	2036	1058	525	466	1520	1010	2522	801	645	572	196	594	1157	630	228
35	329	169	1313	543	557	350	177	211	1068	459	1139	352	254	221	73	258	548	284	114
36	178	201	663	542	1044	954	335	270	530	571	2286	736	980	1101	365	598	1003	494	213
37	190	147	1007	581	640	508	189	221	887	638	1499	346	247	258	66	251	441	283	92
38	36	43	140	118	309	281	89	93	216	241	715	153	128	140	29	106	182	93	30
39	33	37	123	103	259	239	76	79	192	214	719	158	167	211	37	106	184	100	32
40	17	15	61	44	109	105	37	38	90	133	438	149	84	141	51	109	149	69	24
41	63	75	240	179	473	349	154	160	384	537	1643	526	280	247	63	482	842	290	117
42	23	20	70	50	118	90	40	42	131	173	409	133	73	66	16	119	250	128	71
43	130	79	376	243	335	253	118	172	796	496	956	238	159	178	50	189	364	340	122
44	32	19	95	53	72	51	24	39	178	100	183	43	31	29	6	29	54	46	16
	9619	7925	30247	21170	25890	17376	9970	9606	28909	23848	54497	22292	15383	14258	6779	20991	35734	27900	12846

Table 2A.4 (cont'd)

ESTIMATED 1995 DISTRICT TO DISTRICT VEHICLE TRIPS (24-HOUR, ALL PURPOSES)

UFMTR 11JUL80

9APR82 14.07.10 UFMTR REPORT 4 PAGE 4

EST. DATA SET J1 TABLE 1

I/J	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
1	340	463	296	284	273	617	212	142	30	194	220	33	37	68	617	329	183	190	37
2	356	280	165	128	126	292	104	77	12	125	231	38	39	79	484	172	200	147	43
3	940	1422	604	510	452	889	402	398	69	474	689	147	147	365	4503	1297	670	1004	140
4	1030	867	290	260	254	573	190	195	34	268	516	104	113	289	2828	540	546	584	119
5	1401	613	441	248	233	486	207	204	37	516	949	231	242	503	2024	559	1052	638	309
6	1193	330	301	159	171	306	160	150	32	390	636	191	210	410	1074	355	982	507	281
7	461	206	202	112	110	253	92	79	17	205	346	71	73	138	518	180	338	190	89
8	385	277	291	172	160	358	143	112	24	205	290	62	58	117	468	210	272	220	93
9	611	1302	1536	938	920	2068	853	535	144	837	663	126	120	246	1520	1062	547	887	216
10	570	526	809	351	340	736	354	242	60	819	830	172	133	236	998	456	586	638	242
11	1539	999	1339	551	565	1073	617	472	111	1659	2563	663	514	793	2511	1147	2309	1500	716
12	693	331	494	172	206	453	253	162	36	734	1378	327	145	247	785	353	735	346	153
13	750	265	255	127	130	273	136	114	19	382	744	235	183	228	646	257	964	247	127
14	715	214	217	114	123	244	119	109	22	325	597	345	215	221	566	219	1103	258	140
15	415	89	86	45	56	149	59	44	7	132	333	279	65	75	192	68	366	66	29
16	769	279	409	148	221	519	259	154	34	786	1815	251	113	187	597	257	593	251	106
17	837	488	1315	326	469	955	673	354	97	2724	3832	390	206	362	1149	544	986	441	181
18	740	380	1219	397	616	1628	909	324	80	1477	1355	134	98	165	633	281	483	283	94
19	365	136	598	175	270	759	408	145	32	946	1050	162	40	62	224	113	206	93	30
20	716	740	639	311	335	508	301	318	65	751	1161	436	650	1633	2202	773	2672	620	394
21	735	620	602	645	574	1248	455	352	68	425	488	90	88	197	2306	1212	395	372	51
22	640	606	881	734	995	2672	1075	438	103	1813	1347	76	71	110	647	461	336	248	55
23	309	632	741	794	1339	2372	832	642	139	599	491	44	47	100	739	659	208	355	49
24	341	570	1003	1311	2848	3762	1702	2361	466	974	727	156	57	103	751	629	233	364	56
25	522	1264	2672	2363	3760	5628	2945	2402	569	2538	1736	146	132	250	1727	1428	524	1067	176
26	306	455	1083	829	1691	2856	1329	691	261	1185	878	54	41	79	526	475	196	197	36
27	323	348	445	643	2328	2415	698	1660	354	474	465	49	46	83	583	394	197	247	38
28	65	68	107	137	467	588	253	356	8	107	103	6	8	13	88	62	32	18	3
29	753	423	1824	603	970	2567	1181	468	108	3454	4934	117	90	141	574	377	456	269	70
30	1167	481	1359	489	710	1756	877	468	101	4974	6980	304	197	310	1024	468	948	334	112
31	444	90	78	45	53	148	53	49	7	117	307	215	63	73	190	64	362	55	21
32	652	92	73	48	51	129	40	47	7	90	193	63	25	136	206	65	1503	92	52
33	1629	194	114	97	104	249	81	92	15	139	312	74	134	208	744	179	669	258	50
34	2191	2319	645	748	758	1755	520	582	88	581	1032	191	213	738	8504	1848	1008	1379	135
35	761	1221	461	675	627	1437	473	389	62	377	462	66	65	176	1838	673	349	292	32
36	2678	392	339	203	229	525	195	200	33	456	956	363	1493	673	1004	352	4166	424	253
37	618	369	245	351	363	1069	198	245	17	268	336	54	93	258	1379	295	424	1087	238
38	395	51	54	51	56	176	37	37	3	69	113	21	51	50	136	31	252	122	0
39	246	51	58	52	57	187	39	43	3	77	120	26	24	38	106	30	562	21	16
40	78	24	37	24	31	102	21	21	2	46	88	35	17	12	50	13	93	22	11
41	250	88	164	99	124	452	107	77	7	420	966	44	41	40	172	54	228	2349	164
42	64	32	100	58	75	292	67	37	4	282	397	12	13	15	58	20	63	100	15
43	232	198	362	562	1221	2479	413	532	73	348	323	41	54	58	365	159	222	8157	3995
44	37	54	58	121	108	305	54	59	5	55	40	5	8	9	85	46	33	260	62
	30262	20849	25011	17210	25569	48308	20096	16578	3465	33817	43992	6449	6472	10294	48341	19166	29252	27199	9229

Table 2A.4 (cont'd)
ESTIMATED 1995 DISTRICT TO DISTRICT VEHICLE TRIPS (24-HOUR, ALL PURPOSES)

-----------------------------UFMTR 11JUL80 -----------------------------

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EST. DATA SET J1 TABLE 1

I/J	39	40	41	42	43	44	ROW TOTAL
1	33	14	62	22	131	32	9596
2	39	16	76	20	80	18	7925
3	125	60	239	72	377	95	30249
4	102	43	179	50	242	53	21127
5	258	109	473	120	334	73	25873
6	240	106	348	88	255	51	17351
7	76	37	155	41	117	23	9950
8	78	38	159	41	173	39	9599
9	192	90	383	133	794	179	28958
10	214	133	537	172	494	101	23831
11	718	438	1642	410	956	183	54408
12	157	148	525	133	239	43	22254
13	166	84	281	74	158	31	15360
14	213	142	247	65	179	28	14219
15	36	50	63	17	49	6	6764
16	105	109	481	120	189	30	20959
17	181	154	843	248	364	54	35708
18	97	68	292	130	342	45	27901
19	34	23	117	71	120	16	12860
20	249	76	251	66	231	37	30254
21	47	26	87	33	197	53	20854
22	57	35	165	100	362	58	24997
23	53	25	99	55	564	120	17275
24	57	34	122	77	1221	106	25697
25	185	98	449	295	2477	307	48471
26	40	23	107	68	414	55	20114
27	41	21	78	35	530	59	16592
28	4	1	8	4	73	6	3495
29	77	46	420	280	350	54	33845
30	120	90	964	399	321	42	43973
31	26	34	44	10	42	5	6450
32	22	17	42	14	53	8	6458
33	38	12	40	14	60	8	10312
34	108	49	171	57	365	84	48314
35	30	13	54	22	161	46	19181
36	559	96	227	62	220	35	29197
37	101	19	3255	177	8872	176	28998
38	8	10	105	12	3907	27	8916
39	8	15	12	20	316	5	5201
40	24	0	21	11	268	0	2914
41	16	13	0	110	2257	148	15494
42	33	9	62	44	1074	83	5031
43	331	1007	2658	296	1342	289	31311
44	7	13	103	0	457	11	3095
	5305	3644	16646	4288	31727	2922	901331

SINOFF 6700 (INFORMATION): UFMTR ENDED AT 14.07.13 (RETURN CODE= 0)

Table 2A.5

ESTIMATED 1995 DISTRICT TO DISTRICT VEHICLE TRIPS (24-HOUR, WORK TRIPS)

UFMTR 11JUL80

9APR82 14.03.48 UFMTR REPORT 4 PAGE 3

EST. DATA SET J1 TABLE 1

I/J	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	30	28	152	67	54	106	40	55	160	166	289	74	42	56	3	42	67	40	5
2	31	24	137	72	75	111	43	61	123	149	304	85	48	60	5	48	83	45	7
3	33	33	320	200	155	165	58	53	100	165	418	104	60	82	5	61	98	34	7
4	41	51	544	188	234	240	77	66	101	209	519	131	83	111	8	78	105	37	7
5	10	26	193	148	122	177	73	52	58	140	412	113	84	90	12	74	103	39	7
6	4	10	46	51	79	81	31	18	22	57	187	51	48	55	12	37	46	13	3
7	15	26	69	56	102	109	24	31	53	124	321	88	50	55	11	51	56	47	8
8	33	41	40	41	55	67	28	0	92	112	216	60	31	34	5	32	33	47	7
9	56	49	65	30	41	76	41	54	167	190	245	65	31	43	1	31	49	63	10
10	33	30	18	16	30	48	41	49	101	51	325	95	23	26	5	33	38	155	32
11	1	4	4	1	13	9	13	8	3	30	10	51	19	17	8	21	11	26	7
12	6	15	41	30	74	117	52	38	49	189	613	40	94	86	40	176	183	97	28
13	8	17	44	35	97	147	49	30	26	105	420	140	13	166	42	107	124	37	13
14	3	7	37	27	58	104	28	20	26	80	314	83	109	81	42	59	84	19	5
15	3	9	51	33	52	105	26	22	35	100	308	117	70	121	41	86	121	29	9
16	4	17	98	54	115	210	63	46	62	222	705	314	135	148	57	258	475	124	56
17	0	12	45	27	55	115	32	25	32	137	379	160	73	76	18	191	288	130	70
18	29	37	144	81	113	277	92	93	196	528	1040	289	107	155	12	193	545	317	218
19	9	12	79	41	62	157	42	42	90	229	490	150	67	94	9	120	356	253	34
20	19	24	121	114	149	190	48	36	45	108	309	83	81	92	24	50	91	17	4
21	90	47	315	152	104	218	63	81	325	265	590	145	80	116	5	86	136	53	10
22	63	42	237	106	110	326	85	108	439	450	945	245	113	173	8	160	397	300	117
23	50	18	112	49	32	122	31	50	203	156	318	68	33	65	2	40	60	47	12
24	27	14	101	45	33	151	31	37	152	172	392	90	41	82	3	64	105	64	15
25	49	10	24	7	4	48	13	27	205	98	136	21	4	33	0	17	29	145	47
26	31	14	119	50	36	169	39	46	199	205	461	114	47	90	3	77	170	157	51
27	23	13	107	47	34	157	31	35	118	166	397	92	40	85	4	61	98	54	11
28	10	6	27	19	13	44	9	11	39	48	108	24	12	24	1	15	28	15	4
29	20	21	180	80	93	397	90	79	212	505	1137	324	143	225	10	266	784	356	199
30	11	26	186	97	149	402	95	80	137	437	1185	379	175	240	21	333	989	184	126
31	6	8	52	31	59	118	27	23	35	100	337	122	76	133	73	82	125	29	7
32	2	7	40	26	54	106	24	20	28	79	245	64	57	81	13	38	57	14	4
33	13	19	108	93	126	193	46	39	55	143	405	102	73	99	11	61	99	24	7
34	130	116	1208	816	446	617	173	140	347	589	1456	347	205	304	11	200	294	74	24
35	79	45	409	185	143	295	78	81	305	319	794	193	107	159	6	121	188	57	16
36	8	27	128	89	182	382	86	67	85	274	898	230	242	329	62	141	220	49	15
37	86	78	482	337	238	480	124	118	311	479	1124	285	159	240	31	237	220	159	31
38	13	24	64	76	132	211	54	47	66	167	455	107	75	102	14	84	86	49	8
39	15	21	75	72	97	181	45	39	64	156	444	106	88	127	15	87	83	51	10
40	8	9	35	34	44	89	22	21	27	88	255	78	44	77	19	63	64	35	8
41	21	41	110	121	185	326	97	82	108	370	1047	335	168	196	29	316	414	152	41
42	8	14	51	47	54	113	30	25	45	122	315	93	53	73	14	81	103	54	18
43	56	44	178	171	113	334	88	92	206	392	828	218	118	188	23	195	176	187	38
44	14	10	46	33	25	59	17	21	70	73	146	38	21	32	2	31	27	25	5
	1201		6642		4241		2299		5402		22242		3452		740		7908		1361
		1146		4095		8149		2168		8952		6113		4921		4604		3903	

Table 2A.5 (cont'd)

ESTIMATED 1995 DISTRICT TO DISTRICT VEHICLE TRIPS (24-HOUR, WORK TRIPS)

UFMTR 11JUL80

9APR82 14.03.48 UFMTR REPORT 4 PAGE 4

EST. DATA SET J1 TABLE 1

I/J	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
1	134	110	50	79	43	265	13	36	1	7	49	0	1	13	87	50	26	0	0
2	145	64	27	47	23	195	5	28	1	5	57	2	1	18	75	20	34	0	0
3	213	120	28	63	22	256	2	40	0	3	74	0	3	23	221	45	49	0	0
4	310	174	30	70	17	290	2	40	0	3	82	4	3	50	519	57	64	0	0
5	245	50	19	34	7	152	0	22	0	4	66	11	11	41	147	15	78	0	0
6	177	13	8	14	4	66	0	11	0	3	27	11	15	36	45	5	90	0	0
7	122	22	20	22	3	92	0	10	0	2	39	7	6	20	37	8	40	0	0
8	83	33	27	24	1	76	0	8	0	0	20	5	1	13	19	9	22	0	0
9	89	81	110	70	37	243	27	28	2	11	31	2	0	11	28	36	20	0	0
10	39	21	39	16	0	55	1	4	0	1	11	1	3	5	5	3	9	0	0
11	7	2	2	0	0	3	0	0	0	0	9	0	3	6	0	3	16	0	0
12	122	17	20	24	6	126	1	15	0	1	141	34	2	17	12	4	53	0	0
13	167	19	15	18	1	91	1	11	0	1	83	37	20	26	19	6	153	0	0
14	139	16	12	20	5	101	0	13	0	3	56	38	22	17	15	5	142	0	0
15	154	25	17	29	14	157	4	24	0	11	78	61	8	17	20	4	78	0	0
16	253	42	46	60	19	305	7	44	1	65	363	36	5	27	31	7	78	0	0
17	137	20	40	34	14	188	10	20	0	110	250	10	2	14	11	2	36	0	0
18	320	73	204	135	98	711	122	90	3	193	252	4	2	33	44	6	65	0	0
19	190	42	109	79	56	407	59	57	1	161	247	3	2	18	29	4	41	0	0
20	184	67	22	42	9	141	1	24	0	1	64	22	40	138	141	36	207	0	0
21	287	143	90	189	111	591	39	95	2	17	105	1	1	33	234	182	50	0	0
22	385	174	196	279	242	1215	186	163	5	319	319	1	1	44	107	65	72	0	0
23	127	131	116	215	272	726	133	139	14	28	58	0	2	22	64	108	20	0	0
24	173	81	97	241	521	945	196	443	54	45	92	0	0	21	49	42	30	0	0
25	30	102	308	346	437	846	362	245	55	163	25	0	0	6	12	103	3	0	0
26	190	91	177	229	374	953	258	167	41	135	146	1	0	25	48	50	33	0	0
27	173	76	65	196	587	861	114	451	69	20	84	1	0	24	54	43	28	0	0
28	43	24	20	52	144	253	56	120	0	2	28	1	0	7	19	10	10	0	0
29	444	117	383	246	208	1261	179	170	5	77	1260	2	0	49	67	24	82	0	0
30	483	98	128	180	105	924	62	135	1	623	1290	6	2	52	67	15	99	0	0
31	176	26	17	35	13	167	3	27	0	4	78	59	8	18	18	6	84	0	0
32	214	22	16	29	9	127	1	21	0	2	44	8	7	30	15	3	391	0	0
33	520	52	25	54	18	227	1	39	0	2	72	5	15	49	143	27	134	0	0
34	838	601	122	302	110	1118	16	205	0	4	242	0	3	173	2066	364	133	0	0
35	380	343	94	248	149	796	52	139	1	20	142	0	0	54	387	142	68	0	0
36	763	60	45	85	23	396	2	60	0	1	152	53	326	109	44	8	914	0	0
37	446	188	104	226	93	867	16	164	0	91	213	7	13	118	441	96	158	0	0
38	244	32	23	40	6	168	1	31	0	20	60	3	1	32	36	9	105	0	0
39	158	36	29	48	15	204	3	38	0	26	69	3	1	22	43	14	195	0	0
40	67	18	15	25	5	109	1	20	0	14	46	9	3	10	21	7	44	0	0
41	220	55	62	83	13	407	6	66	0	112	490	4	4	32	53	17	82	0	0
42	86	25	25	40	16	194	3	30	0	49	139	4	2	14	33	9	46	0	0
43	243	112	129	310	455	1525	67	274	1	106	197	3	6	48	100	54	82	0	0
44	38	29	22	65	35	198	8	35	0	16	27	0	0	8	24	13	13	0	0
	9958	3647	3153	4643	4340	19004	2020	3802	257	3218	7377	469	562	1543	5650	1736	4177	0	0

Table 2A.5 (cont'd)

ESTIMATED 1995 DISTRICT TO DISTRICT VEHICLE TRIPS (24-HOUR, WORK TRIPS)

```
----------------------------UFMTR   11JUL80 ----------------------------
9APR82  14.03.48          UFMTR    REPORT  4                    PAGE     5
          EST.          DATA SET J1      TABLE  1
 I/J      39     40     41     42     43     44      ROW TOTAL
----  -------  -----  -----  -----  -----  -----  -------------
   1        0      0      0      0      0      0           2440
   2        0      0      0      0      0      0           2258
   3        0      0      0      0      0      0           3313
   4        0      0      0      0      0      0           4545
   5        0      0      0      0      0      0           2835
   6        0      0      0      0      0      0           1376
   7        0      0      0      0      0      0           1746
   8        0      0      0      0      0      0           1315
   9        0      0      0      0      0      0           2133
  10        0      0      0      0      0      0           1369
  11        0      0      0      0      0      0            316
  12        0      0      0      0      0      0           2579
  13        0      0      0      0      0      0           2293
  14        0      0      0      0      0      0           1790
  15        0      0      0      0      0      0           2039
  16        0      0      0      0      0      0           4552
  17        0      0      0      0      0      0           2763
  18        0      0      0      0      0      0           6820
  19        0      0      0      0      0      0           3041
  20        0      0      0      0      0      0           2750
  21        0      0      0      0      0      0           5051
  22        0      0      0      0      0      0           8197
  23        0      0      0      0      0      0           3643
  24        0      0      0      0      0      0           4649
  25        0      0      0      0      0      0           3960
  26        0      0      0      0      0      0           4996
  27        0      0      0      0      0      0           4427
  28        0      0      0      0      0      0           1246
  29        0      0      0      0      0      0          10395
  30        0      0      0      0      0      0           9522
  31        0      0      0      0      0      0           2190
  32        0      0      0      0      0      0           1098
  33        0      0      0      0      0      0           3099
  34        0      0      0      0      0      0          13794
  35        0      0      0      0      0      0           6595
  36        0      0      0      0      0      0           6555
  37        0      0      0      0      0      0           8470
  38        0      0      0      0      0      0           2655
  39        0      0      0      0      0      0           2690
  40        0      0      0      0      0      0           1434
  41        0      0      0      0      0      0           5865
  42        0      0      0      0      0      0           2028
  43        0      0      0      0      0      0           7437
  44        0      0      0      0      0      0           1226
       -----  -----  -----  -----  -----  -----  -------------
           0      0      0      0      0
                  0      0      0      0      0      175095
SINOFF 6700 (INFORMATION): UFMTR     ENDED AT 14.03.54 (RETURN CODE=   0)
```

Table 2A.6
1995 CARPOOL MARKET ADJUSTMENT FACTORS

Adjustment Factor for:	Rte. 220 N/ I-81 NE	Rte. 460 NE	Rte. 24 E	Rte. 116 E	Rte. 220 S	Rte. 221 S	I-81 SW	Rte. 311 N	Roanoke County	City of Roanoke	City of Salem
Income	0.969	0.967	0.967	0.985	0.985	0.998	0.971	0.981	0.939	0.975	0.939
Roanoke County Destinations											
Distance	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.918	0.833	0.833
Firm Size	0.809										
Employment Type	0.940										
City of Salem Destinations											
Distance	1.61	1.61	1.61	1.61	1.61	1.35	1.35	1.35	0.844	0.844	0.66
Firm Size	0.938										
Employment Type	0.940										
City of Roanoke Destinations											
Distance	1.35	1.35	1.35	1.35	1.35	1.35	1.61	1.61	0.81	0.81	0.81
Firm Size	0.959										
Employment Type	0.940										
Roanoke CBD Destinations											
Distance	1.35	1.35	1.35	1.35	1.35	1.35	1.884	1.61	0.884	0.81	0.81
Firm Size	0.915										
Employment Type	0.966										

Table 2A.7
1995 VANPOOL/BUSPOOL MARKET ADJUSTMENT FACTORS

Adjustment Factor For:	Rte. 220 N/ I-81 NE	Rte. 460 NE	Rte. 24 E	Rte. 116 E	Rte. 220 S	Rte. 221 S	I-81 SW	Rte. 311 N	Roanoke County	City of Roanoke	City of Salem
Income	No Adjustment Factor										
Roanoke County Destinations											
Distance	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.645	0.565	0.565
Firm Size	1.049										
Employment Type	0.883										
City of Salem Destinations											
Distance	2.747	2.747	2.747	2.747	2.747	1.804	1.804	1.804	0.565	0.565	0.227
Firm Size	1.056										
Employment Type	0.883										
City of Roanoke Destinations											
Distance	1.804	1.804	1.804	1.804	1.804	1.804	2.747	2.747	0.448	0.448	0.448
Firm Size	1.003										
Employment Type	0.883										
Roanoke CBD Destinations											
Distance	1.804	1.804	1.804	1.804	1.804	1.804	3.462	2.747	0.565	0.448	0.448
Firm Size	0.845										
Employment Type	0.933										

Table 2A.8
1995 EXPRESS BUS MARKET ADJUSTMENT FACTORS

Adjustment Factor For:	Rte. 220 N/ I-81 NE	Rte. 460 NE	Rte. 24 E	Rte. 116 E	Rte. 220 S	Rte. 221 S	I-81 SW	Rte. 311 N	Roanoke County	City of Roanoke	City of Salem
Income	1.019	1.014	1.01	1.00	1.00	0.992	1.012	0.997	1.042	1.008	1.035
Roanoke County Destinations											
Distance Firm Size Employment Type	Not Analyzed										
City of Salem Destinations											
Distance Firm Size Employment Type	Not Analyzed										
City of Roanoke Destinations											
Distance Firm Size Employment Type	Not Analyzed										
Roanoke CBD Destinations											
Distance	1.452	1.452	1.452	1.452	1.452	1.452	1.365	1.365	0.936	0.886	0.886
Firm Size	No Adjustment Factor										
Employment Type	0.941										