Northern Virginia Transportation Technical Study

NVTC Northern Virginia Transportation Commission

NORTHERN VIRGINIA
TRANSPORTATION
TECHNICAL STUDY

SEPTEMBER 1977

NVTC

NORTHERN VIRGINIA TRANSPORTATION COMMISSION
2009 NORTH 14th STREET
ARLINGTON, VIRGINIA 22201

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I. INTRODUCTION

In late 1972, public transportation was beginning to become the focus of public and governmental attention in Northern Virginia and throughout the Washington, D.C. area. The Shirley Highway Express Bus Demonstration Project was spectacularly successful, Dial-a-Rides were being tried in a number of different areas in the country, and public takeover of the local bus systems was imminent. It was apparent that there were several portions of Northern Virginia where detailed study of bus and bus-related improvements would be fruitful. The Northern Virginia Transportation Commission (NVTC), a regional agency charged with transit development in the area, applied for a grant from UMTA through the Second Unified Work Program (FY 1974) of the Metropolitan Washington Council of Governments (MWCOG) to study and develop implementation plans for these type improvements.

The original work program was divided into three main work elements:

1. Investigate the feasibility of providing new and/or expanded circulation, collection, and distribution transit services to serve current and proposed travel demands in the Alexandria Central Business District and Old Town areas, and their connection and relationship to Metrorail stations in Alexandria.
2. Analyze the feasibility of initiating dial-a-ride transit services in sparsely developed or "transit isolated" sections of Northern Virginia.

3. Investigate priority bus movements, improved and expanded bus services and additional fringe parking in two major corridors in Northern Virginia, and study the feasibility of utilizing short sections of the abandoned W&OD railroad right-of-way for transit.

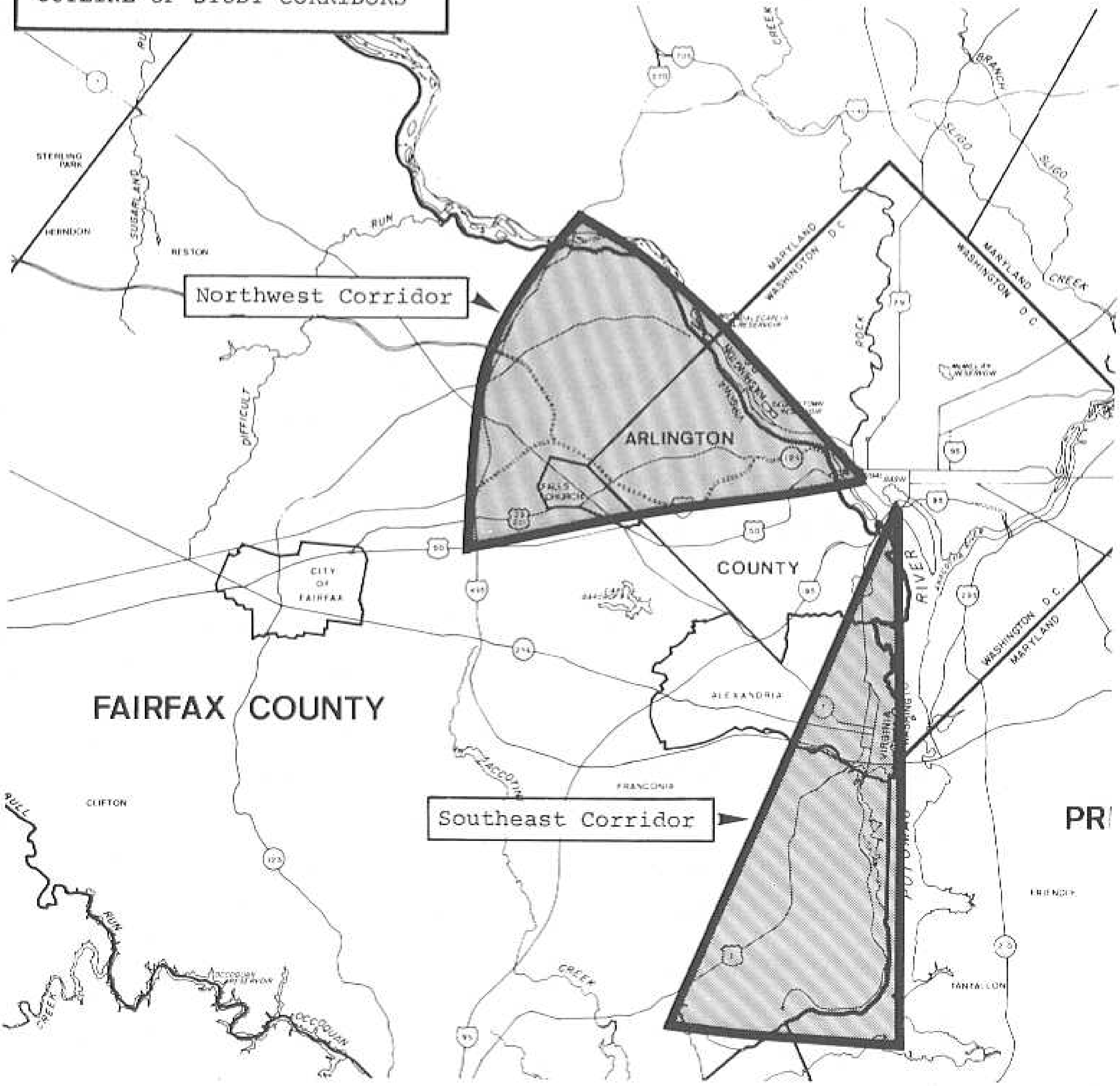
The work program was subsequently amended to delete the dial-a-ride feasibility study, based on the one-year experimental dial-a-ride service operated in Fairfax City. This project showed that dial-a-ride is an expensive service that is probably not feasible in Northern Virginia at this time due to the rapidly growing financial commitments of the local jurisdictions for Metrobus and rail services. The budget was amended, and funding for this work element was withdrawn.

The Alexandria Downtown Collector-Distributor system study was done for NVTC by a consultant, Barton-Aschman Associates. It was divided into two phases; the first looking at the potential demands, and a range of circulation alternatives, the second being a detailed ridership, cost and organizational analysis of a "mini-bus" system which was recommended in Phase 1. Both these reports have been completed, and are available through NVTC and the City of Alexandria. The sections dealing with Findings and Recommendations from each of the Phases are attached in Appendix 4.

The overall objectives of the bus improvement study were to investigate, and where appropriate develop implementation plans for bus service improvements in two geographic corridors of the Northern Virginia region. These improvements would include not only bus routings; but

Figure 1

OUTLINE OF STUDY CORRIDORS



other important related items such as preferential treatment for buses, fringe parking, and investigating the use by buses of the abandoned Washington and Old Dominion (W&OD) railroad roadbed and right-of-way (ROW). The remainder of this report will deal with this element of the overall study.

The study area consisted of two major transportation corridors in the area, the U.S. Route 1 corridor in the southeastern part of Northern Virginia, and the Lee Highway corridor in the northwest. (See Figure 1.) It was felt that both these areas had high transit ridership demand and potential, and that benefits could be gained from improving services here. These corridors were broadly defined to allow efforts to be focused on specific areas as further study dictated.

The study was coordinated throughout its length with the Northern Virginia jurisdictions, and meshed well with other on-going efforts such as the Arlington County Long-Range Transit Plan, and the NVTC Design of Busways in Northern Virginia Study (carried out under the First Unified UMTA Technical Studies Grant). In fact, in several instances data collected during the study was used as input to these other projects. Similarly, bus service improvements identified while evaluating for preferential bus treatment often led to other, more general routing efficiencies. Therefore, the study benefits were not limited to the actual project implementation, but have had other, more general effects.

It should be noted that the papers presented in the Appendices are as they were originally circulated during the course of the study. They have not been updated to account for changed bus routes, or newer traffic counts. In the case of the I-66 right-of-way, a four lane plan was approved by the U.S. Secretary of Transportation, and construction has begun. In the other papers only minor changes in conditions have occurred.

II. SUMMARY OF FINDINGS AND RECOMMENDATIONS

CORRIDOR STUDIES

Bus Preferential Treatment

As the scope of this study was quite broad, it was necessary to develop a methodology for determining those areas worthy of detailed analysis. In particular, determining locations where delays occur, and preferential bus treatment would be justified, was a priority goal.

The NVTC staff developed a methodology for doing this screening, and determining the potential benefits of preferential treatment. First, buses on a route of interest were followed in an auto during "rush hour", and time and distance were recorded at specific intersections. By graphing these times and distances, a picture of where delays occurred became immediately apparent.

After identifying intersections where delays were occurring, a detailed analysis was made. This analysis centered around on-the-ground counts of buses, passengers, and delays experienced during morning and evening rush hours. It was generally found that the majority of the delays occurred in the morning peak periods, as traffic begins to feed into the major radial routes, so most attention was placed here. The methodology is detailed later in this final report.

A great deal of effort was expended on identifying potential preferential treatment locations, collecting data, and designing means for bus priority treatment. It became apparent that the studies must take into account the possibilities for implementation, or effort would be wasted. Also, it was necessary to involve from the start of the study a number of other agencies which have operational control over various roadways. NVTC is a regional body with no real operational responsibility or control over transportation. Study results were always sent to other agencies such as the Virginia Department of Highways and Transportation (VDH&T) and the Washington Metropolitan Area Transit Authority (WMATA) for comment, and their appropriate action.

During the course of the project two preferential bus facilities were begun in the corridors, which were not directly involved in the project, but which affected bus movements. These were Wilson Boulevard, where unbalanced lane operations are used, and Arlington Boulevard, where peak direction exclusive lanes are used. These add to the previously existing bus priority lanes on Shirley Highway, Washington Street (northbound) in Alexandria, and Rosslyn Circle. This combination of preferential treatment improved bus movements in the Northwest Corridor considerably, and alleviated some of the most pressing needs present when the study began. However, several other routes were evaluated in depth including Dolley Madison Boulevard (Rt. 123), the George Washington Memorial Parkway, Lee Highway (Rt. 29-211), and Washington Street (southbound) in Alexandria. A summary of the analyses are found in Chapter III and copies of the detailed papers dealing with Dolley Madison Boulevard, George Washington Memorial Parkway, and the I-66 busway are in the Appendix to this report.

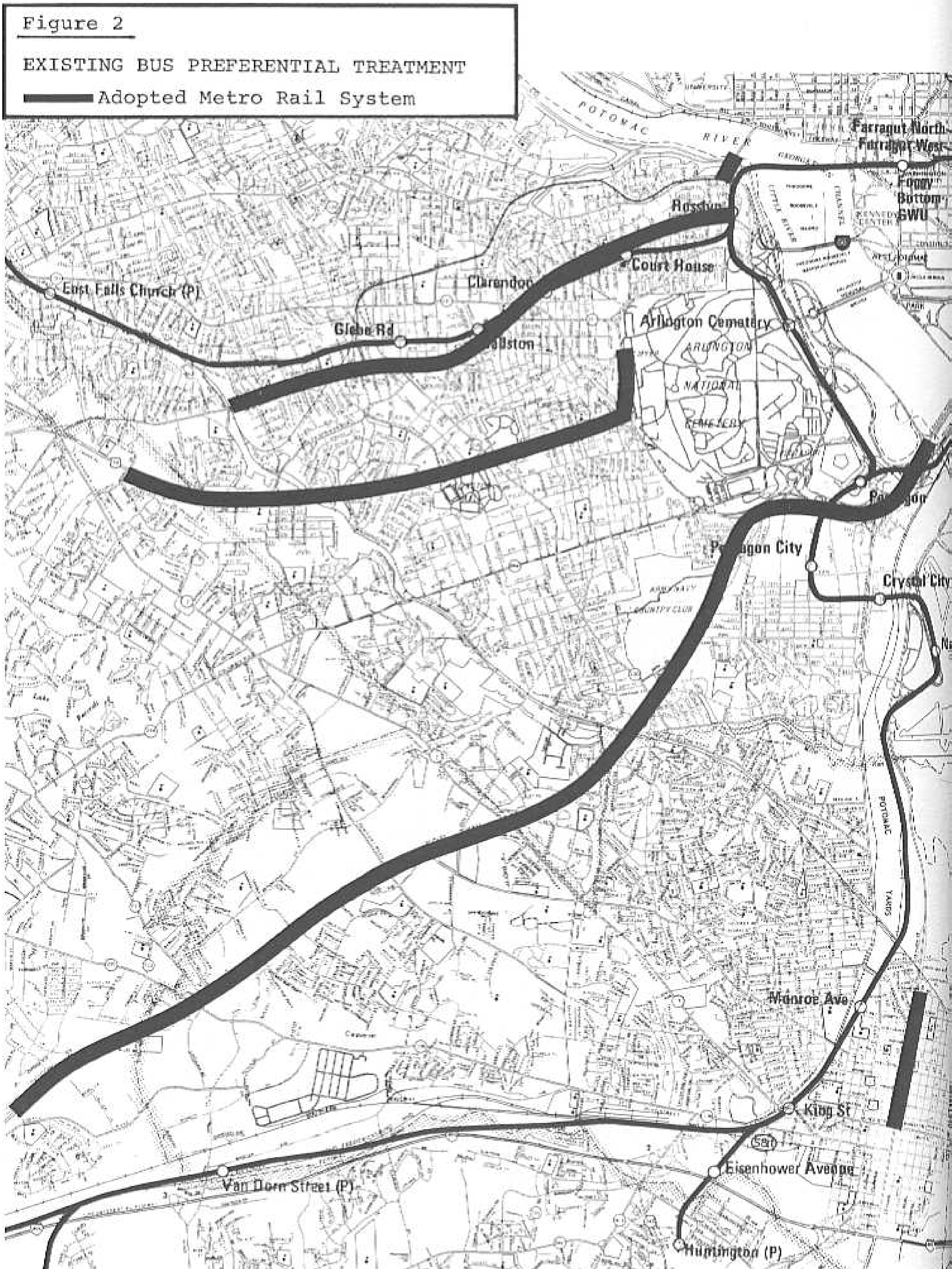


Figure 2

EXISTING BUS PREFERENTIAL TREATMENT

Bus Service Improvements

Existing Metrobus services in the two study corridors were analyzed to determine what changes or additional service was needed to increase peak period ridership, and to take maximum advantage of the proposed preferential bus treatment and fringe parking facilities. This analysis examined several factors including additional service to meet peak hour demand, provision of service to new residential and commercial developments, improved service frequencies where they were below minimum standards, and increased service on facilities where preferential bus treatments were under study or had been recently implemented.

In the Southeast Corridor, the analysis identified a need for eight additional peak period buses. It was recommended that all of these buses operate through Alexandria via Washington Street with only one stop at King Street. In Fairfax County, the buses were allocated to several routes providing service to most of the Mount Vernon District, including several new residential developments in the Woodlawn area. In addition, two existing bus routes in this corridor were recommended to be extended, one in Fairfax County to Mount Vernon and the other in Washington to Capitol Hill and Union Station.

Five additional buses were added to routes in the Northwest Corridor, and the additional bus service and route extensions were implemented by WMATA in conjunction with Phases I and III of the bus service improvement program. Rerouting of buses from Chain Bridge to the George Washington Parkway and Key Bridge has been deferred pending opening of the Key Bridge ramp to buses in the A.M. peak period. Monitoring of ridership on these new services has continued, using data available from WMATA and ridership levels have been satisfactory on all of them.

Fringe Parking

This was originally conceived to be a major analysis of possible fringe parking sites throughout Northern Virginia, looking at under-utilized church and shopping lot space. Experiences from the Shirley Highway project, which used 400 spaces in the Springfield Plaza Shopping Center for a park-and-ride lot, showed that increased maintenance costs to the lot owner could be expected and demands for payment made. Initial contacts with three locations brought similar responses, and offers of lot use in exchange for agreements to improve the lots and provide maintenance. Since NVTC has no funds for this purpose, the policy was established that the appropriate local jurisdiction must pay the cost incurred. The Fairfax County staff felt that they could not support use of small lots, and the majority of the candidate locations are in that County. Improving the existing lot in the I-66 ROW at Lee Highway and Washington Boulevard was also proposed to VDH&T, but again no action was taken awaiting resolution on construction of this facility. Its recent approval means the lot location will now be available for only a limited time more. The Fairfax County staff has, however, recently begun its own program to identify means of obtaining and constructing lots on vacant land in the County where larger centralized lots could be situated.

Study showed that the most efficient locations were those well removed from the core area, where the driver could be intercepted before beginning the inbound trip. Therefore, a special effort was made in the Town of Vienna to identify a site. NVTC originally proposed use of the W&OD right-of-way, but this was unacceptable to the Town. A joint effort between the Town and NVTC staff identified a new site, in an unused shopping center lot. (Figure 10) NVTC assisted the Town staff in developing a plan for this site, in holding public hearings, and obtaining express bus service to the site. The Town agreed to provide a new fence, and maintenance services. This site, with capacity for 100 cars, is currently in operation.

Other locations have been identified in the corridors, and initial contacts made, but have not been formally implemented because of the problems outlined above. However, informal fringe parking is occurring at several of the locations, and has been allowed by the owners.

Washington and Old Dominion Right-of-Way

At the inception of this Transit Technical Study it was felt that the Right-of-Way (ROW) from the Washington and Old Dominion Railroad (W&OD) offered an ideal location for transit use. (Figure 8) This right-of-way was purchased by VEPCO, and has been utilized to place towers and transmission lines. A further complication to use of the ROW has been the use of it by the Northern Virginia Regional Park Authority, and local jurisdictions as park facilities. Several miles of bike-hiking paths are currently located in the ROW, and more are planned.

The NVTC staff did one detailed analysis of using the ROW as a feeder route to the Dunn Loring Metrorail station. However, this station is not presently projected for operation until late 1981, with the financial future of the entire Vienna line somewhat questionable, and so local officials are not prepared to address access issues at this time. Therefore, the proposal generated little comment.

It appears that use of the W&OD ROW for transit has been basically precluded by construction of VEPCO transmission towers and recreational facilities along much of its length. The railroad bridge over the Capital Beltway (I-495) has also been removed, and would be difficult to replace, although a pedestrian facility has been proposed by the Northern Virginia Park Authority. Planning for selected and limited transit use of the ROW, including fringe parking, should continue on a conceptual level so that in the future if access to Vienna line and Metorail stations appear to require this use, detailed plans can be prepared.

ALEXANDRIA COLLECTOR-DISTRIBUTOR SYSTEM

This portion of the Transit Technical Study was prepared through contract with a consultant, Barton-Aschman Associates. It had two distinct phases: An alternative analysis, and a detailed evaluation and design of a selected system. The findings and recommendations from the Phase I and Phase II reports are attached. To briefly summarize, it was found that demand for a downtown circulation system, to provide access to the Braddock and King Street Metrorail stations, as well as enhance circulation within Old Town, was 30,000 - 40,000 person trips per day. The system best suited to meet this demand within the constraints of the City is a fleet of small rubber-tired buses. These should run in conjunction with Metrobus service, and probably only in the off-peak periods. They could be operated by Metro, or the City itself, and would cost less than Metrobus service they would replace.

The Phase I report, showing the alternatives analysis, was presented to the Alexandria City Council, and the concept of the "mini-bus" system endorsed. The Phase II report, detailing the design and cost of the system, and outlining operating and management alternatives, has also been presented to the City staff. The report will be available as a decision making tool to the City, and its implementation rests with them.

FIVE YEAR RECOMMENDED IMPLEMENTATION PROGRAM

(1978 - 1983)

It is felt that the following would be a logical sequence for implementation of the corridor recommendations founds in this report. Costs and funding after the first year would be developed based on the first year study, and continuing planning efforts. The Alexandria Study has a separate short-range program which is outlined in Appendix 4 of this report, and detailed in the Phase II final report.

Year	Activity	(Involved Agencies)
1	Continue study to detail implementation plans, and secure funding. Implement Washington Street southbound bus lanes. (NVTC, Alexandria) ($30,000 UMTA funding proposed)	
2	Implement improved access to Rosslyn from GWMP. (VDH&T, NVTC, NPS, Arlington County) Assist Fairfax County in fringe parking lot program. (VDH&T, Fairfax County, NVTC)	
3	Monitor effects of I-66 busway/carpool lanes on peak-period traffic. Implement GW Parkway bus lane if traffic levels are not decreased. (NVTC, NPS, Fairfax County) (Time phasing dependent on I-66 construction schedule) Continue assistance with parking lot program. (NVTC, VDH&T, Fairfax County)	
4	Study need for feeder busways to Vienna line Metrorail stations based on ridership levels, and bus service needs, and design appropriate facilities. (NVTC, VDH&T)	
5	Implement feeder busways to rail stations if evaluation shows them necessary. (VDH&T)	

III. METHODOLOGY

BUS PREFERENTIAL TREATMENT

The work program for the bus preferential treatment element was quite general in scope. It was apparent that a methodology had to be developed to allow an identification of particular intersections and areas where more detailed analysis was justified.

Simply plotting the major bus routes and number of A.M. peak hour buses, as is done on Figures 3 and 4, indicates the highways that show immediate potential. The major bus routes and roads that are in the study corridors, and do not already have preferential treatment, are then candidates for further study.

A major finding from this first analysis is that in the Southeast Corridor (Alexandria) area, only Washington Street has more than ten buses per hour in the peak period. This number is generally considered the minimum that warrants preferential treatment, so only Washington Street received further detailed delay analysis. Attention was given, however, to rerouting some of the other routes in the Mount Vernon area to make higher volumes on "collector" streets. This was found not to be feasible at this time.

When considering preferential treatment, a number of different strategies are potentially applicable. There have been many publications recently dealing with this subject, so a detailed list and explanation will not be made here. However, it is notable that preferential treatment includes not only long stretches of bus or bus-car

Figure 3

MAJOR BUS SERVICE
Northwest Corridor
January 1976

Legend:
(3) Route Number
2▶ Number of Buses, A.M. Peak Hour (7:00-8:00)
Base Day Route
Rush Hour Only

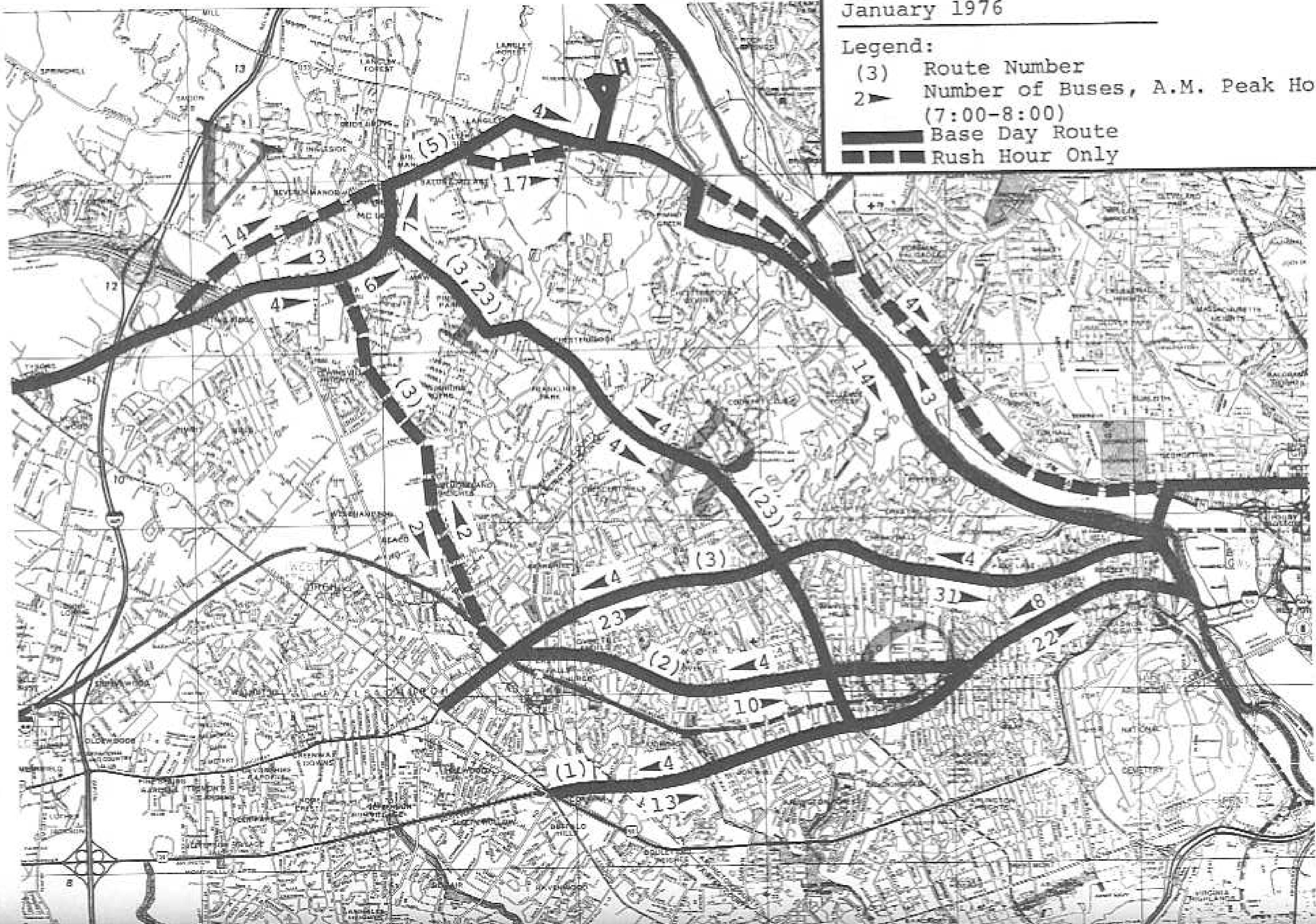
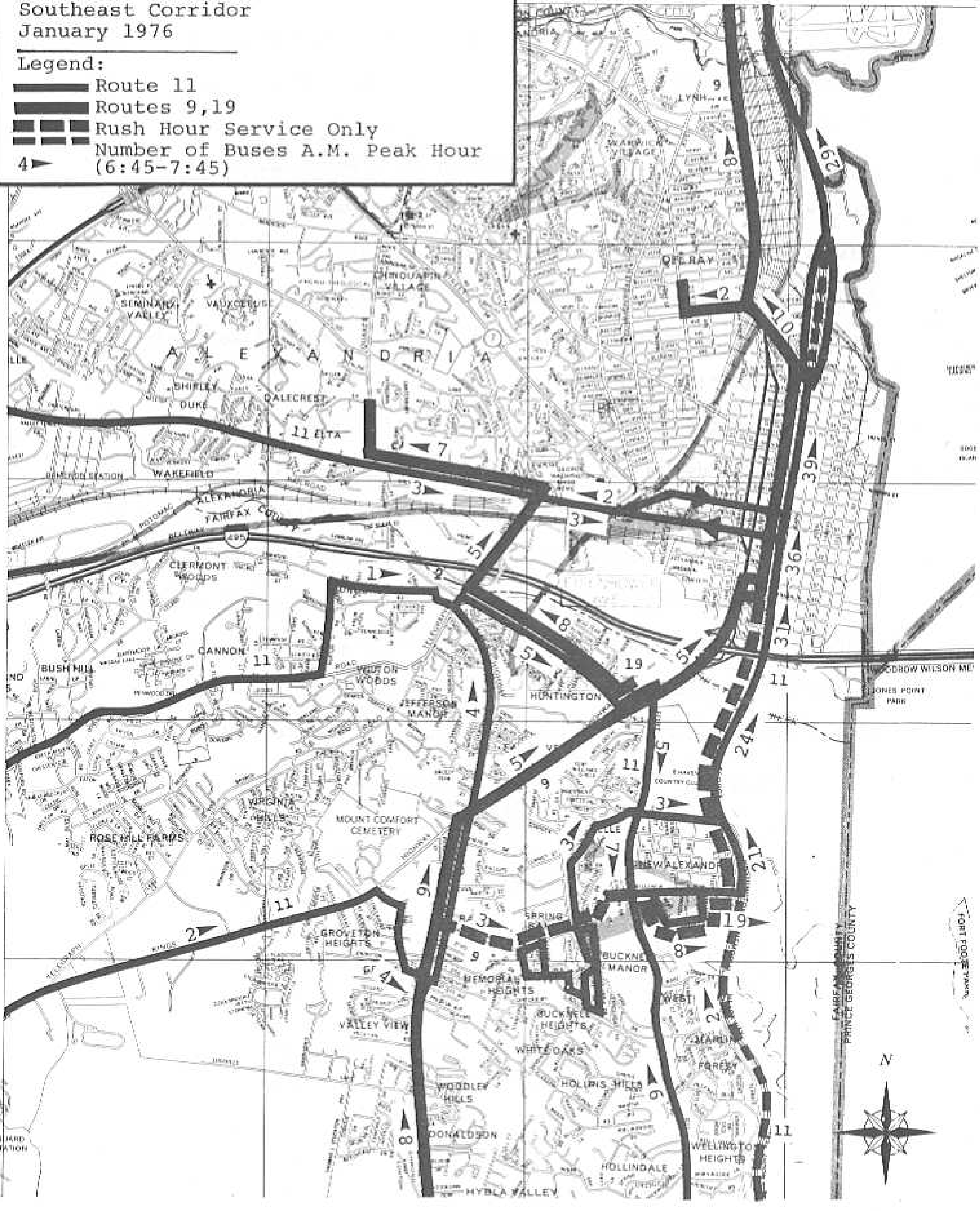


Figure 4

MAJOR BUS SERVICE
Southeast Corridor
January 1976

Legend:
Route 11
Routes 9,19
Rush Hour Service Only
4► Number of Buses A.M. Peak Hour (6:45-7:45)



pool separate lanes, but also more specific improvements such as preferential movement for buses at traffic signals, or short queue "by pass" lanes.

One of the basic assumptions made in all analysis under this study was that recommended improvements must be low capital intensive. This is necessary due to the shortage of available highway improvement funds, the long lead time for major construction projects, and the possibility of major bus routing changes with the progressive completion of Metrorail segments.

Once specific road sections or intersections where delays were occurring were identified, the task became one of deciding on a strategy for preferential treatment, quantifying the potential benefits, and estimating costs. These would be incorporated into a technical proposal which would be presented to appropriate local and state governmental officials and staffs who had implementing responsibility.

The steps generally taken are briefly outlined below, as an overview of the process. A more detailed discussion then follows.

Tasks for Preferential Bus Treatment Study
Road Sections/Intersections

1. Identify specific study section/intersection
2. Gather available data
3. Take delay counts
4. Convert cost of delays
5. Develop means of bus priority
6. Cost out improvements
7. Compute delay costs vs. construction costs
8. Analyze other potential benefits and costs to buses, autos.

When gathering data on the study area, the resources of VDH&T, MWCOG, WMATA, and the local jurisdictions Departments of Transportation were used, as well as on-the-ground counts where necessary. Of importance was the number of buses, average ridership, auto volumes, and street/intersection geometrics.

"Delay counts" were used to determine how long buses were being delayed by traffic tie-ups. This required on the site observations during peak periods. At intersections the observers noted the time that each bus entered the queue, when it finally cleared the intersection, and how many signal cycles passed during the delay. The approximate number of passengers was used as a check with previous data. Observations on queue length, movement, and other traffic data was also gathered during the observation periods.

Over longer stretches of roadway two observers were used, one at each end of the study section. Each noted the bus number, route, and time of passing for each bus. These allowed an accurate computation of travel times for buses throughout the peak period. Such management items as schedule adherence could also be checked with the data.

After the data was taken, it was reduced into aggregate figures showing bus delays over the peak period. In each case, a reasonable estimate of minimum travel time was determined, as even with preferential treatment some delays will be encountered. Using this minimum, and the observed actual travel time, the potential savings per bus could be found. Using the average number of passengers, the passenger hours lost through delays was computed. As passengers value their time at a certain rate, an assumed value could be used to find cost of delay.

This technique, while admittedly crude, at least gives some quantitative basis for comparison with construction costs. However, a detailed analysis of the effects of the recommended strategy on bus movements, existing traffic, and the surrounding land uses was also necessary so that a fully-informed decision could be made. Other considerations such as the potential of the preferential treatment for increasing flow through the study section, and even aiding long-term transit growth were included where appropriate.

After delay counts were taken, and compared with potential minimum travel times, and it was determined that bus priority treatment seemed justifiable, the various strategies for providing the treatment were investigated. It was necessary to take into account the necessity for low capital investment, the surrounding land uses in the study area, and amount of bus and auto flow when determining the most promising technique. Often, several would be roughly costed out, and considered against the potential benefits. The technique that appeared to best fit the situation was then detailed. Using the detailed design concept and costs, if there seemed to be sufficient other benefits to overcome possible problems, the recommendation was made for implementation. This usually included a detailed study paper outlining the process discussed above. Sometimes, as in the case of Washington Street in Alexandria, it simply resulted in discussions with staff with more complete papers and analysis to be done at a later time, if required.

The procedure was used to analyze preferential treatment for Dolley Madison Boulevard (Rt. 123) in Fairfax; the George Washington Memorial

Parkway (GWMP), between Rt. 123 and Key Bridge; Lee Highway from the Arlington County line to Rosslyn; and Washington Street southbound in Alexandria. The papers dealing with Dolley Madison Boulevard and the GWMP are found in Appendix I, and the results of the other analyses are shown below. All have been discussed previously, and appropriate papers sent to a variety of agencies, including MWCOG, WMATA, VDH&T and local government staffs.

The analysis of routes for preferential bus treatment lead to a discussion of the I-66 right-of-way (ROW). This proposed route has a right-of-way primarily acquired and cleared that runs from the Capital Beltway (Rt. 495) into Rosslyn. An analysis was made and a sketch plan proposed for a two-lane bus/car pool facility in this corridor, to replace the previously proposed six to eight lane facility declared environmentally unacceptable by Transportation Secretary Coleman in 1975. This proposal stimulated new thinking, and the approved VDH&T plan is for a four-lane highway, used only by high-occupancy vehicles in the peak periods. The paper outlining the NVTC proposal is also included in Appendix I.

Below is outlined the findings and recommendations on each of the routes listed earlier.

Lee Highway. There are two major congestion points on Lee Highway, between Fairfax and Rosslyn, in the morning peak period. These are the intersection with Glebe Road, and the section of roadway from Veitch Street through Rosslyn Circle. Improvements at Glebe Road are hampered by the commercial development surrounding the intersection, and the large number of bus patrons who board or alight there. No physical changes were recommended, and the possibility of using an electronic signal pre-emption was seen as being of some assistance. However, short of major construction, no preferential treatment would be very effective.

The section from Veitch Street to Rosslyn is only three lanes wide, and uses two lanes in the peak direction. Here, the suggested plan would be a one-way operation in the A.M. peak, with the curb lane for buses. There are many problems with this, including rerouting of counter-flow buses and autos, and access to residences in the area.

Another idea was rerouting of buses from Lee Highway, down Spout Run Parkway to the Goerge Washington Parkway, and then into Rosslyn, by-passing the restricted section. The time savings here are questionable, and access to Rosslyn impossible without major intersection changes, or a new ramp.

These proposals were discussed with the Arlington County staff as input to the County Master Transit Plan. However, the restricted section of Lee Highway will be replaced by the proposed I-66, which would rework it to six lanes. As construction has begun on this facility, no other changes should be made at this time.

George Washington Memorial Parkway (GWMP). This Parkway, operated by the National Park Service (NPS), is a major commuting corridor between northwestern Fairfax County and Washington, D.C. A number of alternative strategies were investigated, and a one-lane bus-carpool priority lane was proposed.

This plan was coordinated through a technical committee including representatives of NVTC, MWCOG, NPS, and Fairfax and Arlington Counties.

The proposal had some opposition from Fairfax and Arlington County representatives, who were concerned with the autos that would be diverted to other routes, and the NPS, who wants to prevent use of the Parkway as a commuter facility. A detailed environmental impact study was outlined by NVTC, MWCOG, and the NPS. However, the presently proposed I-66 peak period busway/carpool roadway would alleviate much of the need for this type of treatment on the GWMP, and the impact analysis was held up pending resolution of this question.

Dolley Madison Boulevard (Route 123). This route, which connects the Beltway with the GWMP is a major commuting corridor from western Fairfax County. Analysis showed that bus delays were occurring at two major intersections: Great Falls Street, and Old Dominion Drive. In this situation, it appeared that a paved shoulder to create a bus queue-bypass lane, and preferential signal treatment would work effectively to speed up bus service. Appropriate designs were proposed and forwarded to the VDH&T for comments.

The Department reviewed the plan and had a number of negative comments concerning its possible detrimental effects on traffic flow, and diversion of autos into residential areas. They further mentioned possible future development around the intersections, and questioned whether there were sufficient buses to justify preferential treatment. Informal discussions with the Department staff failed to find acceptable alternatives, so the proposal was not actively pursued.

Washington Street, Alexandria. NVTC investigated and recommended the provision of a southbound curb bus lane in the evening peak period,

Figure 6

STUDY SECTION
Washington Street
(Alexandria)

from the intersection of the George Washington Parkway to Hunting Towers. This would be opposite a similar, but shorter curb lane operated only in the A.M. peak period. This southbound lane seems justified by the number of buses that use the route, and the width of the road would allow implementation with minimum disruption to existing traffic patterns. NVTC presented this plan informally to the City staff, who are reviewing it.

I-66 Busway. A two-lane exclusive busway could be constructed in the existing I-66 right-of-way at relatively low cost, and in a short period of time. This bus way would provide express bus service along the route from the planned Vienna Metrorail station at least into the Glebe Road station. The advantages are ease and speed of implementation, and increasing attractiveness of bus service to riders, thereby building ridership for Metrorail and increasing the efficiency of the buses. Problems include the issue of car pools, safety at intersections, and the question of where to terminate the lanes.

This proposal has been superceded by the formally proposed plan of VDH&T, endorsed by the U.S. Department of Transportation for a four-lane road. This road would be constructed through Arlington to the Potomac River, and would allow only high-occupancy vehicles during peak periods. This plan has been approved, and construction by VDH&T contractors has begun.

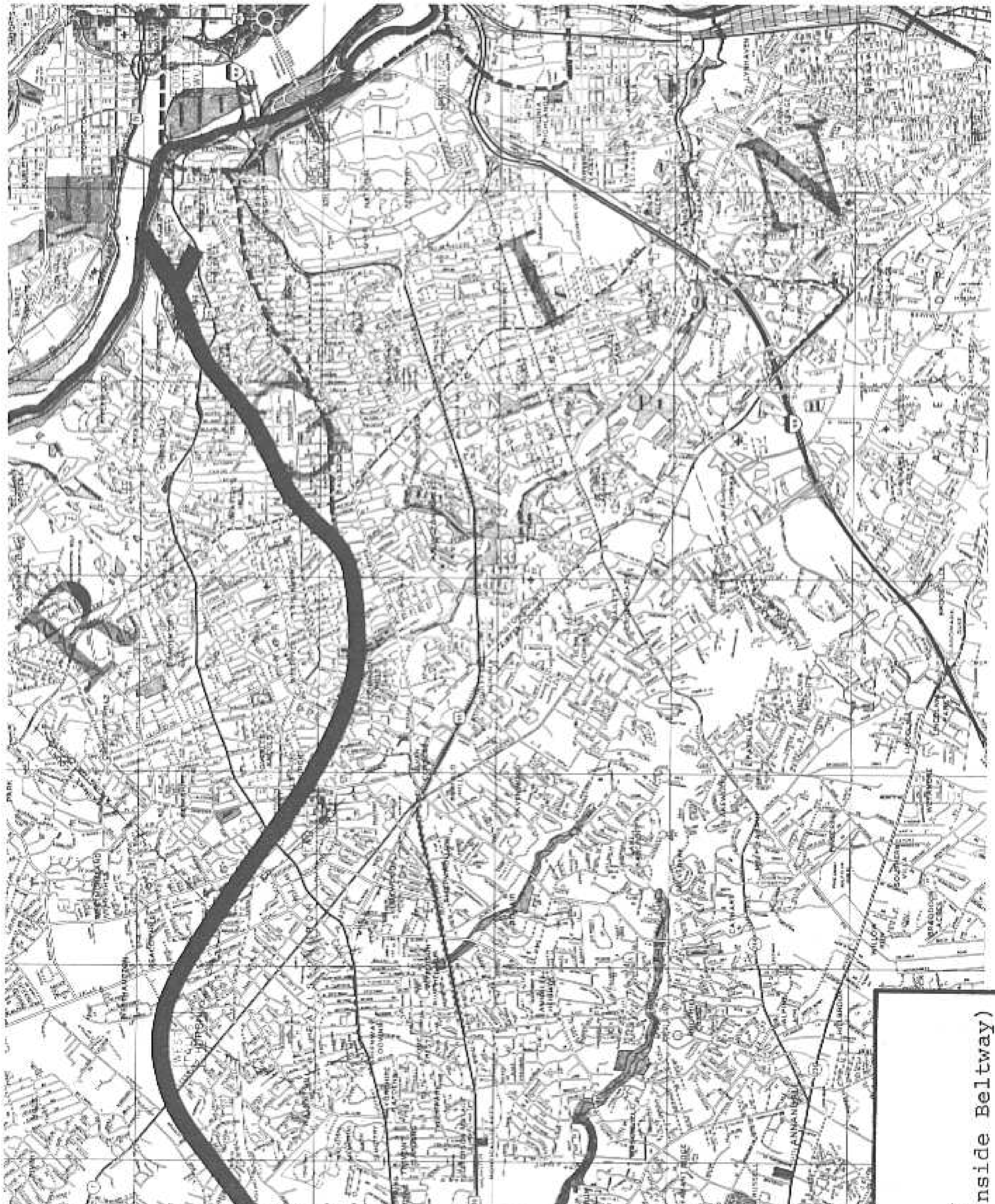


Figure 7

STUDY SECTION
I-66 (Inside Beltway)

BUS SERVICE IMPROVEMENTS

NVTC has had an on-going program of monitoring bus service, and recommending improvements as appropriate. The work done in connection with the bus service improvement element of the technical study was integrated into this on-going effort. The grant efforts focused in particular, however, on the Phase I and III expansion to the WMATA bus fleet. These new buses (27 in Phase I, 42 in Phase III for Northern Virginia) presented an opportunity to add new routes, and additional service on existing routes. The buses were assigned on the basis of existing ridership, and past ridership growth patterns, land uses indicating growth potential, and citizens and staff requests for service. The changes were coordinated with the local jurisdictional staffs, and presented at public hearings.

Several of the routes receiving additional buses serve fringe parking areas, and operate express or limited-stop into the District of Columbia. Use of existing bus priority lanes were made wherever possible. Ridership has been monitored continuously on these and other routes, and has been growing in almost all cases. There were twenty-one new buses added in these corridors, and over 2,000 new passengers per day carried. Below is a brief list of the routes established or receiving additional peak-period service. A detailed list of the improvements, and analyses of ridership as of May 1976 is found in Appendix 2.

Phase I: Route 3M, 3Z, 11P, 11Y

Phase III: Route 3S, 3C, 5X, 23S, 23T, 9P, 11M, 11W

In addition, other changes identified during the study have been incorporated into the Metrorail Phase II bus program. The coming of Metrorail to Northern Virginia with Phase II will be an opportunity for major reroutings and improving efficiency of service.

Study was given to changing the Route 9 buses, which ran a circuitous route from downtown Alexandria to the District of Columbia via U.S. Route 1, down the GWMP for a faster trip. Because these buses are the only ones serving the Route 1 corridor, it was decided to retain them. However, a new Route 9D, which uses the GWMP to the Airport Metrorail station was developed for implementation with Metrorail Phase II service.

WASHINGTON AND OLD DOMINION RIGHT-OF-WAY

The use of the abandoned Washington and Old Dominion (W&OD) railroad right-of-way (ROW) for transit use was perhaps one of the most difficult issues involved in the technical study. The ROW, which runs through portions of Arlington County, Falls Church and Fairfax County is quite valuable vacant land. It is currently owned in the western areas by VEPCO, which has constructed large power transmission towers along much of the length. The portion in Arlington will be used in part by I-66.

In addition to these uses, the Northern Virginia Regional Park Authority (NVRPA) and the local jurisdictions have seen the long, continuous (except for a break at the Capital Beltway) ROW as an excellent location for a bike-hiking trail and linear park. They have proposed

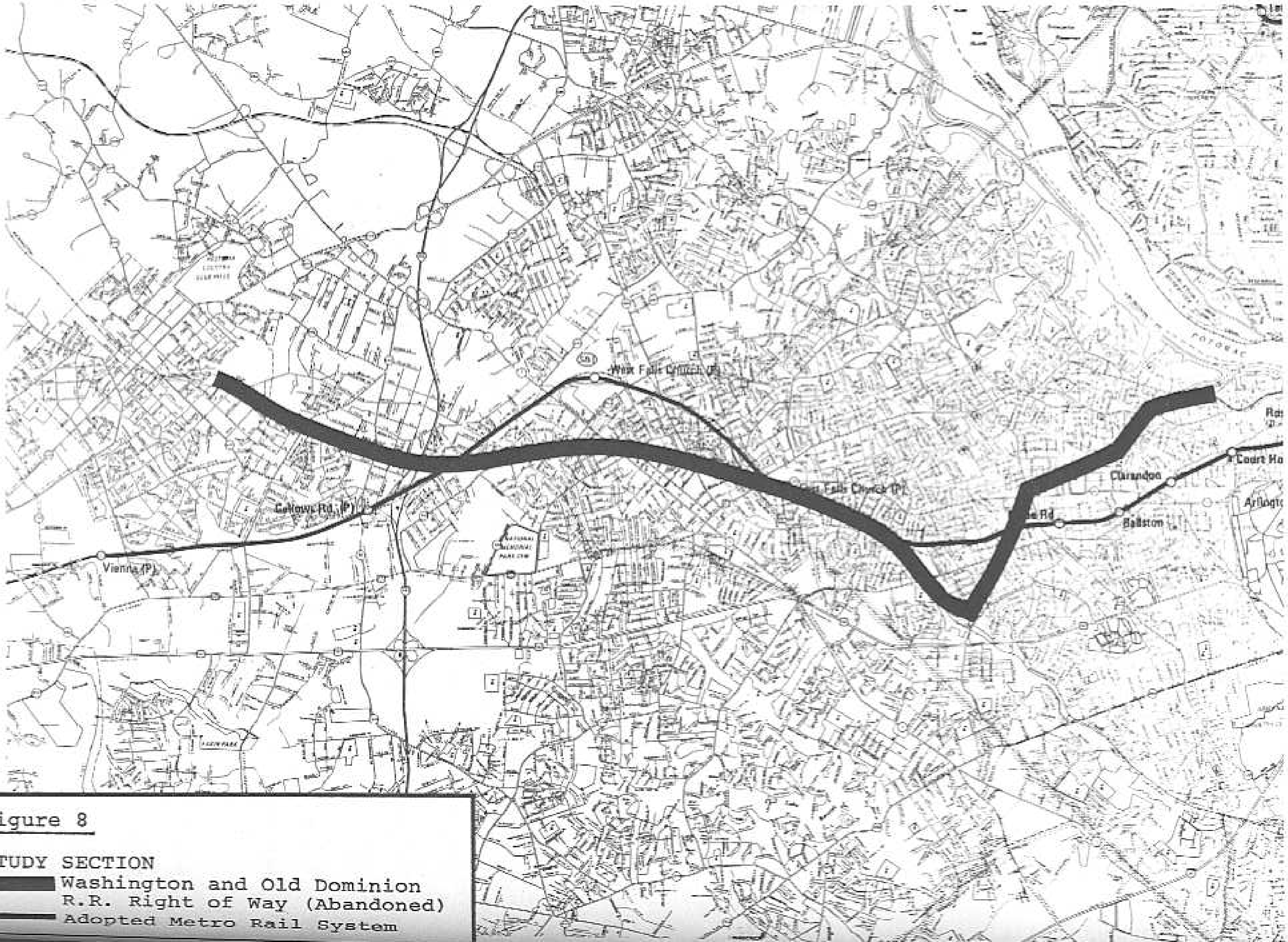


Figure 8

STUDY SECTION
Washington and Old Dominion R.R. Right of Way (Abandoned)
Adopted Metro Rail System

such a use, and in fact have constructed a trail through the City of Falls Church, connecting with an existing one in Arlington which also uses some of the W&OD. This trail and park concept has been the subject of considerable discussion between the NVRPA and VEPCO, but no resolution short of purchase has been found.

In this "maize" of different interests, it has been difficult to raise interest in still other uses such as public transportation. However, there does appear to be some future potential there for use, so that work was done to make local officials and staff aware of the types of transit facilities that might be included. There does not in general seem to be enough space in some areas to have both a transit facility and park-biking trail, and the two uses are in some ways not really satisfactorily compatible, so considerable analysis of alternatives will be necessary to identify satisfactory locations.

Potential uses seemed to fall in two main categories, fringe parking lots, and express bus lanes. The fringe lots would be constructed at locations where the ROW crosses major arterial routes. One such lot exists currently at Lee Highway and Washington Boulevard. However, maintenance, which is a VDH&T responsibility, has been neglected and only a portion of the lot potential spaces are being used. This points up the question of who would maintain other locations, and be responsible in terms of insurance and operation? Some other locations were evaluated, and these are discussed in the following section dealing with fringe parking.

A detailed evaluation was made of the costs and benefits of using a portion of the W&OD ROW near the proposed Dunn Loring Metrorail station as a feeder busway to the station. The basic approach was:

1. Estimate bus usage to the Dunn Loring Metro Station in 1992, using WMATA-MWCOG projections.
2. Establish bus networks, one with the busway, one without. Assign travel speeds based on type road, projected congestion, etc.
3. Calculate travel times from surrounding zones to the rail station over each network.
4. Assign trips to routes over each network.
5. Calculate total travel times, and passenger time savings from the feeder network. Convert to dollars by putting value on passenger time.
6. Design feeder busway, and needed bus lanes on existing roads, and estimate capital cost.
7. Annualize capital costs, and include maintenance.
8. Compare annualized costs with passenger savings. Discuss other costs and benefits of the busway.

This analysis was carried through for the Dunn Loring area, and a copy of the analysis can be found in Appendix 3. It was found that there were considerable time savings to be gained by a feeder busway, and that they compared well with the capital costs. The plan was discussed by the Vienna Council and Fairfax County Board, but no decisions were made. This analysis could really only form the basis for further, more advanced studies. The current Metrorail uncertainties make this further analysis premature at this point, but at some time in the future it may be very valuable.

In general, because the W&OD feeder busways would deal primarily with the "outer" stations on the Vienna line, no more analysis is probably desirable at this time. The NVTC study outlines a methodology, and shows a concept that can be kept on the "shelf", and brought forward in the future as funds are assured to complete the Vienna line.

FRINGE PARKING

The concept of fringe parking evolves from a realization that it is not possible to provide convenient bus service into all neighborhoods in the suburban areas. A combination of a short auto drive to a convenient parking lot, and a bus ride through the more congested central areas is one that can be very attractive to commuters. This has worked well with the Shirley Highway Project, where large lots are filled daily, and looked very promising at the onset of the technical studies.

The approach was to review the areas in the Northwest Corridor, where the commuting distances appeared longest, and traffic volumes are high, and evaluate potential sites. Contact with the owners would then be made for permission to use the lot. The basic premise was that land would not have to be purchased, and that existing lots in churches and shopping centers could be used. In these lots the peak use hours are evenings and weekends, presenting largely unused capacity during the work day. The abandoned W&OD right-of-way, discussed previously, also appeared to offer some locations.

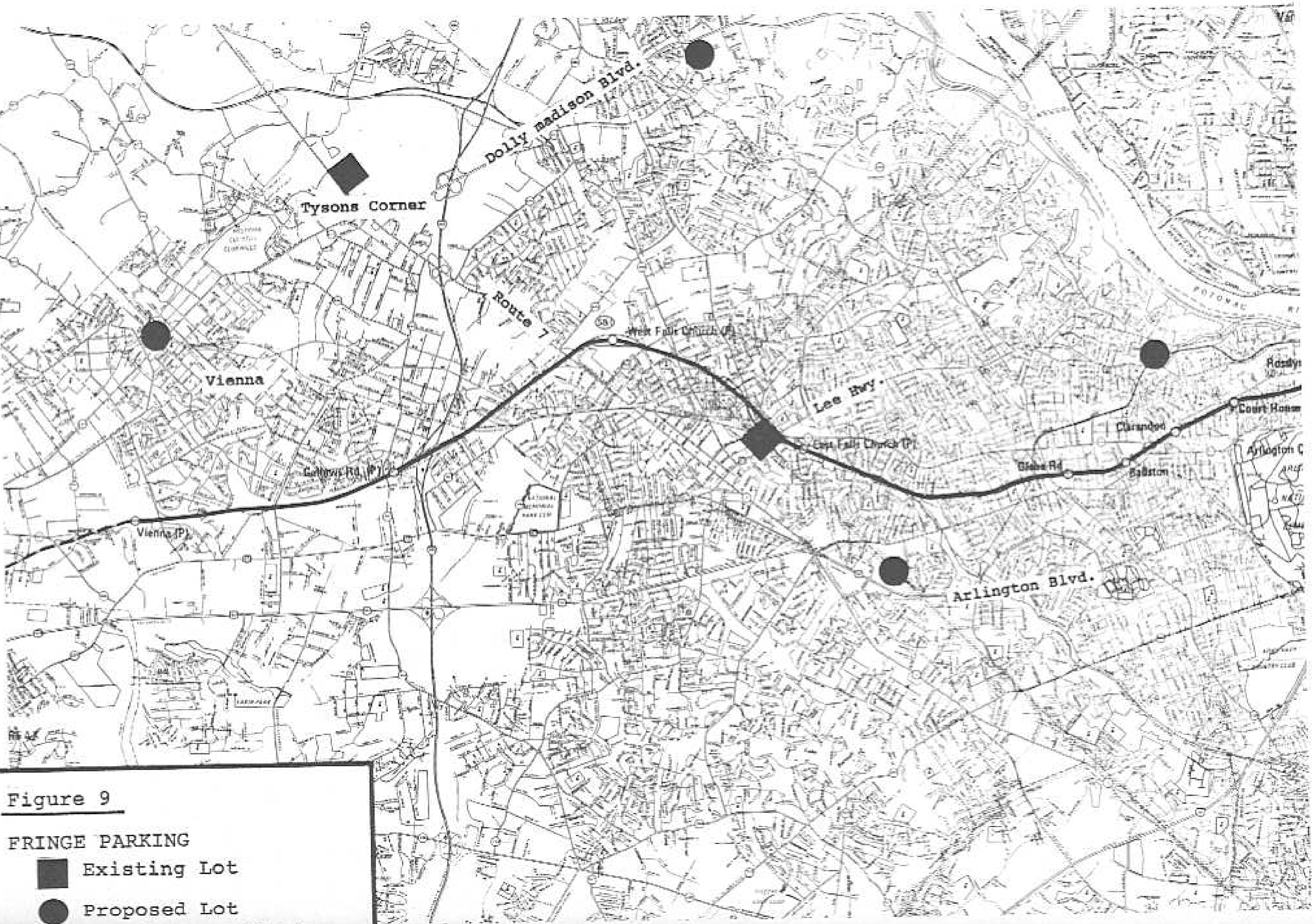


Figure 9

FRINGE PARKING

- Existing Lot
- Proposed Lot
- Adopted Metro Rail System

The basic screening was done, using the following criteria:

1. Proximity to existing bus service.
2. Number of spaces available.
3. Accessibility to autos.
4. Compatibility with existing surrounding land uses.
5. Ownership.

It was felt that lots that would require least changes in bus routings and auto travel patterns would be most desirable. Also, the lot must not conflict with surrounding land uses, or require buses to travel in predominately residential neighborhoods. Experience with bus routings has shown that these are areas of conflict that will bring unfavorable public comment, and should be avoided. The size of the lot is important in that about 50 spaces is the least that would justify arranging for special bus stops, and other agreements.

Using the evaluation criteria, several locations were identified that seemingly offered high potential. They were (see Figure 9):

1. W&OD Right-of-Way in Vienna.
2. The Trinity Methodist Church, on Dolley Madison Boulevard (Rt. 123) in McLean.
3. W&OD Right-of-Way at Kirkwood Road in Arlington.
4. Montgomery Wards parking lot, on Route 50 at 7-Corners.

Initial contacts were made with the owners in each case. Both the church and Montgomery Wards expressed concern over the additional maintenance that would be needed by a commuter lot, and over other issues such as liability insurance, and disruption of normal uses. These concerns were reinforced by the experience with the Shirley Plaza Shopping

Center fringe lot, when the owners requested a "rent" of $400 per month for the 400 parking spaces to pay for maintaining the lot.

The NVTC had previously established a policy that each individual jurisdiction must bear the cost of fringe lots within their area. Based on the Springfield Plaza experience, the Fairfax County staff took the position that church and commercial lots were not of sufficient size and impact to justify the costs involved. Most potential locations are in Fairfax County so further detailed analysis and implementation were not pursued. However, an informal agreement with the Trinity Church has allowed some parking to occur at this location, and the management at Wards has also permitted informal use.

Because of the obvious value of fringe parking to public transit, Fairfax County has embarked on a program to identify means of obtaining vacant lot locations, and constructing lots with the assistance of the Virginia Department of Highways and Transportation. It is hoped that usable land may be obtained from developers, either through purchase or other agreement, and large, efficient lots constructed.

The W&OD location at Kirkwood Road is a part of the proposed I-66 Right-of-Way. VDH&T has strongly indicated that they would not permit any uses of this area until the construction question is resolved. This has also been reflected in decreased maintenance on the existing lot at Washington Boulevard and Lee Highway, in the W&OD ROW, where only a portion of the available space is usable. A plan to upgrade the lot to use more of its capacity was presented to the Department as part of the fringe parking program, but no action was taken. The recent decision to construct I-66 within the Beltway means these lots will be eliminated within the near future.

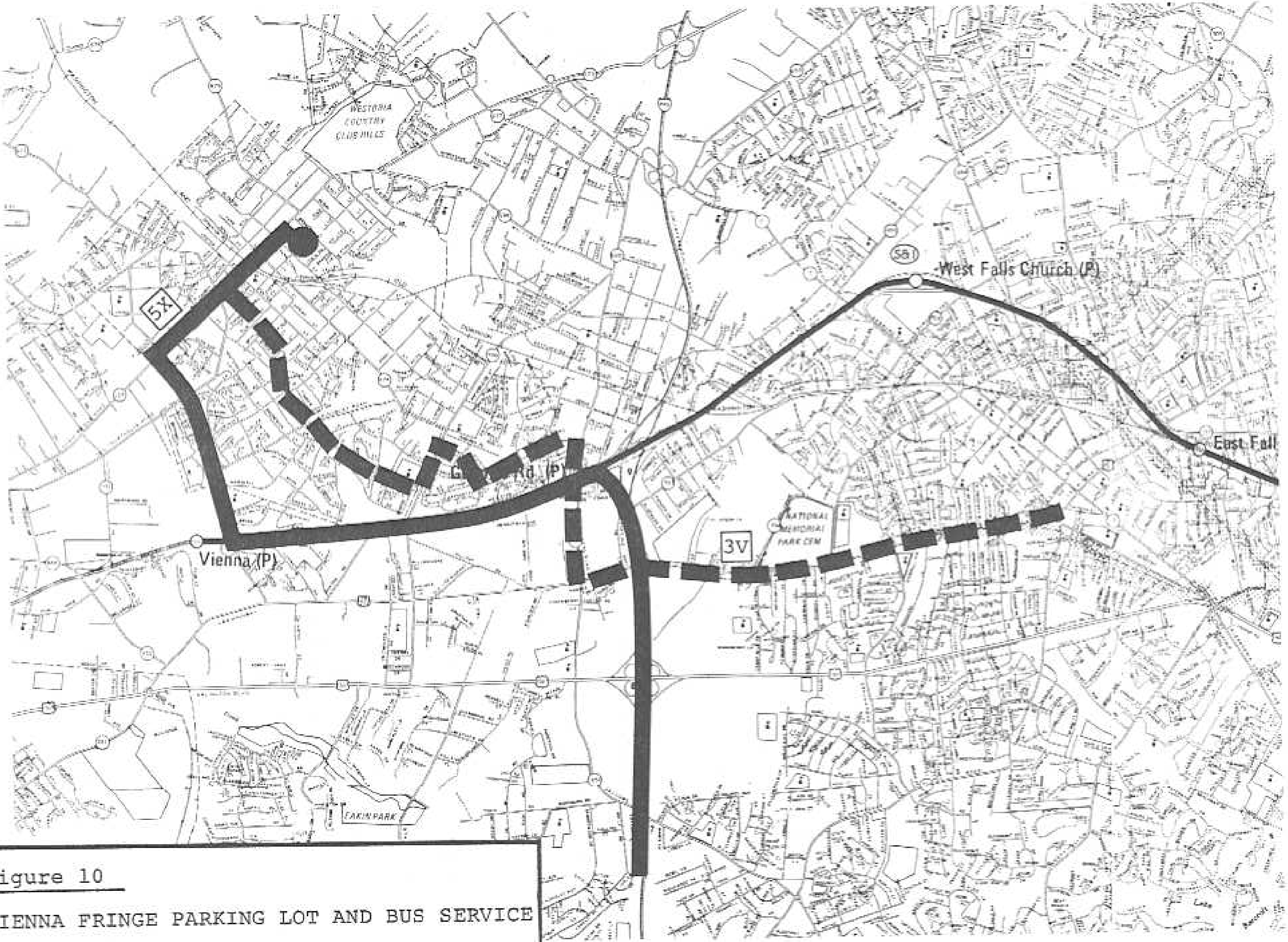


Figure 10

VIENNA FRINGE PARKING LOT AND BUS SERVICE

Adopted Metro Rail System

Discussions on the Maple Street location resulted in the Town staff becoming involved in identifying what they felt would be a more suitable location. (Figure 10) An unused portion of a commercial lot located behind the Giant Food Store on Glyndon Street with some 100 spaces was found, and its free use was allowed in return for Town agreement to maintain the paved area, keep the lot clean, and carry liability insurance to protect the owner. The Town felt that the lot was desirable, if served by express bus service into the District. This service, consisting of four buses per day by Route 5X was provided by NVTC and Metro and the lot has proved quite satisfactory. In addition, existing 3V service was rerouted to serve the lot during the rush hours.

Another location that offered great potential is the site of the future Huntington Metrorail Station, in southern Fairfax County adjacent to the City of Alexandria. The property has already been purchased and is well situated to intercept commuters before they travel through Alexandria in the A.M. period. This lot is currently under construction by WMATA, and bus service is being planned. The lot will offer fringe parking in an area where there are few other available spaces.

In summary, the fringe parking concept offers potential for increased transit usage. However, there are many institutional barriers to overcome, and each location presents different problems. Even with the extensions of Metrorail, there will be areas where fringe parking will be valuable, and a continuing effort to find and implement suitable locations will be worthwhile.

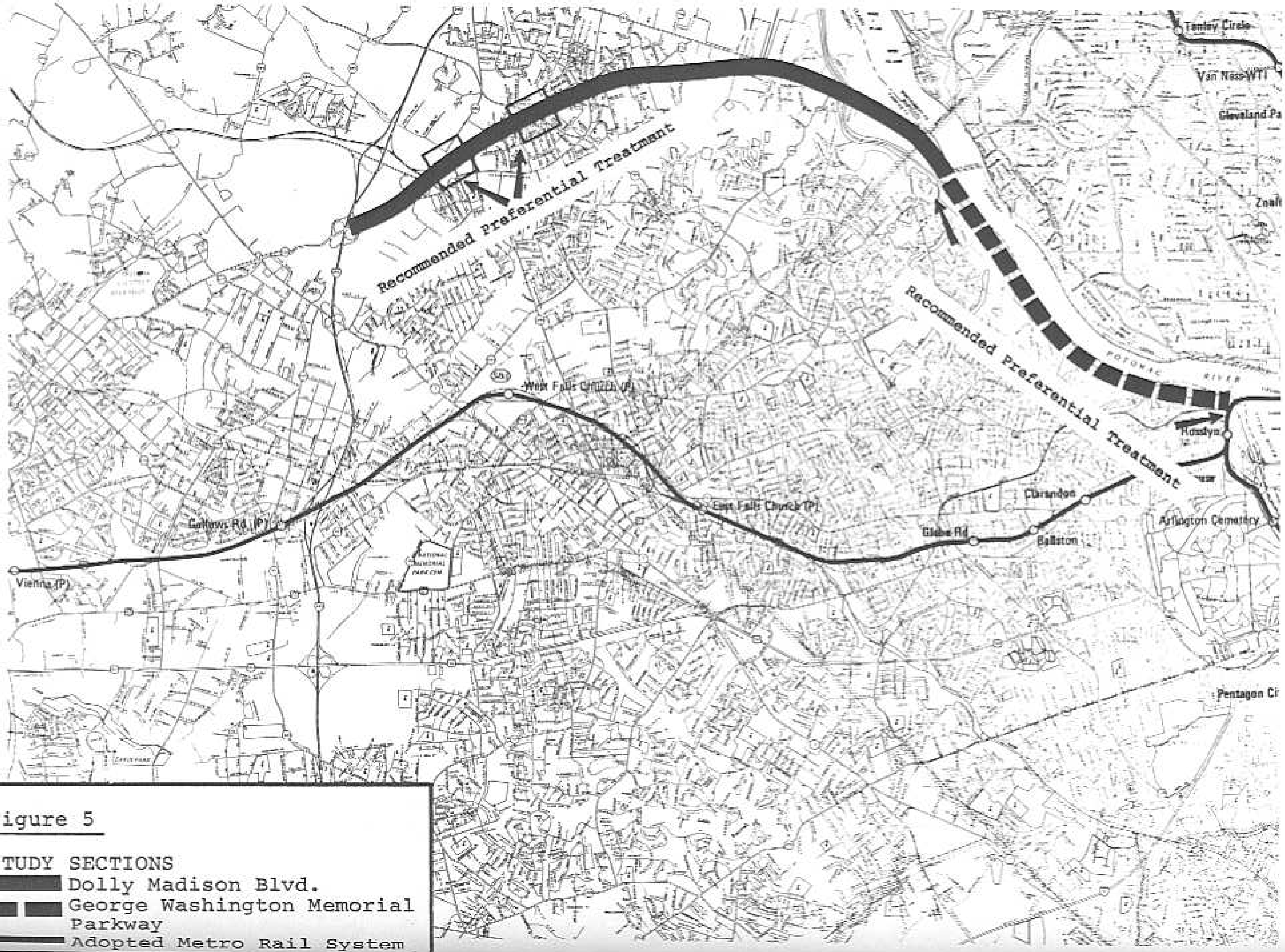
APPENDIX 1

REPRESENTATIVE BUS PRIORITY STUDIES

A. Dolley Madison Boulevard

B. George Washington Memorial Parkway

C. I-66 Busway


Recommended Preferential Treatment
Recommended Preferential Treatment
Tenley Circle
Van Ness-WTI
Cleveland Pa
Rosslyn
Clarendon
Arlington Cemetery
Ballston
Glebe Rd
East Falls Church (P)
West Falls Church (P)
Gallows Rd (P)
Vienna (P)
Pentagon Ci
POTOMAC RIVER
Figure 5
STUDY SECTIONS
Dolly Madison Blvd.
George Washington Memorial Parkway
Adopted Metro Rail System

July 19, 1974

AN ANALYSIS OF PREFERENTIAL BUS TREATMENT FOR DOLLEY MADISON BOULEVARD

Dolley Madison Boulevard, from I-495 to the beginning of the George Washington Parkway, was studied to determine the feasibility of preferential bus movements. The overall purpose of looking to improved bus movement is to encourage a shift from auto to buses for the commuting trip to downtown Washington. This shift would ease congestion on the highway and surrounding streets, reduce air and noise pollution, and conserve gasoline.

Much of the commuter traffic from the highly auto-oriented suburbs of McLean and Vienna uses Dolley Madison Boulevard as a link with the George Washington Parkway, and downtown Washington. It also leads to Chain Bridge, another major route used by commuters. However, the reaction of the commuters in the area to high-quality bus service has been good, as evidenced by the almost capacity loads of the express buses from the Tysons Corner lot. It is felt that if faster service can be offered through preferential bus treatment, that it will result in greater bus usage.

HIGHWAY/TRAFFIC CHARACTERISTICS

The five-mile section of Dolley Madison Boulevard from Tysons Corner to the GW Parkway is all four-lane divided highway, with partially limited access. Traffic flows are quite heavy, with ADT of 33,165 on the section from Route 309 (Old Dominion Drive) to I-495. This means a peak morning period flow of about 5,300 vehicles. The flows below Route 309 are somewhat less, with ADT of 26,632 and corresponding peak flows of 4,261.

Buses on the highway include up to 28 Reston and Sterling Park commuter buses, seven Metrobus Route 3Z (Capital Flyers) from Tysons, and others from Metrobus Routes 5 and 25 which enter at the intersection of Chain Bridge Road. The routes of the Reston buses are somewhat variable, but normally a total of about 20 buses pass through the intersection at Old Dominion Drive during each peak 2-hour period, and 30 at Chain Bridge Road. The occupancy of these buses is high for a suburban area. No exact figures are available, but spot counts show the occupancy around 45 passengers (per 51 passenger bus).

The peaking characteristics of this section are somewhat different from that of downtown areas. Because of normal delays on the GW Parkway, Chain Bridge, and Canal Road drivers must begin their morning trips early. Therefore, the peak flow periods occur from approximately 7:15 to 8:00 A.M., with some variations due to weather and other conditions. Waiting queues are substantially reduced after about 8:15 and have disappeared by 8:45.

In the evening peak, the traffic is dispersing into the suburban areas and no major delays are found along Dolley Madison until its intersection with I-495 at Tysons Corner. Because of this, the evening peak periods were not included in the study.

The signal timing on the highway plays a large part in the traffic flows. Signals are located at the intersections with Anderson Drive, Great Falls Road, Old Dominion Drive, Churchill Road, Chain Bridge Road and Kirby Road, and are all partially demand actuated. Because there is considerable amounts of cross traffic at these intersections, green time on Dolley Madison is seldom longer than about 70 seconds. As the road is four-lane, the traffic flows well, and the delays occur at the intersection locations. For this reason, this study focused on means of expediting bus movement through the intersections.

DELAYS

It was necessary to quantify the bus delays, to reduce them to a factor that would be comparable with construction costs. If delay times were available, they could be converted to passenger time "lost", and then into dollars lost, for comparisons.

A series of field delay counts was made at each of the intersections during weekday AM peak periods in April and May, 1974. Delay was defined as the time from when a bus was first forced to stop by the queue until it cleared the signal. The bus route number, and approximate number of passengers were noted in addition to the delay information. The delay observations were taken only during the period that delays were occuring, and not over the entire theoretical two-hour "peak period".

It is obvious that delays will be a function of many variables, including traffic volume, cross-street traffic, and weather. The survey data shown were taken on a series of different weekdays, in two different months, and are felt to be at least representative of the average conditions.

A summary of the survey is shown below:

Intersection	Average number of Buses Observed	Average Total Delay (Secs.)	Average Delay/Bus (Secs.)
Great Falls Street (Rt.694)	14	509	36.3
Old Dominion Drive (Rt.309)	15	1,228	81.9
Churchill Road (Rt.687)	13	170	13.1
Chain Bridge Rd.(Old Rt.123)	14	55	4
Kirby Road (Rt.695)	15	270	18.0

It is apparent from these figures that only two of the intersections, Great Falls Street and Old Dominion Drive, deserve a more detailed analysis. The Old Dominion Drive intersection is the most critical in terms of delays. Here the queues are often up to 250 yards long, with delays of two to three light cycles for buses during the busiest period.

The short delay times on Churchill Road and Chain Bridge Road are due primarily to the light timing, which is closely coordinated with that at Old Dominion. The lights at these two intersections change to allow the "platoon" released at the Old Dominion light to move through without delay.

The signal at Kirby Road provides relatively longer green times for Dolley Madison. The traffic is reasonably free-moving, and although long queues develop, they clear well during the green periods.

DELAY ANALYSIS

It is apparent that the intersection of Dolley Madison and Old Dominion Drive offers the best potential for eliminating delays in bus movements. To convert the delay times to a "cost" figure, it is necessary to use the average passenger load and obtain passenger-hours delay. This figure can then be costed at dollars per hour to determine the theoretical cost of the delays to the passengers and, therefore, potential benefit to them. In formula form:

[total delay (bus-hours)] [passenger/bus] [dollars/pass.-hour] = delay cost/day (dollars)

Using 45 passengers per bus, and $3.00 per passenger hour, the total daily cost of delay is $45.90/day, and with 250 working days/year, the yearly cost is $11,475.

For the Great Falls Street intersection, using these same assumptions and procedures, the yearly delay cost is $4,725. This again is potential benefit savings for the users.

ANALYSIS OF POSSIBLE SOLUTIONS

There have been a number of methods used to expedite bus movements, several of them already in use in the metropolitan Washington area. These methods usually involve counter-flow lanes (using a lane in the off-peak flow direction for peak-flow traffic), building an additional lane for exclusive use by buses, giving buses special traffic signals and timing which allow them to go ahead of the traffic, or reserving one existing lane for use by buses. The particular situation of Dolley Madison added some constraints that eliminated several potential methods. One major constraint is that because of the Metrorail system, the solution should involve a minimum of new construction. When Metro rail is completed to the Nutley Road Station, the number of buses, and probably autos also, will be greatly reduced. Because of this, a practical useful life of seven years will be used in the analysis. Another problem is that the directional distribution of the traffic requires both off-peak lanes to be available, and so excludes the use of contra-flow laning. The amount of peak direction traffic also precludes use of an existing lane for buses only, as this would greatly overcapacitate the remaining lane.

It was felt that a combination of a special additional lane and bus signals at the intersections offered the greatest potential benefit. The lane need not extend the entire length of the highway, but only a few hundred yards, to allow the buses to bypass the queues. A special signal light and timing could then be used to allow the buses to go before the remainder of the traffic flow. This solution seems to be within the constraints, and still allow expeditous movement of the buses through the congestion points, the intersections. This approach has been used by Arlington County in the Rosslyn area, at Lynn Street and Wilson Boulevard, and has been quite successful.

IMPROVEMENT COSTS

Old Dominion Drive

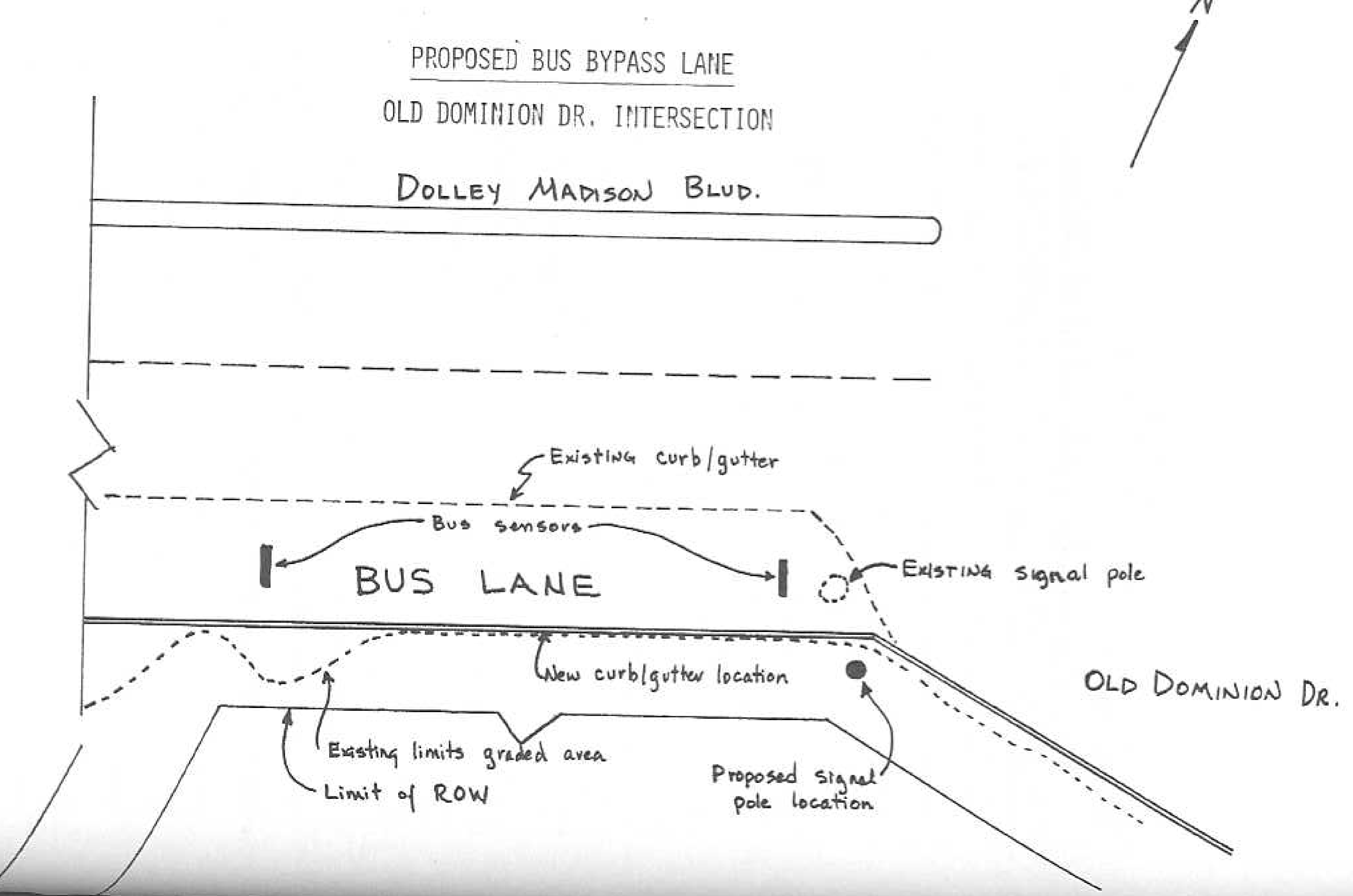
The concept of the bus "bypass" lanes at the two intersections in question, with special signal lights that would allow the buses to move ahead of the queues, seems most promising. At the Old Dominion Drive intersection, an evaluation of the project plans indicates that along Dolley Madison Boulevard the highway right-of-way (ROW) extends to an average of 24 ft. beyond the edge of the pavement on the Southwest side. There is a 2 ft. wide curb and gutter, and 10 ft. of additional graded area for the first 350 ft. After this distance, the graded area expands to a stabilized shoulder some 10 ft. wide.

Because the bypass lanes would be used for relatively slow speed movement by buses and right turning vehicles, an 11 foot lane would be sufficient. A lane this size could be constructed without purchase of any property, and primarily in the existing graded or shoulder area. The signal support pole, a utility pole, and some signs would have to be relocated.

The most crucial aspect of this plan is the signalization. It requires a special signal for buses that would allow their priority movement though the intersection during the peak period, and also be usable as a right turn lane during other hours. The current controller at this intersection is an Automatic Signal 1826-N, which is demand actuated, with a 3-phase capacity. VDH is currently considering installing an Automatic Signal 90 series controller at this intersection, and this controller would fit well into the recommended bus lane project.

PROPOSED BUS BYPASS LANE

OLD DOMINION DR. INTERSECTION

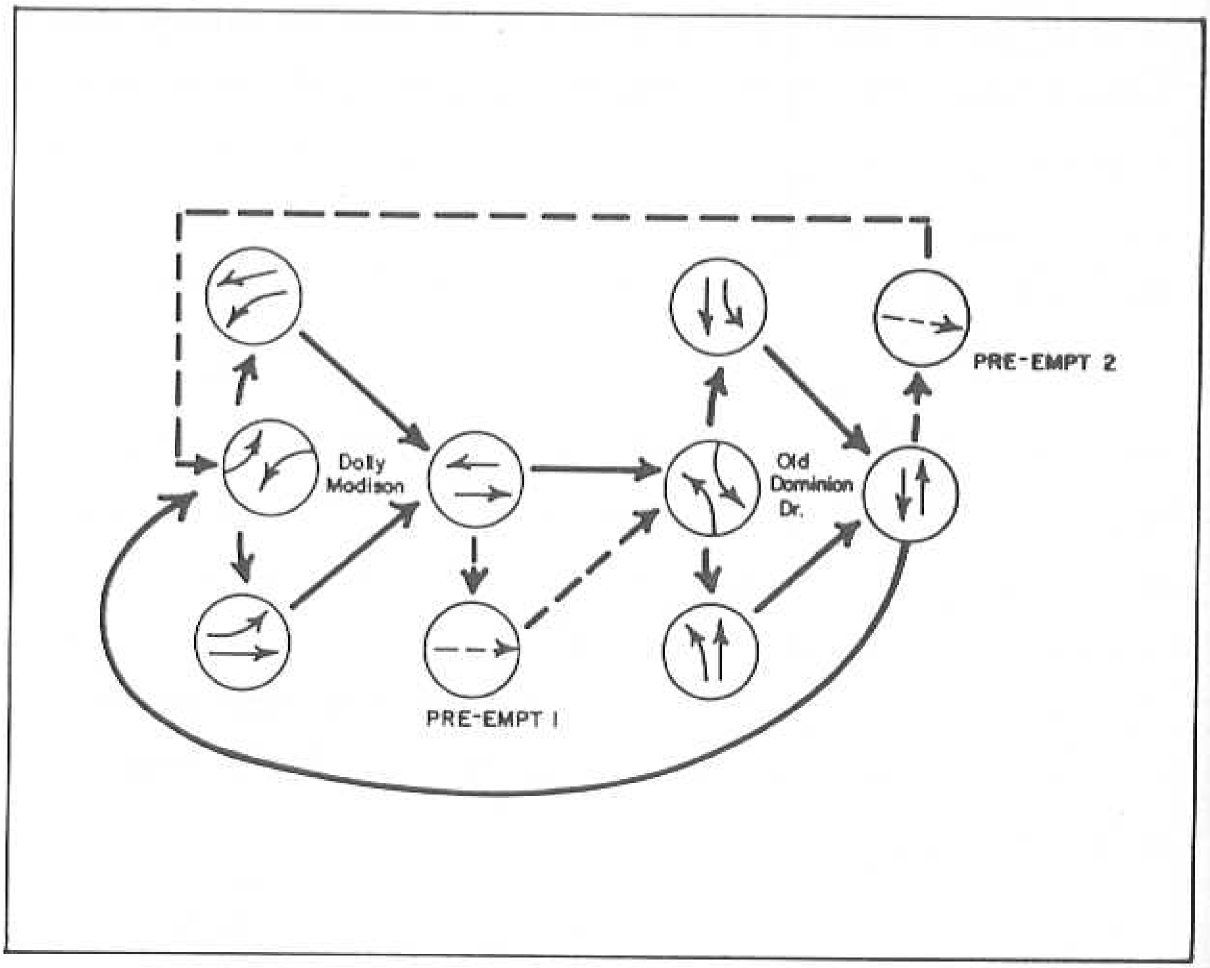


The controller could be wired with a "preemptor" that, under certain conditions would introduce a bus green signal into the cycle. These conditions would include both a limited time of day and day of week, and also the detected presence of a bus. The bus signal could be introduced after the movements on Old Dominion Drive, and after the through green on Dolley Madison Boulevard (see sketch). Using these, the bus would always be able to bypass the queue, and never have to wait more than one-half the cycle to move through the intersection. When no bus was present, the cycle would simple continue as usual, with no bus signal being given.

Several areas deserve further consideration. Obviously, buses will sometimes arrive at the rear of the queue while the signal is green for Dolley Madison. They can then continue in the normal right hand lane if the driver feels he will get through. Otherwise, he will go around the queue in the bypass lane, and wait for the bus signal after the green cycle. If a bus is just coming into the lane when the signal turns green for Dolley Madison, the driver could merge into the left lane, much as buses coming out of any bus stop turn-out.

It would be necessary to prohibit right turns from the bus lane during the period when the bus signal is in use. Otherwise, complicated sensors to distinguish cars from buses are necessary, and problems with the cars delaying the buses become very complex. A count of right turns at this location from 7:00 to 8:15 A.M. on a week day showed 157 vehicles turning. These vehicles could turn right at Lewinsville Road, or Park Avenue, the next cross street along Dolley Madison, and easily move to Old Dominion. The 'hardware'

PROPOSED DOLLY MADISON BLVD.— OLD DOMINION DRIVE
Signal Cycle With Bus Phase



to implement this signal would include the preemptor circuit, a 7-day timer to activate the signal only during needed periods, sensors to detect the bus presence, and a special signal head, with an arrow indicating "thru green" for buses. Several additional signs indicating right turns prohibited during the designated period would be necessary.

A breakdown of estimated construction costs is as follows. The costs are based on unit figures obtained from the Arlington County DOT, and assume a 1,000 ft. bus lane.

Grading and compacting	$2,424
Paving	9,826
Relocating curb and gutter	1,925
Relocating signal and utility poles	1,500
Signing	900
Signalization	1,500
Total	$18,075

A detailed explanation of costs is found in Appendix I. The signalization costs assume the 'preemptor' circuit is wired into the controller at the factory, as the device is being prepared for the total intersection installation.

Great Falls Street

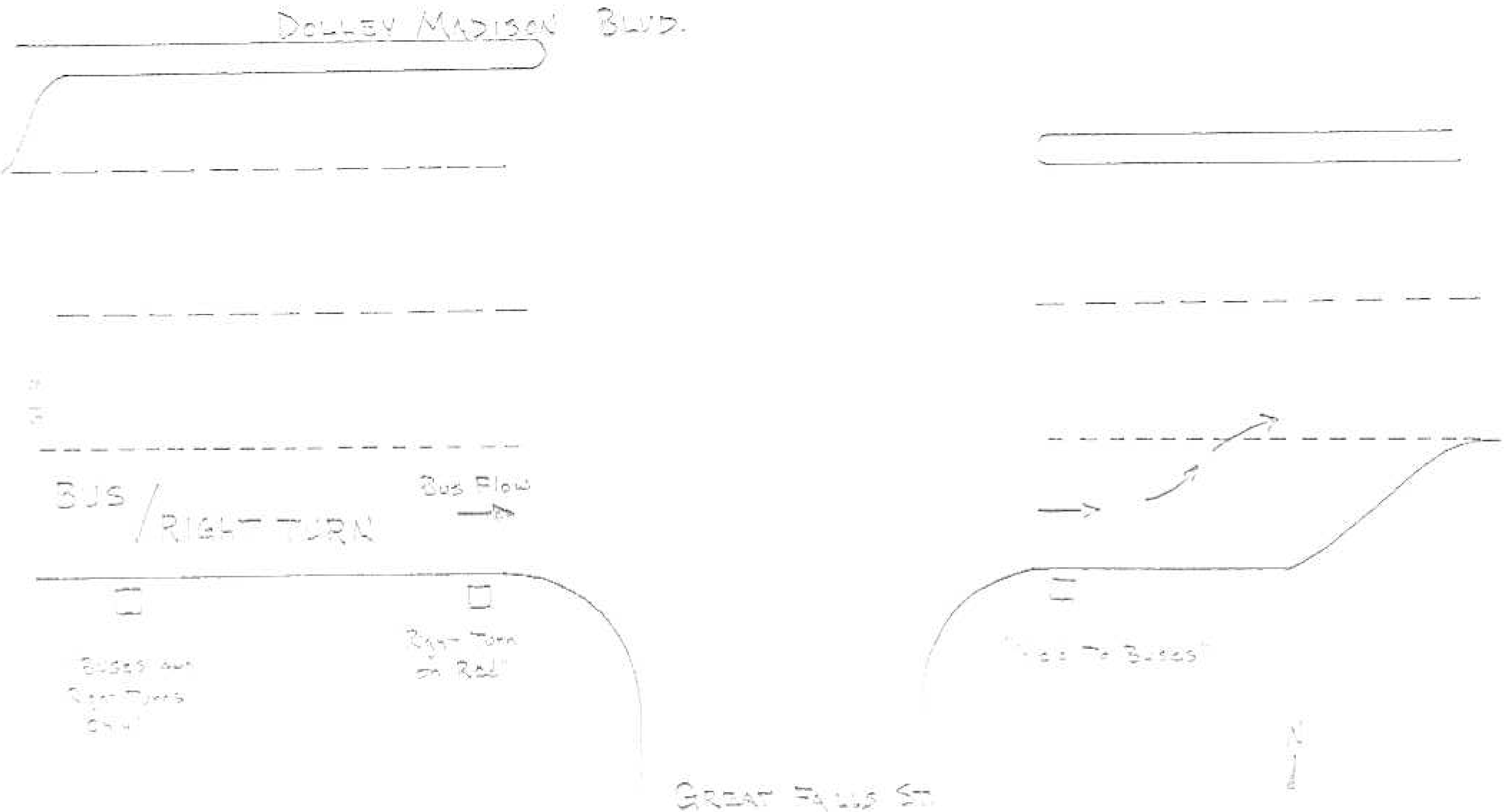
A variation of this approach is recommended at the Great Falls Street intersection. Here, delays are not as long, and right turns must be permitted (as they would be prohibited at Old Dominion Drive). As the basic objective is to allow the buses to bypass queues, the short bus lane could be constructed on the existing 15 ft. shoulder area. This lane would be reserved for right-turning cars and buses at all times. A 300 ft. 'merging' lane would also be constructed along Dolley Madison on the eastern side. The buses would bypass the queue and proceed with the normal green signal. They would then merge into the traffic from the extended lane after passing through the intersection. Signs instructing cars to "yield to buses" could be posted to assist the buses. (See drawing.)

This procedure would require no additional signals and would be very similar to buses pulling into traffic from a curb-side bus stop. The shoulders are all wide enough to accommodate the lanes with little additional grading. The incoming lane would be usable by right turning vehicles even during the morning peak period, preferably with a "right turn on red after stop" condition to aid in clearing right turning vehicles from the bus lane.

The costs for this project are shown below and detailed in Appendix I. An incoming lane of 750 ft. and a "merge" lane of 300 ft. are assumed.

Grading	$1,498
Paving	10,317
New Signs	1,200
Total costs	$13,015

It is assumed that maintenance costs on the two intersections would not be appreciably increased by the short lanes, and new signal equipment. For this reason, no maintenance costs are included in the analysis.



PROPOSED BUS TREATMENT

GREAT FALLS ST. INTERSECTION

BENEFIT/COST ANALYSIS

To compare these potential benefits, and construction costs, they must both be referenced to a yearly basis. The construction cost can be converted using a capital recovery factor, assuming a 7-year life, and 8% interest on money.

Old Dominion:

$18,075 (0.19207) = $3,472

Great Falls Street:

$13,015 (0.19207) = $2,500

A comparison of these, with the yearly potential benefits show a benefit/cost ratio:

Old Dominion:

$11,475/$3,472 = 3.3

Great Falls Street:

$4,725/$2,500 = 1.9

SUMMARY/CONCLUSION

This analysis indicates sufficient benefit to warrant a by-pass lane and signal at Old Dominion Drive, and bypass and merged lanes at Great Falls Street. In addition to the improved bus travel times, however, the lanes could also be used during all but a short period as right-turn lanes, as the shoulder at Great Falls Street is already. This will be quite useful at Dolley Madison, where right turns toward McLean are frequently made, and no separate lane is available.

For these reasons it is recommended that bus bypass lanes, and priority signals with appropriate signaling and/or signing be installed on Dolley Madison Highway at Old Dominion Drive, and Great Falls Street to allow the essentially undelayed movement of buses through these intersections during the A.M. peak period.

APPENDIX I

CONSTRUCTION ESTIMATES

Old Dominion Drive:

1. Grading: $7. per cubic yard

   (1.5') (350')(11') (1/27) ($7) = $1,497

   (0.5') (650') (11') (1/27) ($7) = $927 = $2,424

2. Paving: (8") $18 per ton, 2 tons per cu.yd.

   (0.67') (11') (1,000') (1/27) (2) ($18) - $9,826

3. Relocating curb and gutter:

   (350') ($5.50/ft.) = $1,925

4. Relocating utility pole, signs, etc:

   $1,500

5. New signing:

   3 @ $300. = $900.

Great Falls Street: (Unit Costs as above)

1. Grading:

   (0.5') (1050') (11') (1/27) ($7) = $1,498.

2. Paving:

   (0.67') (11') (1,050) (1/27) (2) ($18) = $10,318

3. Relocating poles, signs: Not needed.

4. New signs:

   4 @ $300. = $1,200

APPENDIX 1-B

George Washington Memorial Parkway

"WHERE PEOPLE ARE FIRST IN TRANSPORTATION PROGRAMS"

NVTC Northern Virginia Transportation Commission

Arlington Executive Building ■ 2009 North 14th Street ■ Suite 300 ■ Arlington, Virginia 22201 ■ (703) 524-3322

August 27, 1975

AN EXAMINATION OF ALTERNATIVES FOR PREFERENTIAL BUS AND CAR POOL TREATMENT ON THE GEORGE WASHINGTON MEMORIAL PARKWAY.

This paper has been prepared as an examination of a proposal for instituting a bus/car pool priority lane on the George Washington Memorial Parkway (GWMP), eastbound from Route 123 to Key or Roosevelt bridges. The first analytical treatment of the concept was accomplished in November 1973 by the Northern Virginia Transportation Commission (NVTC) in the paper "A Technical Analysis of Preferential Treatment for Buses and Car Pools on the GWMP". That paper was circulated and discussed by a number of agencies including the National Park Service (NPS), the Metropolitan Washington Council of Governments (COG) and the Arlington and Fairfax counties' transportation staffs. These discussions brought out the need for more detailed analysis of the GWMP proposal, including an examination of impacts on surrounding roads, and implementation problems, as contained in this study.

The GWMP is one of the major commuting corridors for residents of western Fairfax County to reach downtown D.C., both with autos and buses. Public policy has recognized a need to encourage buses and car pools over single-occupant vehicles. Therefore, the GWMP is a logical choice for bus/car pool preferential treatment. Current severe congestion on the GWMP means that a free-flowing preferential lane would substantially reduce travel times for the commuter, and would therefore encourage transit/car pool use. In so doing, such goals as reducing fuel consumption and air pollution would be realized.

Review of Existing Conditions

Buses: The Parkway is currently quite crowded in the morning peak period, which greatly hinders the movement of buses. There are currently seven scheduled buses on Route 3Z on the GWMP during the 7 - 9 A.M. period, many of them with standees. There are also up to twenty-five Reston Commuter buses that use the road, depending on conditions. In addition, up to seven Route 25 buses that currently use Chain Bridge could easily be rerouted down a GWMP preferential facility.

Autos: The map on the next page shows the GWMP in relation to the other roads in the area. Table 1 below has recent traffic counts and occupancy data on the roads that could reasonably be expected to affect, or be affected by, a GWMP preferential facility:

Table 1

7-9 A.M. Inbound Vehicle Occupancy

Auto Occupancy	GWMP	Rt.309 - Old Dominion Dr.	Rt.123 - Chain Bridge Road*	Average % of Total
1	3,866	1,149	1,229	79
2	950	232	214	16
3	160	46	35	3
4 or more	123	18	22	2
Total Vehicles:	5,099	1,745	1,500	
Total Persons:	7,088			

*Below entrance to GWMP, near Glebe Road.

As can be seen, the GWMP currently has some 5,099 vehicles in the morning peak period, which results in long delays, especially at the Spout Run merge point. In all probability many of the car pools on Old Dominion Drive and Chain Bridge Road are going into D.C., and could be diverted down the GWMP if these long delays could be alleviated by priority treatment.

Spout Run: Traffic flow on the GWMP is affected by vehicles merging into the Parkway from the Spout Run Parkway. The 7:00 A.M. to 9:00 A.M. counts for Spout Run are shown in Table 2.

Table 2

7-9 A.M. Inbound Vehicle Occupancy on Spout Run Parkway

Auto Occupancy	Vehicles
1	1,853
2	499
3	97
4	82
Buses	0
TOTAL	2,531

This traffic utilizes two lanes on Spout Run during the peak morning period. It is restricted to one lane to enable continuous flow during all other periods.

Bus Delays: The large traffic volumes on the Parkway result in delays to the buses, which currently are subject to the same congested conditions as autos. A survey of the A.M. peak period showed 34 buses, both Metrobus and Dulles Airport on the section from Route 123 through the Spout Run merge. The average travel time was 9 mins. 43 seconds, with several times as long as 16 minutes, compared with 7 mins. 30 seconds without queues. This means a potential savings of up to 8½ minutes for some buses, and an average of 2¼ minutes for all buses in the peak, a total of some 76 minutes of bus time per day. The average time saving per bus is roughly equivalent to that obtained by the bus lanes on Arlington Boulevard.

Alternative Preferential Treatment Methods

There have been a number of proposed methods of preferential treatment of car pools and buses on the GWMP. The three seeming to offer the most potential are:

1. One inbound lane reserved for buses/car pools, with either (a) 2 or more, or (b) 3 or more, occupants.
2. Both inbound lanes reserved for buses/car pools (2 or more occupants).
3. Both inbound lanes reserved for buses/car pools, and, the "outbound" lanes used inbound for single occupancy vehicles.

In all of these, it is assumed that the preferential treatment would start at the intersection with Dolley Madison Boulevard, as the traffic between there and I-495 is reasonably uncongested.

The construction of a third lane on the GWMP, from Spout Run to the Roosevelt Bridge has been proposed a number of times. This additional lane would allow one lane of Spout Run and two on the GWMP to flow continuously, and could be used with any of the above alternatives. It would probably not in itself be sufficient to substantially alleviate delays due to the amount of Spout Run traffic, and the complexity of the resulting weaving movements around the Key and Roosevelt Bridges. The benefits gained are partially a function of the method of preferential treatment on the GWMP, and will require a detailed analysis of the potential for improvement to each treatment alternative.

In analyzing the effects of each of these schemes, it is necessary to make some assumptions concerning the diversion of car pool autos to the GWMP from the other routes. It was assumed that all of the multiple-occupant vehicles using Chain Bridge Road would use a preferential lane on the GWMP, and that 2/3's of those on Old Dominion Drive would do so. These are reasonable, and any shortfalls from them would probably be made up by new car pools formed to take advantage of the faster travel. Therefore, these assumptions should provide figures good enough for indications of possible usage.

With the above assumptions, each scheme can be analyzed. In all of them, the basic number of buses using the lanes remains constant, and so will not be specifically mentioned. This number is estimated at 37, which includes seven Rt. 3Z, twenty-five Reston Commuter buses and five Rt. 25 buses from the previous Chain Bridge Road route. The average occupancy would be expected to be 45 for the two hour period. It should be pointed out that the persons attracted out of the single occupant auto could easily become transit riders instead of car poolers if more bus service is provided. The effect on the preferential lanes would be the same, until the point was reached where car pools began to impede bus movements.

Also, it is envisioned that the ramp to Key Bridge from the Parkway would be opened for bus only use, to allow maximum flexibility of routing for buses on the Parkway.

The 1(a) alternative, one lane of the existing facility for buses and two or more person car pools, would result in approximately 1,700 vehicles in the priority lane. The 1,700 vehicles would mean a preferential lane that would not be free-flowing, but would have delays and back-ups. It would have the least disruption on the existing traffic patterns, but would provide little in the way of benefits to car pools and buses.

1(b) - restricting the preferential lane to buses and car pools of three or more would create a much greater inbalance in the lanes. Some 382 car pools would be in the preferential lane, and 4,816 autos, in the remaining lane. In reality, 3,600 vehicles is all that can be expected to flow over one lane in a two-hour period. It could be expected that the remainder of these autos in the non-preferential lane would be diverted to another route, although hopefully many would be induced to change their travel patterns and either form car pools or ride buses to take advantage of the preferential facility.

It is difficult within the context of this paper to estimate how many car pools would be formed, as drawing conclusions from Shirley Highway, the only existing car pool route in the area, is somewhat questionable. However, Table 3 gives some indication of the effects of a 10% and 20% diversion to pooling. It is assumed that the non-preferential lane will continue to flow at capacity, and that the poolers would come out of the "diverted" traffic.

Table 3

Effects of One Three-Or-More Person Car Pool/Bus Lane on GWMP

	Current Proposed Conditions	10% decrease 1 and 2 Occup.autos	20% decrease 1 and 2 autos
Car Pools (3 or more)	382	519	657
1 & 2 Occup.autos remaining	3,600	3,600	3,600
1 & 2 Occup.autos diverted	1,216	735	254
Buses	37	37	37
Persons carried, Preferential lane	2,868	3,349	3,830

As noted earlier, these figures include no increase in transit, other than rerouting the existing service. In all probability, there would be more service justified and utilized, which would bring the "persons per lane" figure even higher.

The problems with this application is primarily one of control over the preferential lane. A free-flowing lane would be very inviting to drivers standing still in the other lane, and only rigid enforcement would prevent excessive violations. However, as there are no turn-off points, a police officer stationed at any of several locations could easily apprehend violators. The knowledge that there was a good chance of spot checks and that illegal use of the lane would result in a fine would be sufficient deterrent without the use of other barriers which are expensive to install (and remove, in the case of temporary ones) and probably would not be effective without police enforcement.

There might also be a problem with queues onto Rt. 123 in the early stages of an implementation. Experience has shown that drivers will adjust quickly to delays, and will divert to other faster routes, so the situation would probably not continue long. Also the total number of vehicles entering the Parkway would be less than at present. The expansion of the on-ramp to the GWMP from one to two lanes, to allow car pools and buses speedy access to the lanes, would be a low-cost addition to the program, that would add greatly to its effectiveness.

The merge at Spout Run could be done in the same manner as presently, with control by a traffic officer. The addition of a third lane below Spout Run, mentioned earlier, might eliminate this necessity.

The alternative 2, a two-lane preferential GWMP, would offer the greatest advantages to buses and car poolers, but would result in considerable disruption to existing traffic. Only single-occupant vehicles would be excluded, so any auto with two or more persons in it could travel. Currently this would mean that there would be some 1,700 autos on the GWMP during the peak two hours, and 3,866 diverted to other routes. Here, however, the free flow, and lack of queues, plus no delays at the Route 123 entrance, would no doubt result in a large number of new car pools. It should be noted that a two-person "pool" is not nearly as difficult to form and maintain as a three or four person one, and so a larger diversion to pooling would be expected. Also, the Shirley Highway experience has shown that high speed bus service can attract a large number of riders.

The success of this plan would rest with providing services to aid the commuter in his switch to transit or pooling. Specifically, several well-placed fringe parking lots that would allow buses to stay on the major routes, and so maintain fairly rapid travel times, while still "drawing" on the residential neighborhoods, would be needed. The existing lot at Tysons Corner, which is filled to capacity almost every day, is an example of the success of this technique.

A car pool matching effort, aimed at the McLean area for instance, and matching common residence areas with work ends, would give the commuters assistance in forming car pools. Car pool matching techniques have been developed by NVTC and COG, and are usable at this time. They are low-cost, and could be administered through local institutions such as the community associations.

The combination of these improvements, along with some increased bus service as needed, would give the individual driver an alternative to continuing to drive alone, and would help deter the disruptive effects of closing the Parkway to the single occupant vehicle.

It seems logical that this plan would include a bus/car pool only Spout Run facility, although this would require further study. This would eliminate the delays at the merge, and would allow the vehicles to continue unobstructed to the bridge ramps.

A summary of the potential effects of this plan are in Table 4. The decreases in the single occupant autos could be diverted to either car pools or transit, but a 50/50 modal split is assumed for simplicity.

Table 4

Effects of a Two-Lane Preferential GWMP

	Current Proposed Conditions	20% decrease s/o autos	40% decrease s/o autos
Car pools (2 or more)	1,700	1,854	2,008
Single Occup.Autos diverted	3,866	3,093	2,320
Persons in Preferential Lane	5,604	6,377	7,150

From the viewpoint of providing large incentives to use buses and car pools, as well as ease of enforcement and control, this is the best plan. However, it would mean that under the best of conditions some 2,000 or more cars would be put onto other routes such as Chain Bridge Road, and Old Dominion Drive, and this would result in additional queues, and delays on these routes. This would have to be balanced against the benefits gained from the preferential facility.

Alternative 3, using the Northwest bound (outbound) lanes of the GWMP as inbound in the A.M. peak, much as Rock Creek Parkway currently is, seems to offer the same advantages as Alternative 2 to transit and car pool users. The problem is that free-flowing inbound lanes for single-occupant vehicles would result in more, rather than less, auto usage, based on past experiences from all parts of the country. It would also be necessary to develop signing for alternate routes for northbound travelers, and extensive other signing and barricades at ramps.

CONCLUSIONS

It is apparent from this brief analysis that both buses and car pools could benefit greatly from preferential treatment on the GWMP. Preliminary research to date has found no legal problems, and the enforcement is feasible given adequate manpower funding. The positive effects of reduced travel times attracting more bus riders and car pools, and resulting in reduced fuel consumption, air pollution, and traffic delays must be compared against the probable negative impacts on the single-occupant auto. This comparison should provide a good basis for decision making on the issue.

APPENDIX 1-C

I-66 BUSWAY

September 26, 1975

IMMEDIATE USE OF THE I-66 RIGHT-OF-WAY

The NVTC staff's major objection to the approach taken by FHWA in preparing their paper on the I-66 Corridor is that it failed to address the issue of "what to do with the I-66 Right-of-Way (ROW) in the near future". Although on page 3 they point out the need to utilize the ROW as quickly as possible, all the alternative transit uses are oriented toward providing access and supplementing the Metrorail system. Yet Metrorail is at least four years away on the outer Vienna Line. The long-term uses are certainly important, but the immediate use of the land to improve transportation in the Corridor also deserves attention.

Obviously, as the I-66 ROW contains the planned Metrorail line and stations, there is a great deal of demand for transit in the I-66 Corridor. Western Fairfax County is one of the fastest growing sections in the region, with large population increases planned for the next five years. This area does not have a great deal of bus service, and the existing service is often not heavily utilized. One of the main reasons for this is that the routes from this area to downtown, via Lee Highway (Rt. 29-211), Rt. 7 or Rt. 50, are heavily congested. Bus service is therefore slow, and expensive to run.

A logical use of a portion of the I-66 ROW is a two-lane busway from the planned Vienna Station to the Glebe Road Station, or the Rosslyn Station. The two lanes would be reversible, operating only in the peak direction during peak periods. Buses could collect passengers throughout the residential neighborhoods, and then enter the busway for an express trip to the Glebe Road or Rosslyn Metrorail stations. "Fringe" lots which have proven highly successful throughout the region could be constructed at reasonable cost at station locations.

This plan has a number of advantages:

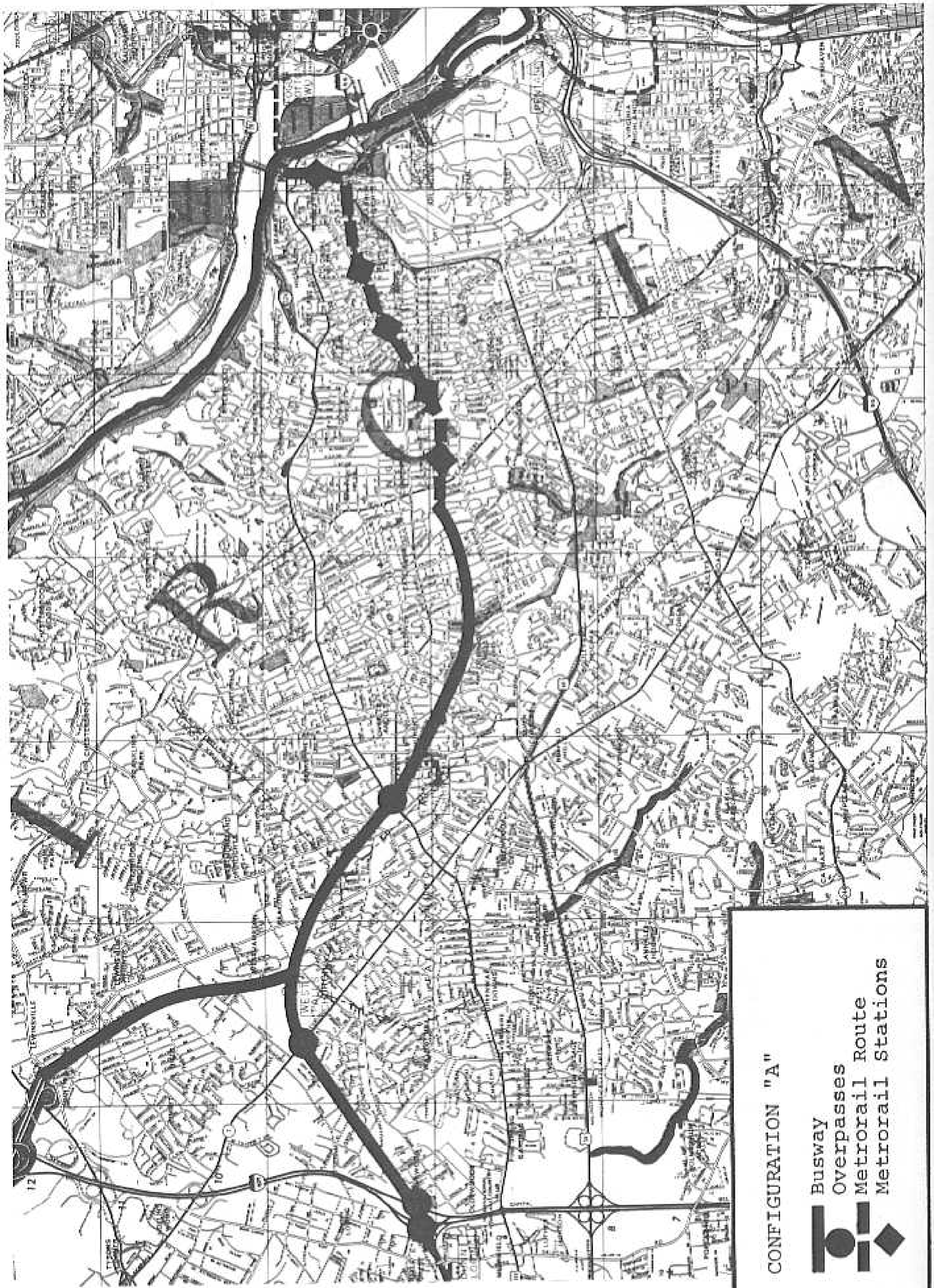
- The roadway would be relatively inexpensive, as much of the route is already roughly graded.
- It could be implemented within a reasonable period of time, perhaps operational within two years, as the design and construction are simple.
- The express routing would allow many buses from Fairfax to make a second peak-period trip, thereby increasing their productivity.
- As the rail line to Vienna progresses, the bus lanes could be used to provide feeder bus service to the stations.
- The provision of express bus service would be a good step toward attracting the commuters in this area to transit, so that when Metrorail is constructed it has an established ridership to build on. Longer trips benefit most from express service, and so transit is most attractive for these trips.
- The projections of growth in the I-66 Corridor indicate that some form of improved transit service is needed. The Shirley Busway has shown the ability of quality bus

service to attract riders, and to carry large numbers of persons in a small number of lanes.

Probably the most difficult technical issue would be at intersections with roads. Grade separation could be provided by Metro, if the rail line is committed. Otherwise, or even as an interim measure, it might be necessary to provide some form of pre-emptory signals or barriers, perhaps like a railroad crossing, at the intersections.

Indications are that when the Rosslyn Metrorail station opens, many buses will not make the time-consuming trip downtown, and so will be available for other routings and uses. This will allow more extensive service to be offered in the areas served by the bus lanes. The fares from the outer areas are relatively high, and as the trips would be primarily express, the buses should be near the break-even point.

The question of how far to extend the lanes is one that must be explored. The lanes should run at least to the Glebe Road station. From there they could be continued over the old W&OD ROW to the Rosslyn station. This would require additional construction, and probably include two overpasses over Lee Highway, as the ROW is elevated along much of the section. An alternative would be to route the buses down Fairfax Drive, and perhaps Arlington Boulevard to the Rosslyn station. The decision will have to take into account how much additional costs and time are involved in constructing the W&OD lanes, how long they would be usable before the Glebe Road station is operational, and how soon the cut-and-cover construction on Fairfax Drive would be completed to allow bus usage. Some form of preferential treatment, even on existing roads, should be provided to prevent undue delays to an otherwise express trip.


CONFIGURATION "A"
Busway
Overpasses
Metrorail Route
Metrorail Stations

The Dulles Access Road extension as a bus lane connecting into the I-66 lane makes a great deal of sense, too. The Reston-Herndon-Northern Vienna area is projected to more than double in population within five years. The major transit commuter access is the Dulles Access Road, which is closed to most of the auto commuter traffic. Even without preferential treatment, some 25 buses come from Reston today, at fares higher than the normal Metrobus ones. Additional bus lanes would no doubt continue this trend of high ridership, which would relieve some congestion on the heavily used Rt. 7 area.

The issue of car pool use of the lanes must be addressed. Again, Shirley Highway has shown that preferential treatment results in more car pool formation. However, in this situation the only terminus for the poolers would be the radial highways, as there is no parking at the close-in Metrorail stations. Also, car pool use would necessitate grade-separated intersections, at much higher expense and delay. The use of the lanes would probably greatly encourage the long-range commuter, from Manassas for example, to car pool, so the question would require study of these benefits vs. the resulting problems. A car pool facility into the West Falls Church Station, with expanded parking, might be an acceptable solution.

The bus lanes, and a wide strip for Metrorail construction, would take up much less than the total width available in the I-66 ROW. As mentioned in the FHWA paper, bike trails and other park-type facilities could be built here. Off-peak and weekend usage of the lanes could include a number of items. Buses and limousines to Dulles Airport could use the roadway, as could perhaps an occasional bus to "outer" areas such as Reston. However, most off-peak buses would retain their present routing, to make service available to the maximum number of residents. Weekend use might preclude any buses, and consist of bikes and hikers, in conjunction with the "park" use of the remaining ROW. This concept would not only mitigate some environmental impacts, but provide needed park space to Northern Virginians.

APPENDIX 2

ANALYSIS OF RIDERSHIP GROWTH FROM BUS IMPROVEMENTS

CORRIDOR STUDY

TRANSIT SERVICE IMPROVEMENTS

Phase I of the WMATA bus service expansion program was implemented in April, 1974. This phase added 100 buses to the WMATA fleet in the metropolitan area (27 in Northern Virginia). The buses were assigned to established peak period routes to relieve overcrowding and provide improved frequency of service so as to attract additional patronage. Specific improvements in the study corridors are detailed below, and indicate ridership as of May, 1976.

Northwest Corridor

1. Route 3M, McLean to 11th & E Streets, N.W., via Old Dominion Drive, Lee Highway, Rosslyn, Georgetown, and Farragut Square. Two additional trips in the AM peak period and one additional trip in the PM peak period. Since there were only three daily trips operated on this route prior to Phase I (one AM and two PM), this represents a 100% increase in service for residents along Old Dominion Drive.
2. Route 3Z, Tysons Corner to Southwest Mall Express via Dolley Madison Boulevard, G.W. Parkway, Roosevelt Bridge, Foggy Bottom, Farragut Square, and Federal Triangle.
   Two additional trips in both the AM and PM peak periods which increased service to a total of 14 trips daily. Ridership on this route now averages 48 passengers per trip, and the Tysons Corner fringe parking lot (the only pick-up point for this route in Virginia) is filled to capacity every day.

Southeast Corridor

1. Route 11P, Mount Vernon to Pentagon via Fort Hunt Road and the G.W. Parkway. This route stops in Alexandria only at Hunting Towers and at King and Washington Streets, and operates over the bus priority lane on North Washington Street.

   Two additional trips daily (one A.M. and one P.M.) which doubled the service offered prior to Phase I. Ridership has also doubled and averages 47 passengers per trip.

2. Route 11Y, Mount Vernon to Farragut Square via G.W.Parkway. This route operates as an express through Alexandria and utilizes the N. Washington Street bus priority lane.

   Two A.M. and two P.M. trips were added to this route to supplement the singe A.M. and P.M. trip operated previously. Ridership has more than doubled and presently averages 43 passengers per trip.

Phase III of the WMATA bus service expansion program was implemented in September 1974, which involved the addition of 151 buses to the WMATA fleet (42 in Northern Virginia). The major emphasis in this phase was to establish new routes to serve new residential and commercial developments, both in peak periods and off-peak hours, including weekends. In addition, some established routes were modified and extended to improve service and attract new ridership. Following are the specific corridor improvements.

Northwest Corridor

1. Route 3S, Herndon to 11th & E Streets, N.W., via Reston, Tysons Corner, Falls Church, Lee Highway, Rosslyn, Georgetown, and Farragut Square.

   Two additional peak period trips daily (one A.M. and one P.M.) which doubled the rush hour service offered prior to Phase III. In addition, expanded counterflow, midday, evening and Saturday service was scheduled on this route. Subsequent to Phase III, this service was rerouted in the Tysons Corner area to serve the new Westpark office development.

2. Route 3C, N. Arlington to 11th & E Streets, N.W., via Military Road, Lee Highway, Rosslyn, Georgetown and Farragut Square.

   This peak period service was extended in North Arlington via new Glebe Road to serve the new residential community of Golf Club Manor on the Arlington-Fairfax County boundary.

3. Route 5X, Vienna Fringe Parking Lot to Federal Triangle. Express via the Pentagon and Southwest Mall.

   This new route was established to serve the new fringe parking lot provided by the Town of Vienna. Four daily trips are operated which carry an average load of 35 passengers each.

4. Routes 23S and 23T, Tyson's Corner to Crystal City via McLean, Old Dominion Drive and Glebe Road.

   This new route was established to provide daily service between the residential communities of McLean and North Arlington and the employment complex at Crystal City. The route also serves several major shopping centers, including Tysons Corner and provides a cross-county connection which previously did not exist. Current ridership averages over 900 passengers each weekday.

5. Reston Contract Service, two buses for both the A.M. and P.M. peak periods were provided to the Reston Commuter Bus, Inc., for expanded service on their community-based commuter service between Reston and Washington, D.C.

Southeast Corridor

1. Route 9P, Mount Vernon to Pentagon via Belleview, Alexandria, Jeff. Davis Highway and Crystal City. This route was extended from Belleview to Mount Vernon via U.S. Highway 1 and Va. Highway 235 to provide direct Pentagon service to the U.S. 1 corridor and to provide service for the first time to residents of the Riverside Estates community along Va. Highway 235.
2. Route 11M, Beacon Hill to Union Station via Alexandria, G.W. Parkway, Independence Avenue and 1st Street, N.E. This route utilizes the N. Washington Street bus priority lanes. The route was extended from its original terminal at Southwest Mall in order to provide direct service to Capitol Hill and Union Station.
3. Route 11W, Woodlawn to Federal Triangle via Pinewood Lake, Sherwood Hall Lane, Belleview and G.W. Parkway.
   This new route was established to provide peak period and off-peak service to the newly developed residential communities in

the Woodlawn area of Fairfax County and to provide service for the first time to residents along Sherwood Hall Lane. In peak periods, this route utilizes the N. Washington Street bus priority lane and operates express through Alexandria. Twelve peak period trips (6 A.M. and 6 P.M.) are operated on this route carrying an average of 45 passengers per trip.

APPENDIX 3

PRELIMINARY STUDY OF A FEEDER BUSWAY TO THE DUNN LORING STATION (W&OD)

July 1974

PRELIMINARY FEASIBILITY STUDY OF A FEEDER BUSWAY TO DUNN LORING STATION

Introduction

The Washington and Old Dominion right-of-way in Vienna from Church Street to Gallows Road is being studied by Vienna and the Northern Virginia Transportation Commission for use as an exclusive commuter busway. This proposed busway would enable rush hour feeder bus service to be provided to the Dunn Loring Metro Station via the W&OD right-of-way. The development of this direct route to the Dunn Loring Station should divert many commuters from the Vienna Station to the Dunn Loring Station. This shift will increase the capability of the Vienna Station to serve commuters from other areas such as Fairfax City, Centreville, and Manassas. It should also reduce congestion on the major arteries feeding these two stations. The objective of the W&OD busway is a better use of the entire Metro system within the Vienna area.

Purpose

The purpose of this study is to determine the feasibility of using the W&OD right-of-way for an exclusive commuter busway, by analyzing the benefits and costs of implementing the busway.

Study Design

The first step in the study was to determine benefits attributable to the W&OD busway. Benefit data was obtained by determining study zones, estimating feeder bus ridership by zone and comparing travel times of proposed 1990 busway routes with the 1990 proposed WMATA bus routes. Ridership and bus travel times were used to determine daily commuter time savings per zone. Daily commuter time savings multiplied by a three dollar value of time yielded daily passenger cost savings. These savings multiplied by 252 give the total yearly benefit per zone. The cost of implementing the busway was developed by examining the W&OD right-of-way and generally estimating the amount of construction required.

Finally, the benefit/cost data was analyzed to determine the economic feasibility of the busway project. If benefits exceed cost, the busway is feasible within the limitations and assumptions of the analysis.

Ridership

Ridership was determined by the number of feeder bus trips emanating from predetermined zones. These zones were obtained from a list of traffic analysis zones developed in the 1968 Traffic, Revenue and Operating Costs Study (Net Income Analysis) prepared for the Washington Metropolitan Area Transit Authority by W. C. Gillman Company, Inc., and Alan M. Voorhees and Associates. Zones in the study area were chosen according to their approximate location near the W&OD right-of-way (see Appendix 1). 1990 population estimates were also taken from this study.

The following chart illustrates the population of each selected NIA zone.

NIA* Zone	Population
576	5,149
577	8,082
644	10,992
645	8,313
646	7,995
647	4,159
648	5,755
650	3,718

*Taken from 1968 NIA computer tabs.

In order to develop ridership figures by zones, it was necessary to estimate the percentage of transit trips that actually would use the feeder bus. The only available modal split data by zone did not list feeder bus ridership. Instead, this breakout listed only transit ridership, (see Appendix II) which included any auto trip using transit for part of the trip. This meant that transit trips would include some trips which would not use the feeder bus for travel to the Metro station. The 1968 NIA study results, indicating 60 percent feeder bus arrivals at the Vienna Metro Station were assumed for this study. (See Appendix II.)

An estimate of feeder bus ridership by zone is shown on the following chart.

NIA Zone		Peak 2-hour Feeder Bus Ridership
576		133
577		132
644		132
645		239
646		136
647		71
648		86
650		33
	Total	962

These figures were assumed to be the same for both morning and evening peak periods.

Network

The first step in designating a network is to establish zone population centroids. This is necessary because time and distance figures are based on mileage from each zone centroid to Dunn Loring Station.

Data on 1990 population density distribution by NIA zone was not available from WMATA or Washington Metropolitan Council of Governments. In lieu of this, the centroids for the study zones considered were based upon street densities taken from the 1968 Metro map prepared for COG by Air Survey Corporation.

Centroids were established by placing a zonal overlay chart on the COG map and estimating the area of greatest population density within each zone. In order to determine centroids in this manner, it was assumed that the area of greatest street density within a zone also represented the area of greatest zonal population density.

Zone 650 has two centroids because the W&OD divides the zones. Therefore, the zone has the characteristics of two separate zones. Zone 648 has two centroids because of its unusual shape and the fact that it has two separate population centers.

1990 Proposed WMATA Bus Network

After the centroids were determined, it was necessary to designate two separate bus networks. The networks designated for comparison were the 1990 proposed WMATA routes (see Appendix III - IV) and a network assuming construction of the W&OD exclusive busway. The Vienna street system was assumed to be the same in both cases, except for the busway on the W&OD right-of-way and a reversible Gallows Road bus lane. Travel times on each network were calculated and trips were assigned to the network showing the greatest time saving.

The following are estimated travel times for the 1990 proposed WMATA bus network.

TIMES VIA 1990 PROPOSED WMATA BUS ROUTES

(From Centroid to Dunn Loring Station)

Centroid	Distance	Time (Minutes)		
		Walk[2]	Transit[1]	Total
1	5.9	3	19.6	23
4	4.7	0	15	15
18	3.6	6	7.2	13
28	5.1	4.5	24	29
30	3.9	0	18.6	19
36	3.8	5	16.8	22
40	4.8	0	24	24
43	4	3.3	19.2	23
54	1.4	2.5	6	9
58	.9	3.5	3	7

1. Ave. bus speed for WV&M bus line was projected as 12.3 mph (1968 NIA Study, p. 19)

   Rail distance between Vienna and Dunn Loring was 2.42 miles with elapsed time between stations projected as 220 seconds. (1968 NIA Study, p. 91)

2. Based upon walking speed of 4 mph between centroid and feeder bus route.

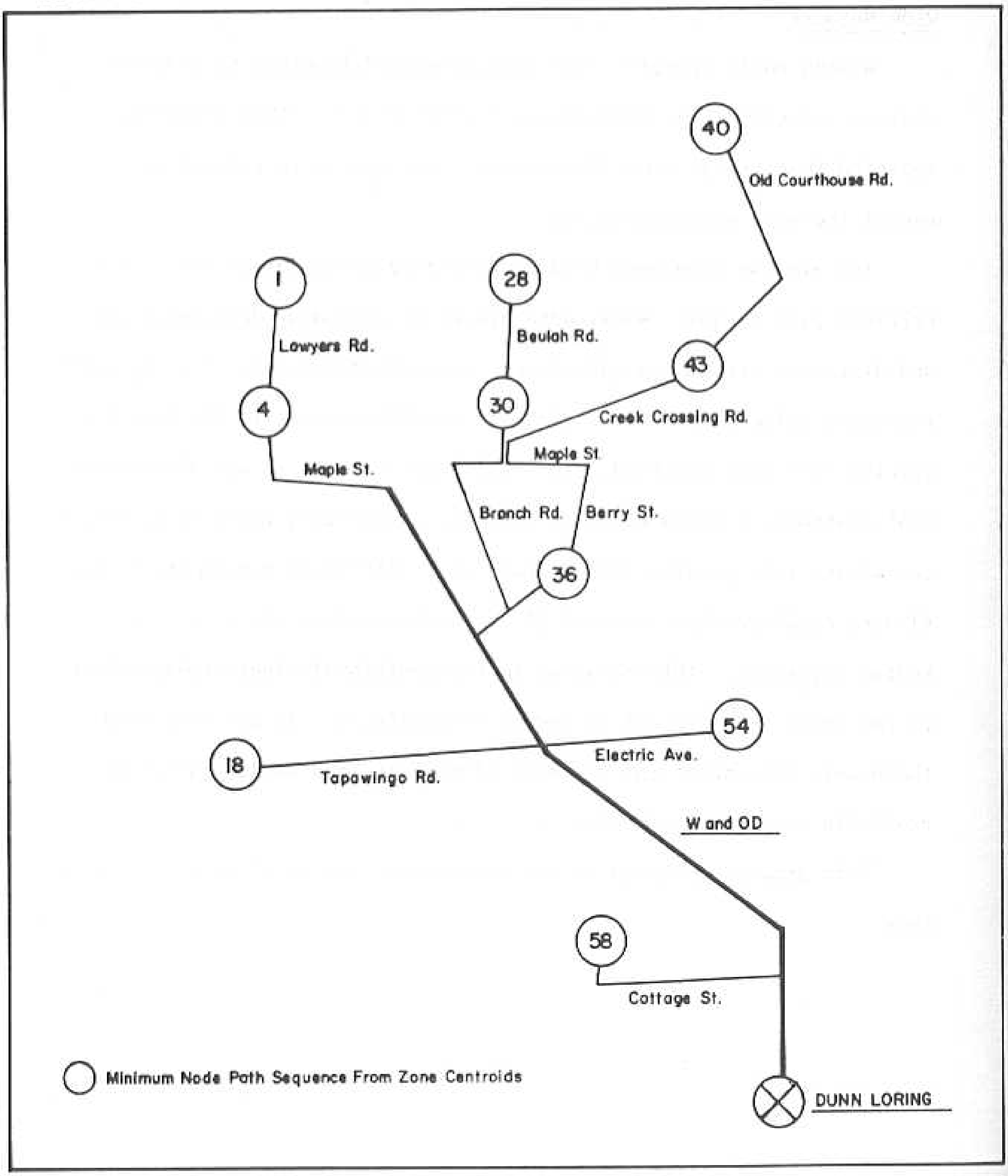
W&OD Network

A W&OD route structure was then developed in order to compare minimum times with the 1990 proposed WMATA routes. This analysis revealed that travel times from every study zone were reduced by use of the W&OD proposed busway.

The minimum time network was derived by a method similar to the critical path method. Nodes were placed at all major intersections and distances were computed between these intersections. The quickest route was selected by calculating all possible routes to the Dunn Loring Station from each centroid. In examining the paths it was discovered that centroids 1 and 4 could be combined on the same route with only a two-minute time penalty for centroid one. Similarly centroids 40 and 43 were combined with centroid 36 to further reduce the number of routes necessary. This resulted in one additional minute being added to the total trip time of 40 and 43 respectively. It was felt that these were more practical in terms of bus use, and would give a more realistic comparison of networks.

This process resulted in the route structure as shown on the next page.

ROUTE STRUCTURE VIA W & OD BUSWAY UPGRADE



The following chart gives a time comparison between the 1990 proposed WMATA bus system and the W&OD busway system.

TIME COMPARISON

1990 WMATA Bus Sytem vs. 1990 W&OD Busway System

Centroid	A 1990 WMATA Routes	B 1990 W&OD Busway Routes	A - B Time Saving
1	23	15	8
4	15	7	8
18	13	9	4
28	29	16	13
30	19	7	12
36	22	8	14
40	24	15	9
43	23	13	10
54	9	5	4
58	7	5	2

The following chart is a summary of benefit data. It gives the total yearly commuter benefit for the W&OD busway. The commuter benefit is the amount of passenger time saved per year at a value of three dollars per hour.

W&OD BUSWAY

YEARLY PASSENGER TIME SAVING AT $3.00 PER PASSENGER HOUR

NIA ZONE	MINIMUM PATH CENTROID[1]	1990 POP.	1990 WMATA ROUTES		1990 W/W&OD BUSWAY		TIME SAVING (Per Pass.Trip)	DAILY FEEDER BUS RIDERSHIP (AM & PM PEAK)[2]	W&OD TIME SAVING (Pass.Hrs./day)[3]	DAILY COST SAVING (hrs.x3)	YEARLY COST SAVING (daily x 252)
			Dist.	Time	Dist.	Time					
576	58	5,149	.9	7	.8	5	2	266	8.8	$26.40	$6,653
577	54	8,082	1.4	9	1.7	5	4	264	17.6	52.80	13,306
644	40	10,992	4.8	24	4.7	15	9	264	39.6	118.80	29,937
645	18	8,317	3.6	16	3.2	9	4	478	31.9	95.61	24,094
646	36	7,995	3.8	22	2.6	8	14	272	63.4	190.20	47,930
647	4	4,159	4.7	18	3.7	7	8	142	18.9	56.79	14,311
648	30	5,755	3.9	19	3.0	7	12	172	17.2	51.60	13,003
	43		4.0	23	3.9	13	10		14.3	42.90	10,810
650	1	3,718	5.9	26	4.8	15	8	66	4.4	13.2	3,326
	28		5.1	29	4.3	16	13		7.1	21.30	5,368
											$168,738

1. When zone has two centroids, population and passenger trips are divided equally.
2. Daily feeder bus trips = 2 hour peak x 2.
3. Passenger hours per day = (time saving x daily feeder bus ridership) ÷ 60.

The next step in the analysis was to determine busway costs. Busway cost development was necessary in order to establish the project's benefit/cost relationship. These costs were developed after a general field survey of the W&OD right-of-way to estimate construction requirements. Unit cost estimates provided by Arlington County DOT (Appendix V) were used to compile the following estimated busway construction costs. Actual computations are provided as Appendix VI.

BUSWAY CONSTRUCTION COSTS

<u>Excavation</u>		
1. 100 yrds. minor grading - on busway	$1,554	
2. 100 yds. minor grading - to extend Branch to W&OD	1,554	
3. 1.2 mi. minor grading - Gallows bus lane	37,296	
4. 400 yrds major grading - on busway	12,439	
5. Widen 3 street crossings	3,108	
6. Widen approach to Gallows Road	2,072	
7. Fill and compacting	6,662	
Total Excavation Costs		$64,685
<u>Culverts</u>		
1. 4 - 18"	$1,800	
2. 3 - 24"	2,100	
Total Culvert Costs		$3,900
<u>Guard Rails</u>		
1. 1½ mi. at $6. per linear ft.		$47,520
<u>Crossings</u>		
1. 3 RR-type guarded crossings - Park, Electric, Cedar	$36,000	
2. 1 Signal light crossing - Maple.	20,500	
Total Crossing Cost		$56,500

Ditch		
1. 100 yrds of 4" paved ditch		$475
Pavement - 8" deep		
1. 2.5 mi. of busway	$141,504	
2. 100 yds.- to extend Branch Avenue	3,216	
3. 1.2 mi. - Gallows bus lane	33,961	
Total Paving Costs		$178,681
Maintenance Costs		
$1,900 per lane mile per year x 3.1 miles ($5,890)		
Total Construction Cost (Excluding Maintenance Costs)		$351,761

To obtain total W&OD busway construction costs, all costs were added except maintenance. Maintenance costs were accrued on an annual basis at a rate of $1,900 per year per lane/mile, so they could not be added to total construction costs until construction costs were converted to a yearly figure. This conversion was made by using a chart which listed the capital recovery factor necessary to repay the principal plus 8% interest over a service life of 20 years.

Once the yearly capital recovery amount was determined, the yearly maintenance costs were added to determine total costs per year. Total cost per year was used as the base figure in the benefit/cost comparison.

The following figures show how total costs per year were derived.

Capital cost per year = Total construction cost x CRF

Capital cost per year = $351,761 (.10186)

Capital cost per year = $35,830

In order to obtain total cost per year, maintenance cost per year must be added to capital cost per year.

Total cost per year = yearly maintenance cost + yearly capital cost.

Total cost per year = $5,890 + $35,830

Total cost per year = $41,720

The final phase of our analysis was a comparison of calculated benefit/cost data. This comparison provides a ratio of the benefits to the costs associated with the busway project. The following is a comparison of derived benefit/cost data.

Yearly Benefit/cost = $192,686/$41,720 = 4.62 to 1

Conclusions

1. The busway has a benefit/cost ratio of approximately 4.62 to 1, therefore, it appears economically desirable.
2. The busway can offer impressive time savings as opposed to using the 1990 proposed WMATA bus routes.

   On some routes the busway saves as much as 14 minutes.
3. Further detailed analysis of the W&OD busway seems justified. An in depth study of ridership and costs should be made when 1994 data becomes available.

Summary

This study has attempted to develop ridership estimates and optimum bus networks in relation to developing the W&OD right-of-way. The yearly time saving benefit was computed and then compared to the estimated W&OD construction costs. This comparison was provided to give an idea as to the feasibility of establishing the busway.

This study is merely an attempt to consider the initial feasibility of establishing the W&OD busway. Its scope has been limited to provide only preliminary figures. Ideally, this report will pave the way for a more detailed study at some future point in time.

The following is a list of assumptions used in the analysis.

A. Ridership

   1. Zonal transit trip data taken from 1968 NIA was reasonably accurate for 1990 estimates.

2. Feeder bus ridership by zone would approximate NIA modal split arrival figures given for each Vienna Metro Station.

3. Feeder bus riders from desginated study zones destined for Vienna Station could be diverted to Dunn Loring Station if the W&OD busway provided a travel time saving.

4. AM and PM peak period ridership would be the same. Therefore, daily ridership would be the total of AM and PM peak 2-hour periods.

5. Zones relatively contiguous to the W&OD right-of-way would draw the majority of riders.

B. Network

1. Areas of greatest street density within a zone also contained the highest population density.

2. Feeder bus riders would emanate from population centroids.

3. 1990 Metro average bus speed for residential areas was 12.3 mph. (1968 NIA study)

4. Commuters travel by fastest route available.

5. 40 mph. was the average speed for the entire busway.

6. The most realistic busway system would serve adjacent centroids with one route whenever possible.

7. Bus waiting times for the two bus systems were assumed to be the same and were therefore not considered.

8. Average walking speed was estimated to be 4 mph.

9. Rail trip from Vienna Station to Dunn Loring Station would take 220 seconds (1968 NIA Study, p. 91).

C. Costs

1. Assumed 8% annual interest for 20 years on construction costs.

2. Maintenance costs were considered since they are a part of total busway costs.

   Interest was not applied to maintenance costs because it was assumed they were paid annually out of operating revenue.

3. Bus operating costs for both networks would be the same, so they were not included.

4. A reversible bus lane would be used on Gallows Road.

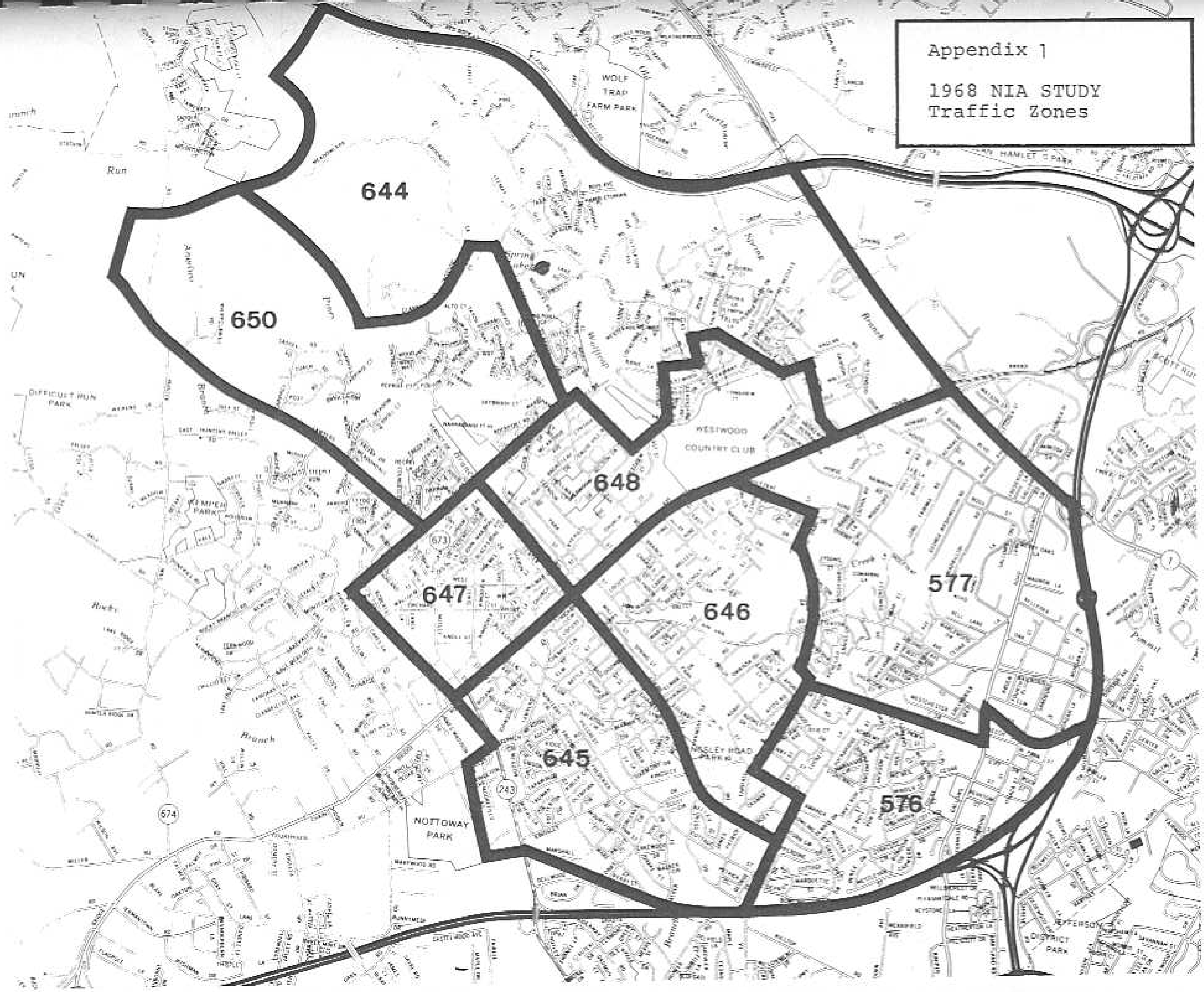
D. Benefits

1. Use $3.00 per hour for passenger time savings.

2. Assume 252 workdays per year.

Appendix 1

1968 NIA STUDY
Traffic Zones



APPENDIX II

TABLE 1

PEAK 2-HOUR MODAL SPLIT

BY ZONE

(1968 NIA Study Computer Tabs)

Zone	Auto Driver		Auto Passenger		Transit		Person Trips
	Trips	%	Trips	%	Trips	%	
576	525	56.5	183	19.7	221	23.8	929
577	844	62.5	286	21.2	220	16.3	1,350
644	944	63.6	321	21.6	220	14.8	1,485
645	1,087	58.4	374	20.1	298	21.4	1,859
646	1,081	64.7	362	21.7	227	13.6	1,670
647	604	65.3	203	21.9	118	12.8	925
648	721	65.0	243	21.9	144	13.0	1,108
650	316	66.5	104	21.9	55	11.6	475

TABLE 2

1990 PEAK ONE HOUR STATION ARRIVALS

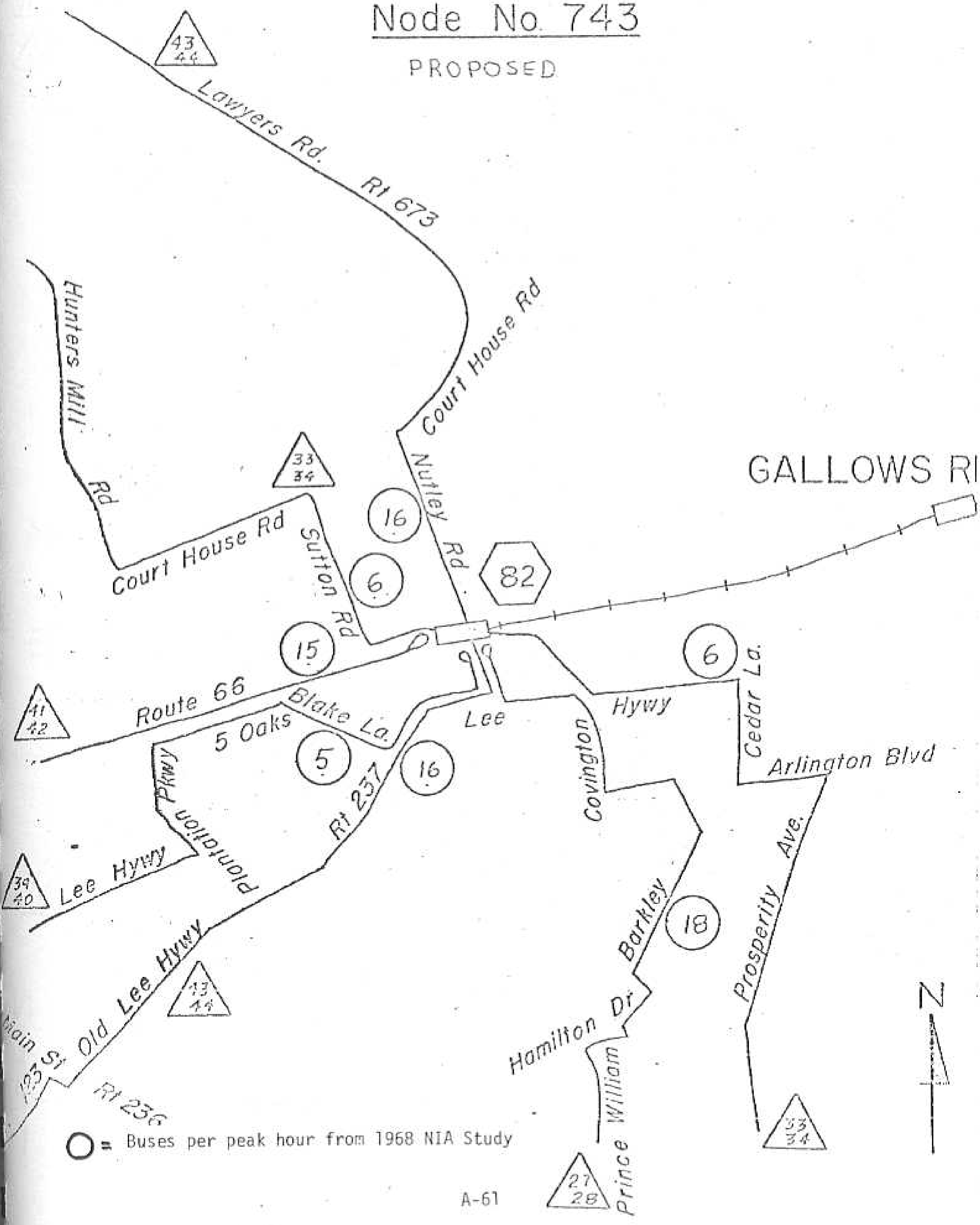
(1968 NIA Study)

	Vienna	Dunn Loring
Walk	27	120
Bus	2,778	877
Drive & Park	1,114	188
Passenger	223	38
Kiss-n-Ride	600	237
Totals	4,742	1,460

NUTLEY ROAD-1990

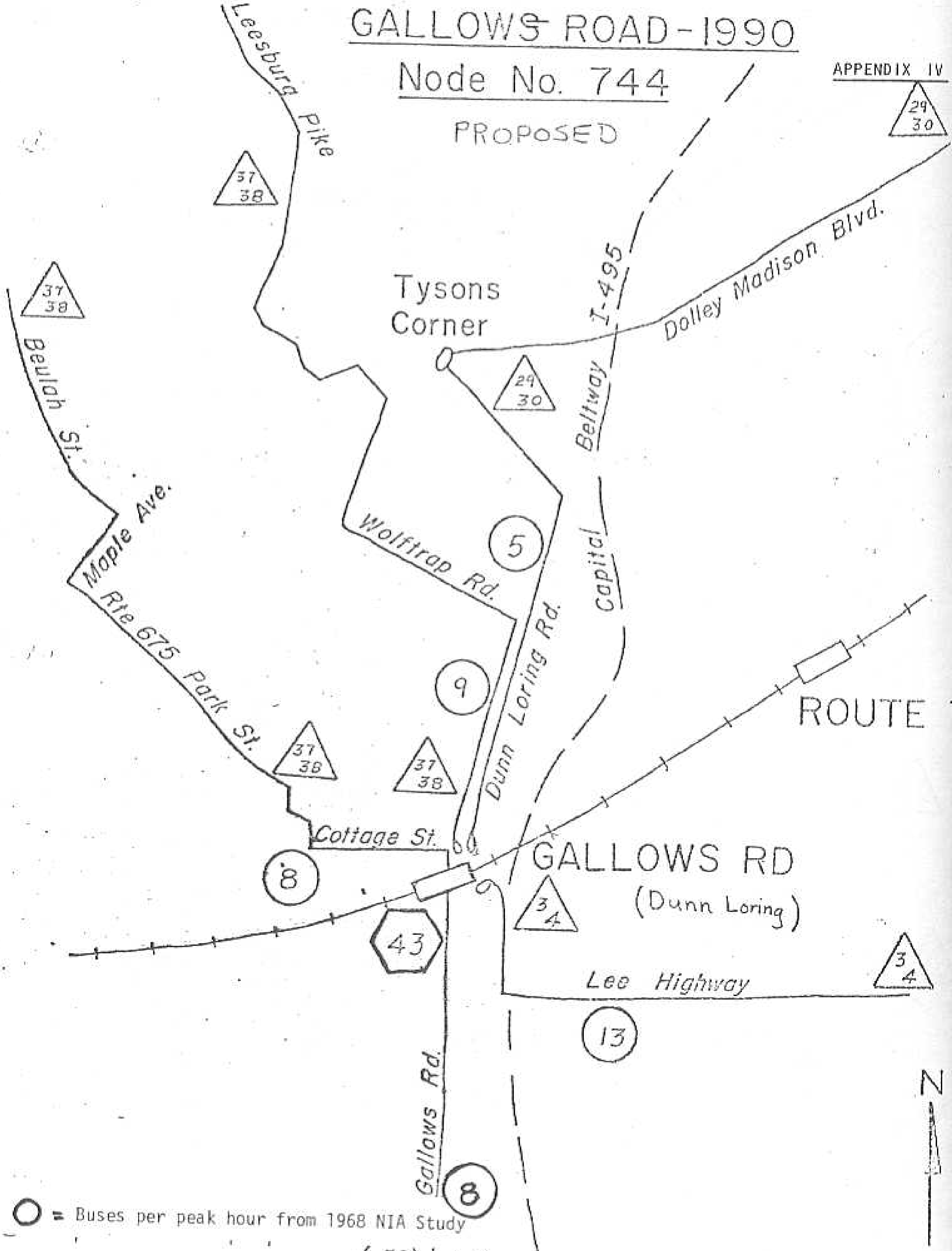
Node No. 743

PROPOSED



○ = Buses per peak hour from 1968 NIA Study

GALLOWS ROAD - 1990
Node No. 744
PROPOSED



○ = Buses per peak hour from 1968 NIA Study

APPENDIX V

Excavation - $7. per cubic yd.

Fill and compacting $8. per yd.

Culverts

18" $18. linear ft.

24" $28. " "

Guard Rail

$ 6.00 per ft.

Paved Ditch - 4" deep

$18. per ton

yd^2 x 1.8 - tons

Crossing

$15,000/signal light or $12,000/gate.

Paving $18 per ton for 8" pavement

yd^2 x 2 - tons

Signal - time coordinated at Maple with adjacent signals

$5,500 and cost for signal at Maple.

Maintenance/per lane mi (Jim Kelly, Hwy. Dept)

$1,900 per yr. Cr. 3-0660

<u>APPENDIX VI</u>

COST FORMULAS

A. <u>Excavation</u>

1. 100 yards minor grading
   (20' wide) (1' deep) (300' long) (1/27) ($7) = $1,554

2. see #1, 100 yards minor grading 1,554

3. 1.2 mi. of minor grading
   (20' wide)(1' deep) (11,616' long)(1/27) ($7)= 37,296

4. 400 yrds, major grading
   (20' wide) (2' deep) (1200' long) (1/27) ($7)= 12,439

5. Widen 3 street crossings
   Average width of 10', 12 sections, 4 to a crossing

   (12 (½' deep) (200' long) 10' wide)(1/27) ($7)= 3,108

6. Widen approach to Gallows Road
   see Diagram in #5
   1 merge point with two sides

   (2) (10' wide)(2' deep) (200' long)(1/27) ($7)= 2,072

7. Fill and compacting

   2 (½)(50'wide)(15' deep) (25'long) (1/27)($8) = $6,662

B. <u>Culverts</u>

18'' = 4 (25' Long)($18) = $1,800
24'' = 3 (25' Long)($28) = 2,100

C. <u>Guard Rail</u>

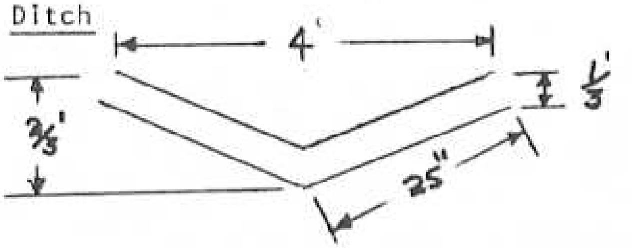
1½ miles
(7,920') ($6) = $47,520

D. Crossings

1. 3 crossings at 12,000 = $36,000

2. 1 crossing for Maple
   15,000 + 5,500 = 20,500

E. Ditch



1.8 converts cu.yrds. to tons for ditch paving

(4'wide)(300' long) (1/3'thick) (1/27) (1.8) ($18) = $475

F. Pavement

1. 2.5 miles of busway

   (12' wide) (13,200' long) (2/3' deep) (1/27) (2) ($18) = $141,504

2. Pave 100 yds to extend Branch Avenue

   (12'wide) (300' long) (2/3'deep)(1/27) (2) ($18) = $3,216

3. 0.6 miles of busway at Gallows Road

   (12' wide)(3,168' long) (2/3' deep)(1/27)(2) ($18) = $33,961

Maintenance Costs

3.1 mi. at $1900/lane mi. = $7,030 per yr.
(20 yrs) ($7,030) = $140,600

APPENDIX 4

CONCLUSIONS FROM PHASES I & II, ALEXANDRIA COLLECTOR-DISTRIBUTOR STUDY

Alexandria Mini-Transit·System Concepts

a downtown transit distributor system

BARTON-ASCHMAN ASSOCIATES INC. WASHINGTON D.C. 1975
for the Northern Virginia Transportation Commission

3 Summary of Conclusions

3.1 Patronage Forecasting

The range of trips projected for the Mini-Transit System in 1992 varies from 30,000 to 40,000 trips per day. The reasons for the range lie in the fact that projections are based on two alternative Growth Models, one Residential, the other Commercial in nature. (See Chapter 4.) The two Growth Models allow for both liberal and conservative assumptions concerning changes in population, housing, jobs, and income during the study period. The commercially biased model resulted in a martinally greater number of trips. Of the total number of trips in the study area in 1992 by all modes, a proportion will be diverted to the Mini-Transit mode. Again liberal and conservative assumptions are made in the diversion (or modal split) process. The following table shows the total 1992 level of demand for each combination of Growth and Model Split.

TABLE 1

	Commercial Model	Residential Model
High level of diversion to Mini-Transit	40,200	37,800
Low level of diversion to Mini-Transit	32,600	30,500

CONCLUSION 1

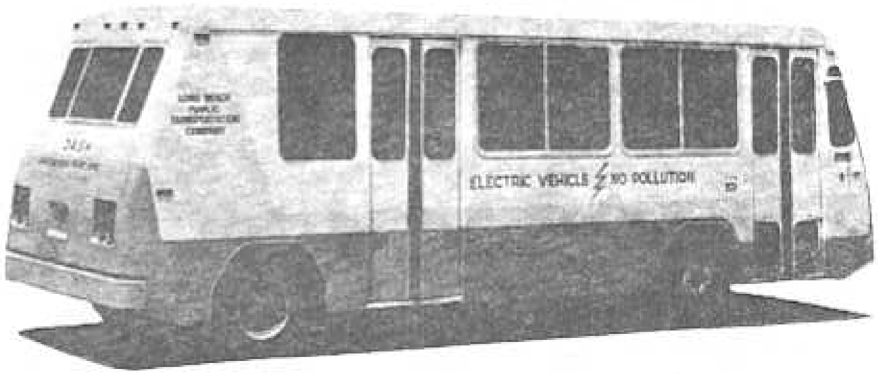
The range of demand indicates that there are sufficient trips to justify a transit system in the central area of Alexandria. under all foreseeable circumstances of growth to 1992.

3.2 Vehicle Types

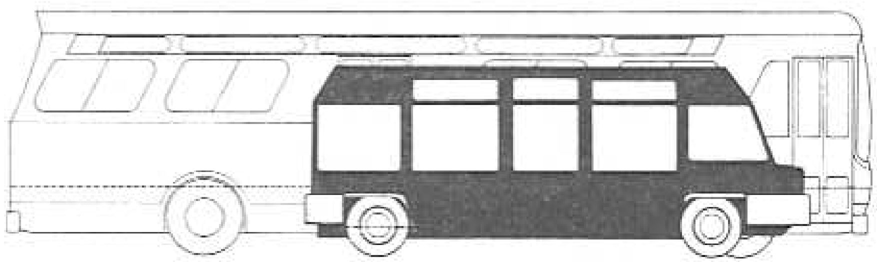
Four major types of systems have been analyzed including 15 different vehicles, all of which are operational in some degree from prototype to full commercial use. A number of systems are designed to handle the volumes of riders expected in Alexandria, including all the small buses and other ground vehicles such as street cars. The low capital cost of a system running on city streets compared with the large capital outlay of all elevated systems makes the "on-grade" vehicles preferable. The ability to change routes and to expand the system on occasion also mitigates against fixed guideway systems. The small, specialized bus systems are admirably suited to carry the projected volumes and very flexible in operation. Furthermore, the introduction of a small bus system over the next 20 years would not preclude the construction of a fixed guideway system in the longer range future, should conditions warrant it after 1992.

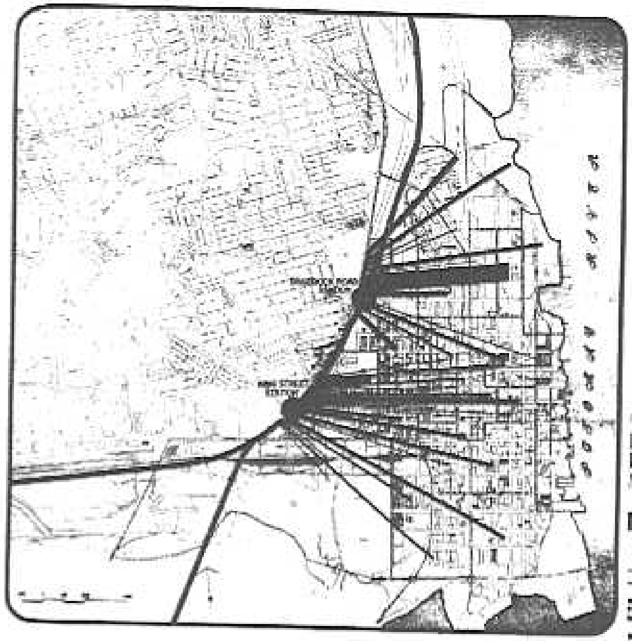
CONCLUSION 2.

A small fleet of mini-buses is well suited to accommodate the 30,000 to 40,000 daily trips which are anticipated by 1992. Even the highest peak hour volumes in 1992 do not of themselves justify the fixed guideway system. All further analysis should be directed to developing an implementation and operating plan for a small bus system.



Electrobus


Ginkelvan



ALEXANDRIA MINI-TRANSIT

a downtown transit distributor system

Figure 20

Desire Lines for Daily Trips to Metro

ALEXANDRIA MINI-TRANSIT

a downtown transit distributor system

Figure 21

Desire Lines for Daily Downtown Trips

3.3 Service Area

Desire line patterns for a Mini-Transit system show heavy volumes approaching both Braddock Road and King Street Stations. The daily approach volumes are shown in Table 2

Table 2

	Braddock Road		King Street	
	High Modal Split	Low Modal Split	High Modal Split	Low Modal Split
Residential Model	4100	3300	3900	3000
Commercial Model	4000	3200	4200	3200

The highest level of interzonal demand is between the North Waterfront and Braddock Road Station.

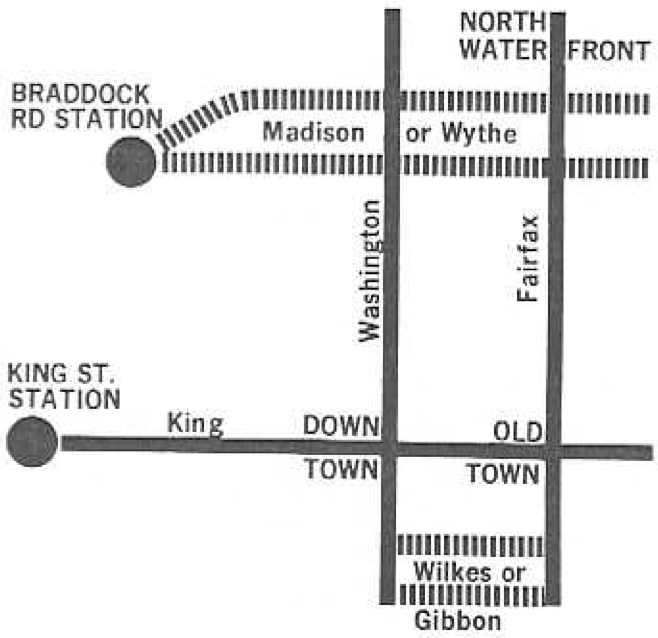
Elsewhere, the non-Metro oriented trips are highest between zones adjacent to King Street east of Washington Street. The distribution of internal trips is generally restricted to the area bounded by First and Second Streets in the north, Henry Street in the west and Gibbon Street in the south.

It is anticipated that Metrobus service to and from the west would be curtailed at King Street, and Braddock Road Stations, so that the Mini-Transit system and Metrobus would not be competing for the same riders.

Additonal input on the question of routes and service areas was received from local community representatives and the Downtown Merchants Association who favored service on King Street, and felt that routes should generally follow streets with present Metrobus service to avoid impacting residential areas.

CONCLUSION 3

Service on either Madison or Wythe; Fairfax; Washington; Wilkes or Gibbon; and King Street would give a good coverage to the study area while concentrating on the centers of maximum demand, and would not cause undue impact to residential areas.



3.4 Phasing

Some form of shuttle service on King Street and Madison/Wythe Streets would satisfy the major demand for transportation to Metro stations. In the downtown area, tripmaking is highest between zones adjacent to King Street. There is a strong feeling among several civic organizations that a King Street shuttle would serve a pressing current need.

The selection of a ground level transit system should not inhibit other longer term decisions on transit service in the area. Therefore, it is conceivable that three distinct phases of transit services should be considered.

- Pre-Metro shuttle service on King Street.
- Mini-bus service coincidental with the introduction of Metro service.
- Long-range replacement of certain bus routes with a PRT system.

CONCLUSION 4

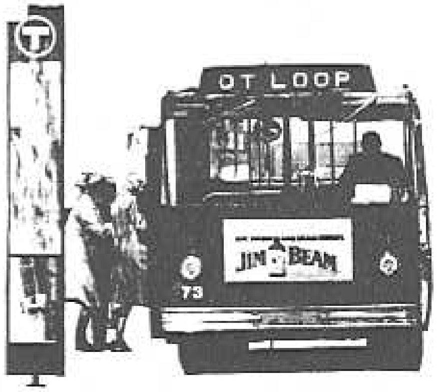
Early introduction of portions of the Mini-Transit system would encourage transit riding habits and serve current needs. The full system should be timed to coincide with Metro's opening, and should be developed with the option of modifying service levels in response to demand. A PRT system may be justified on certain routes in the long-term.

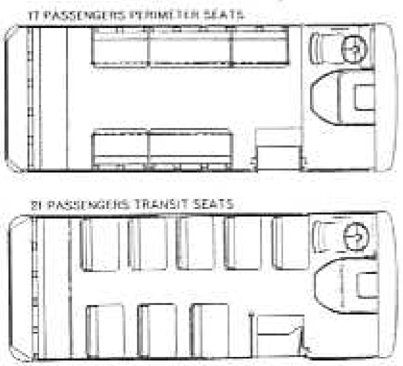
3.5 System Capacity Required

Examination of peak travel demands indicates that the highest passenger volumes will be found adjacent to the King Street and Braddock Street stations. The peak volumes under the Residential Model assumptions occur on the links approaching Braddock Road station, whereas the peak volumes under the Commercial Model occur on the links approaching King Street station. Assuming a small bus with capacity for 25 passengers running at 12 mph over a 5 mile trip loop between the stations the number of buses required can be estimated.

CONCLUSION 5

To satisfy peak hour demand, between 18 and 30 small 25-passenger buses will probably be required depending on the modal split assumptions. This will allow between 90 second and 60 second headways respectively. These figures are tentative, and will be subject to more rigorous scrutiny in Phase 2 of the study, when operating, scheduling and costs will be analyzed in more detail.



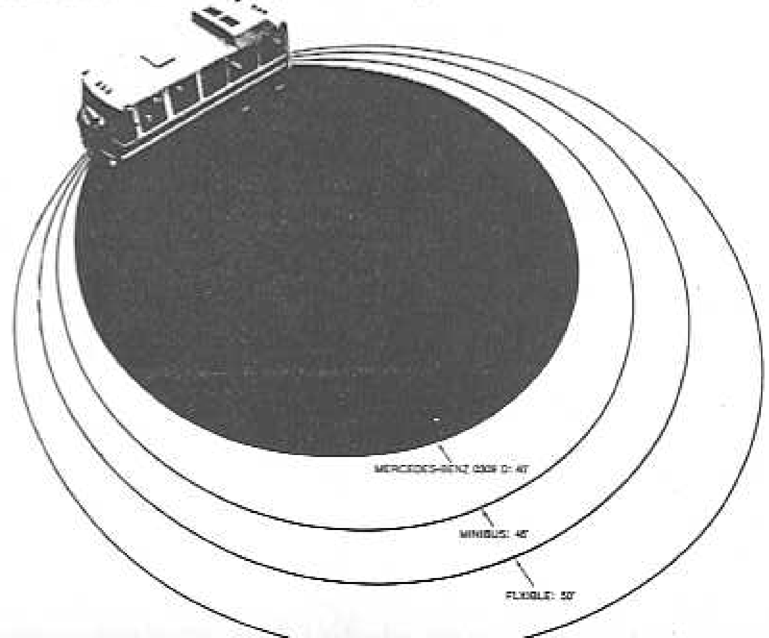


3.6 Vehicle Design

While the elevated "new technology" is certainly attractive in terms of vehicle aesthetics and novelty, there appear to be several variants of the mini-bus concept which also have distinct imageability. The attractiveness of the vehicle itself is of tremendous value in projecting the city's concern for good design among tourists and non-residents. The traditional streetcar achieves this. It may be worth tolerating the impacts of an overhead wire and some traffic disruption in favor of its sheer imageability and tourist-value for the town.

CONCLUSION 6

The ultimate selection of a Mini-Transit vehicle should give strong weight to considerations of comfort, pleasant interior design, and particularly the attractiveness of the vehicle as it contributes to the city streetscape.



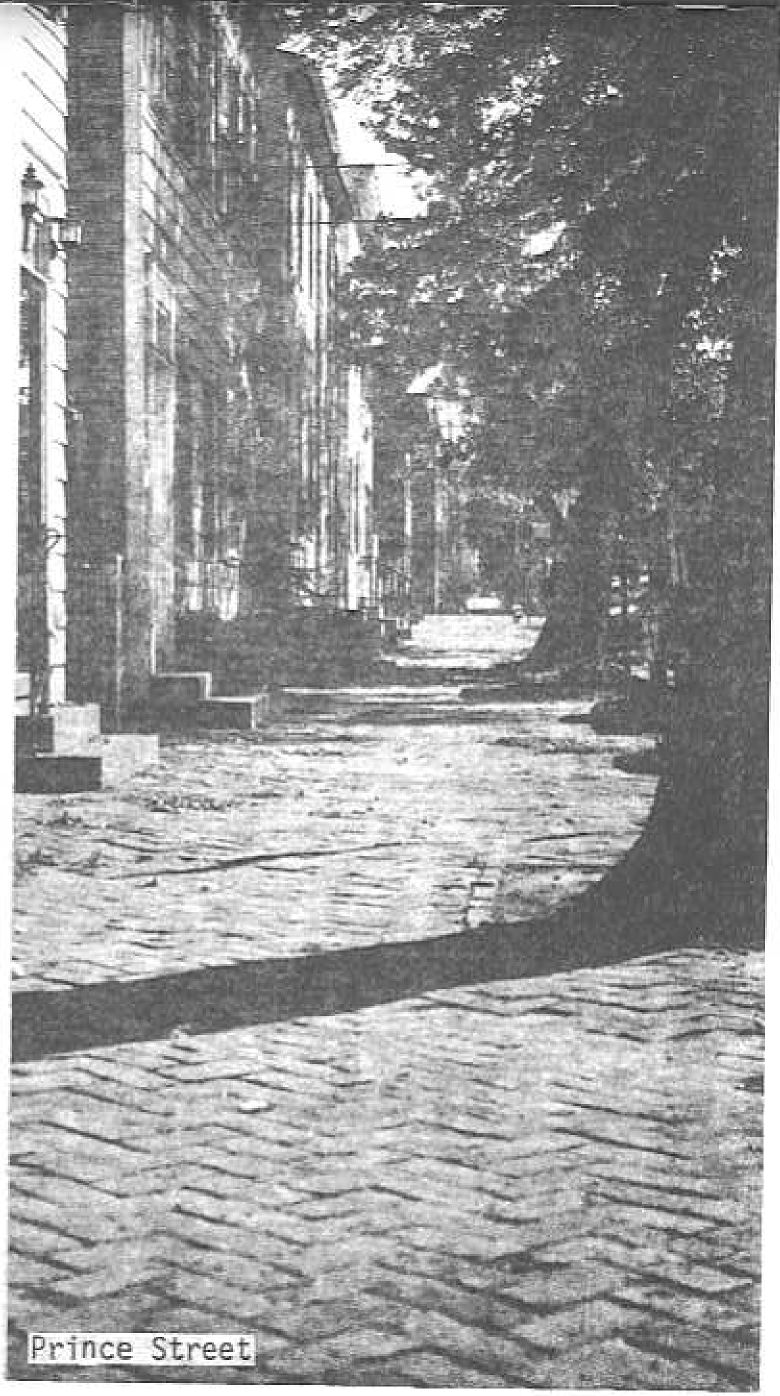
Old Town

3.7 Urban Design and Community Input

The reactions of all groups who were exposed to the study objectives and concepts were generally favorable. In terms of the aesthetic impact, the concensus appeared to be opposed to any form of elevated guideway system. This was supported by the findings of the study that there appeared to be no method of penetrating the Old Town area with an elevated structure without serious visual impact on significant buildings and views.

CONCLUSION 7

Initial public reaction supports the view that a fixed, elevated guideway system would be incompatible with the historic and residential environments of the study area.



Prince Street

3.8 Recommended System

The purpose of this phase of the study has been to narrow down the range of options to arrive at a feasible Mini-Transit System for which the detailed design will be prepared in Phase 2. The basic recommendations at the conclusion of Phase 1 are as follows:

1. On the basis of demand estimates, technological evaluation, urban design considerations, and community input, a small bus system within the central Alexandria area will be necessary in order to prevent savere congestion in the vicinity of the proposed Metro-stations and will provide a highly desirable service throughout the area.

2. The number of small buses required will vary within a probable range of 18 to 30, depending on the growth assumptions, precise routes, fare structure, and capacity of the vehicles.

3. The service area for the recommended system should concentrate on four main corridors:

   - King Street
   - Braddock Road Station to North Waterfront
   - North and South Washington Street
   - North and South Fairfax Street

4. The study should proceed into Phase 2 on the basis of the foregoing recommendations in order to develop final routes, vehicle design specifications, manpower and maintenance requirements, cost/revenue plans, and a management plan.

ALEXANDRIA MINI-TRANSIT: A DOWNTOWN DISTRIBUTOR SYSTEM

SHORT RANGE DEVELOPMENT PROGRAM

Prepared for:

The Northern Virginia Transportation Commission
Arlington, Virginia

by
Barton-Aschman Associates, Inc.
Washington, D. C.

June 1976

UMTA Project No. IT-09-0020-12

"The preparation of this report was financed in part by an Urban Mass Transportation Grant from the U.S. Department of Transportation under the provisions of the Urban Mass Transportation Act of 1964, as amended."

1.0 INTRODUCTION

1.1 ABOUT THIS REPORT

This document is the second and final report prepared for the Northern Virginia Transportation Commission (NVTC) by Barton-Aschman Associates, Inc. for the purpose of describing the level of local transit service which is necessary and desirable for the eastern portion of the City of Alexandria, Virginia over the next five to seven year period.

The first report of this series: "Alexandria Mini-Transit: System Concepts," (March, 1975), examined the maximum long-term potential for a sub-regional transit system which would both provide access between the study area and the King Street and Braddock Road Stations of the regional rail rapid transit system (METRO) now under construction and improve internal circulation within the boundaries of the study area itself. In addition, Phase I of this study examined a number of alternative "generic" transit systems and concluded that a "small-bus" system would be best suited to accommodate the estimated travel demands in the area in the year 1992.

The purpose of Phase II of the Alexandria Mini-Transit Study was:

> "to detail the final system as to vehicle specifications, specific routes, timetables, fare structure, operational and maintenance personnel, capital and operating cost." (1)

In conjunction with the Phase I report, the results of Phase II of this planning study will fulfill the requirements of the Urban Mass Transportation Administration (UMTA) for a subregional Transit Development Program (TDP) and serve as documentation for any capital and/or operating assistance grants from UMTA which might be applied for in order to implement the recommended localized transit service in the eastern portion of the City of Alexandria.

Much of the work performed during Phase II of this study is based upon the conclusions and recommendations of the Phase I work program. In order to

(1) Barton-Aschman Associates, Inc. "Alexandria Mini-Transit: System Concepts", March, 1975, Pg. 3

obtain a complete understanding of this study, it is thus essential that the two reports be considered as an integral unit.

Relationship to Other Transit Planning Activities

This transit technical study has been conducted under the sponsorship of the Northern Virginia Transportation Commission (NVTC) and has been funded in part with monies provided by the Urban Mass Transportation Administration under its Technical Studies Grant Program to the Metropolitan Washington Council of Governments (COG) for use in the completion of the Fiscal Year 1976 Unified Transportation Planning Work Program for the Washington Metropolitan Area. This study has also been included in both the presently adopted Short Range Transit Development Program and the Short Range Transportation Improvements Program for the Washington Metropolitan Area as prepared by COG and, as such, will serve to maintain and improve the validty of these documents.

Study Procedure

The methodology which was employed to produce the Phase II report is illustrated in Figure 1-1 and described below:

Since the end result of Phase II was to be a detailed short range transit development program for the area, a straight forward approach was taken. The time frame for this program is the five year period 1978-1982, with an emphasis on the year 1980 for patronage forecasting purposes. The period from 1978-1982, as opposed to, say, the period from 1975-1980, was selected in order to encompass the scheduled opening in late 1979 or early 1980 of that portion of the regional rail rapid transit system (METRO) which will directly serve the City of Alexandria. This event will have a major impact upon both the magnitude and orientation of the travel demands within the study area and 1980 is, therefore, the critical date for this study.

Throughout the conduct of this study, input from the effected local governments and citizen groups was both continuous and significant. The Transportation Planning Board (TPB), which was established by the Alexandria City Council in January, 1975 and which is composed of laymen selected from throughout the community, took a major interest in the Phase II work program and, more than adequately represented the viewpoint of those portions of the community most directly effected by the project.

Following the initiation of the Phase II Work Program, several major activities were carried out concurrently. An evaluation of the transit service in the study area currently being provided by the Washington Metropolitan Area Transit Authority (WMATA) was performed. This quantified not only the amount of service presently provided but also examined the existing usage of this service by the residents of the study area. This work element is described in detail in Chapter 2, "Evaluation of the Existing Public Transportation System."

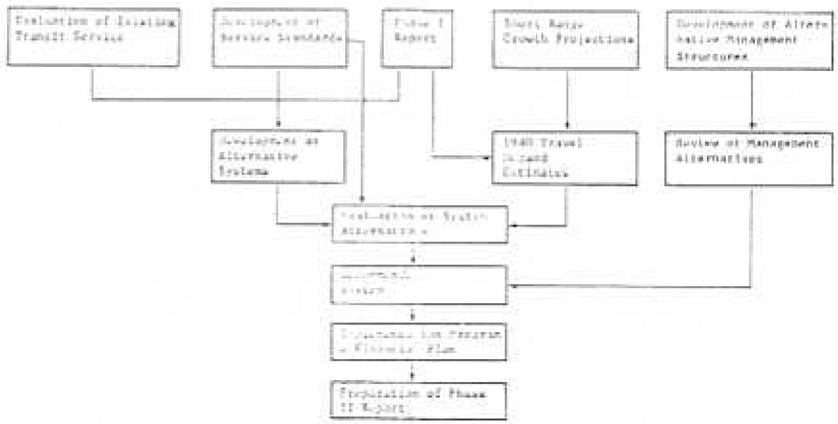
With the principal input from the City of Alexandria's Department of Planning and Community Development, the location and magnitude of the land use and development changes over the period 1975-1980 were quantified. These short range growth projections were used, in conjunction with the long range work performed during Phase I, to develop 1980 Travel Demand Estimates. The procedure which was employed in this portion of the Phase II work program is described in detail in Chapter 3, "Development of Short Range Travel Demands".

At the same time, desirable service standards and criteria for the mini-transit system were developed. These were tailored specifically for the Alexandria Study Area and were the result of substantial input by the local interests involved. Similarly, a number of alternative management and organizational structures for the proposed mini-transit system were reviewed by the local agencies for their ability to satisfactorily provide the character and quality of service desired in the study area.

A number of alternative public transportation systems were then formulated

Figure 1-1

Phase II Study Methodology



based upon the evaluation of the existing transit service in the area, the previously developed service standards and operating criteria and the general conclusions and recommendations contained in the Phase I report. These alternatives were composed of varying mixtures (with respect to both operating concept and route structure) of Metrobus and Mini-Transit service. These alternatives, the rationale underlying their development and the evaluation procedures which were employed, are discussed in detail in Chapter 4, "Development and Evaluation of Alternative Public Transportation Systems."

Each of the various service alternatives was examined for its ability to satisfy the projected short term (1980) travel demands and the previously developed service criteria, with a particular emphasis upon both the costs and the environmental and social impacts of each of the system. The result of this activity was the selection of the "Recommended" Public Transportation System for the area. Chapter 5 details this recommended system with respect to such factors as routings and level of service, the location of bus stops and major transfer points, vehicle requirements (both quantitative and qualitative), and the relationships of this system to other elements of the regional transportation system.

A detailed implementation program and financial plan for the period 1978-1982 was then formulated. This step also included the development of a preliminary transit marketing strategy for the area and a discussion of the functional and organizational factors involved in the continuing update of the Short-Range Transit Development Program for the Alexandria subregion.

1.2 SUMMARY OF RECOMMENDATIONS

Based upon the work performed during Phase I of this two part study, and the further analysis conducted during Phase II, a number of basic conclusions and recommendations can be presented as to the form of localized transit service which is required in the eastern portion of the City of Alexandria over the next five to seven year period. The most important of these conclusions are as follows:

Conclusion 1. The public transportation system currently operated within the study area by the Washington Metropolitan Area Transit Authority (METRO) provides a generally high level of service (as measured by the number of buses operated per hour) in most of the area's primary travel corridors. Combined route peak period headways in these corridors of 3 - 5 minutes are not uncommon with typical corridor headways during base periods of 10-15 minutes. However, this service is predominantly oriented towards the District of Columbia and routes are often very circuitous, especially in those portions of the City of Alexandria immediately to the west of the primary study area.

Conclusion 2. Based upon the Fall, 1972 WMATA origin-destination survey, the average daily transit ridership of 5600 persons within the study area is predominantly destined for downtown Washington; with 72.4 percent of all trips being for the purpose of "Work". "Personal Business" trips account for 13.8 percent of the total, with the remaining trips being divided between "Shopping" (4.6 percent), "School" (6.7 percent), "Social, Recreation or Entertainment" (1.8 percent). Of these total trips, only 169 or 3.03 percent are presently Internal-Internal trips, that is, trips with both their origin and destination within the study area.

Conclusion 3. The estimated 1980 population and employment figures will approximate those developed during the Phase I study for the year 1992. In several instances, 1980 estimates for particular traffic analysis zones exceeded those made during Phase I for 1992. However, this was as a result of having available more detailed redevelopment plans during the conduct of Phase II than during Phase I.

Conclusion 4. It is estimated that some 55,200 person trips per day in 1980 will be potential "Candidates" for diversion to the "Mini-Transit" system. The number of trips for each original travel mode are: Auto-11,600; Transit-14,300; Walk-27,000 and Tourist-1000. The total number of 1980 "Candidate" trips is approximately 98% of those projected to be "Candidate" trips in 1992 during the Phase I study.

Table 3-6 Estimated Diversion to Mini-Transit of 1980 Candidate Trips

	High Diversion Rate		Low Diversion Rate		Average Diversion Rate	
Access Mode	Trips	Percent of Total Trips Diverted	Trips	Percent of Total Trips Diverted	Trips	Percent of Total Trips Diverted
Auto	5805	16.06	2320	7.87	4071	12.40
Transit	14,823	41.00	11,660	42.22	13,352	40.66
Walk	13,434	37.30	13,454	45.73	13,494	41.06
Tourist	2040	5.63	1024	8.19	1932	5.88
TOTALS	36,152	100.00	25,402	100.00	32,839	100.00

Table 3-7 Effect of Proposed Mini-Transit System on Reduction in Daily Internal-Internal Auto Trips in the Study Area

		Person-Trips	Vehicle Trips (1) Number	Vehicle Trips (1) Percent
1980 Auto Person Candidate Trips	-	11,595	9276	100.0%
Low Diversion Rate	-	2,320	1856	20.0%
Average Diversion Rate	-	4,071	3257	35.1%
High Diversion Rate	-	5,805	4644	50.0%

(1) Assuming an average auto occupancy rate of 1.25 for the entire day.

Conclusion 5. Utilizing the parametric modal split methodology employed during Phase I, it is estimated that the number of daily person trips likely to be shifted from their original travel mode to the localized transit service will range from a low of 29,500 to a high of 36,200. Taking into account the alternative configurations of Metrobus and Mini-Transit proposed to operate in the study area in 1980, and using the low diversion rate of 29,500 trips as the upper limit of usage actually attainable in 1980, estimated combined system ridership ranged from a low of 5100 trips per day to a high of 28,500. The table below summarizes these results.

ESTIMATED 1980 COMBINED SYSTEM RIDERSHIP

Alternative	Metrobus	Mini-Transit	Total
Metro Only Options			
Metro I	11,227	0	11,227
Metro II	12,635	0	12,635
Metro III	5,098	0	5,098
Metro IV	6,821	0	6,821
AVERAGE	8,945	0	8,945
Combination Systems			
A-All Day Metrobus Replacement			
A-1	3,789	7,319	11,108
A-2		9,494	13,283
A-3	"	6,974	10,763
A-4	"	24,752	28,541
A-5	"	23,985	27,774
A-6	"	8,302	12,091
A-7	"	15,684	19,473
A-8	3,789	19,846	23,635
AVERAGE	3,789	14,544	18,333
B-Base Period Metrobus Replacement			
B-1	4,761	2,144	6,905
B-2	"	2,526	7,280
B-3	"	2,265	7,026
B-4	"	6,754	11,515
B-5	"	7,252	12,013
B-5	"	2,579	7,340
B-6		4,673	9,434
B-7	"	6,023	10,784
B-8	4,761		
AVERAGE	4,761	4,279	9,040

Conclusion 6. Assuming a per mile operating cost of $1.76 for the full size Metrobuses, a range of operating costs for the Mini-Transit System of from $1.32 to $1.75 per vehicle mile; a $0.40 fare for Metro and a $0.25 fare for the mini-buses; the annual combined system deficits range from $138,500 to $1,145,000. The table below summarizes this data. The cost per mile figures are those actually incurred by transit operations in the Washington metropolitan area during 1975. The $1.76 per vehicle mile represents the average per mile costs incurred by Metro, while the $1.32 per mile rate is that of the Montgomery County, Maryland mini-bus system. The $1.75 per mile figure is approximately that which would be associated with Metro wage rate drivers operating mini-buses.

Conclusion 7. After review and consideration by all of the study participants, it was concluded that the best alternative was that which utilized the "Mini-Transit" system as a partial replacement and supplement to Metrobus service during non-peak hour periods only and with 10 minute mini-transit headways. Not only was this general concept the least costly from both the viewpoints of total annual deficits and deficit per mile of operation, but it would result in a more efficient utilization of transportation resources.

The number of Metrobuses estimated to operate in the study area in 1980 are more than adequate to accommodate the projected peak period transit travel demands and it would thus be illogical to duplicate this service, especially since one large Metrobus has the passenger carrying capacity of three mini-buses. Additionally, since no parking is to be provided at either the King Street or Braddock Road Metrorail Stations, the non-walk access modes are only "Kiss and Ride" and bus. Thus, any action which will minimize the number of transit vehicles in the station area will have a beneficial effect upon the total number of vehicles around the site. Lastly, reducing the number of mini-buses required by not operating peak period service reduces not only the capital, but also the operating costs since fewer mini-transit drivers would be required.

Conclusion 8. In regard to the organization and management of the proposed Mini-Transit system, it is recommended that the service be operated as a Division of the City of Alexandria's Department of Transportation and Environmental Services. Three basic management options were considered:

- Ownership and operation by Metro
- Ownership and operation by a private transit company under contract to the City of Alexandria and/or NVTC; and
- Ownership and operation by the City of Alexandria.

While there are some significant advantages to operation of specialized vehicles within the study area by Metro, the City of Alexandria already provides a limited transit presence in the Old Town Area with a single vehicle operating a shuttle route along King Street between the Masonic Memorial and the Potomac River waterfront. As a result of this commitment by the City, and also to present a quantification of the one-time nonrecurring capital and operating costs associated with the initiation of this specialized service, it has been assumed that the "mini-transit" system will be owned and operated by the City of Alexandria.

Conclusion 9. All of the major travel corridors in the study area which were identified during Phase I, will be served by the proposed Mini-Transit system. Due to the small size of the study area, the differences in routing between the mini-transit options had essentially no effect upon the number of persons served by the system or upon the directness of travel between desired trip origins and destinations. Thus, any of the several alternative mini-transit routing plans could be implemented with approximately equal results. Mini-Transit routes would operate on the following streets:

- King Street - from the King Street Metrorail Station to the Potomac River waterfront.
- Wythe and/or Pendleton Street - from the Braddock Road Metrorail Station to the North Waterfront area.
- Fairfax Street - from the North Waterfront area to Franklin Street in the Old Town South area.
- Franklin Street - from Fairfax Street to South Washington Street.
- Washington Street - from Franklin Street to Wythe or Pendleton Streets.

Conclusion 10. In order to provide the desired level of service in the study area over the specified routes, a total of 12, 25- passenger mini-buses will be required. This includes two vehicles as spares in the event of mechanical breakdowns or unexpectedly high patronage demands.

All of these vehicles should incorporate the latest concepts in small bus design, particularly including such accessibility enhancement features as a low entry step, short interior steps and wide doors to facilitate use of the system by the elderly and handicapped residents of the area. In addition, at least three or four of the vehicles should be equipped with either a ramp or a lift mechanism to allow for wheelchairs to safely and easily enter and leave the vehicle.

A turning radius of 35 feet or less is also highly desirable to allow for improved maneuverability along the generally narrow streets of the Old Town Alexandria area. Air conditioning and two way radios should be standard equipment on all vehicles.

Conclusion 11. The estimates of the capital and operating costs associated with the implementation of the "Mini-Transit" System have assumed ownership and operation by the City of Alexandria and thus include a number of one-time, non-recurring cost items which it would not be necessary to incur if Metro operated the system. For example, a garage and maintenance facility to service the mini-transit system has been estimated to cost approximately $320,000, exclusive of any land acquisition for the one to two acre parcel which would be required. A detailed cost breakdown for this proposed facility is shown in Table 5-4. If the city could obtain the use of the current Metrobus garage on North Fairfax Street when a new regional bus garage is constructed by Metro, or if the mini-transit system vehicle service requirements could be combined with those of other city vehicles, this major cost item could be substantially reduced. Table 5-5 summarizes the estimated total capital costs required to initiate the recommended mini-transit system. These costs were computed using average prices for similar equipment as of the Fall of 1975, with no attempt made to consider the possible effects of inflation upon the escalation of the basic unit costs.

Table 5-4

Estimated Capital Costs - 12 Bus Facility

		Square Feet	Unit Cost	Total Cost
1. Building Area				
a. General Offices		620	39.00	$ 24,200
b. Operations Area		150	23.00	3,500
c. Repair Area		2100	23.00	48,300
d. Vehicle Storage		4200	23.00	96,600
	Subtotal	7070		$172,600
2. Outside Area				
a. Supervisor & Visitor Parking		1050	1.75	$ 1,800
b. Employee Parking		7000	1.75	12,300
c. Circulation		1200	3.50	4,200
	Subtotal	9250		$18,300
3. Major Equipment[1]		--	---	$78,000
4. Site Acquisition[2]		--	---	-----
5. Security		--	---	$20,000
	Subtotal			288,900
	Contingency 10%			28,900
	Grand Total			$317,800

1 Major equipment consists of the following items:

1. Bus washer - $10,000 - 30,000
2. Cyclone cleaner - $6,000
3. Hoists (hydraulic) - $8,000 each
4. Air compressors - $7,000
5. Spare engine - $5,000
6. Spare transmission - $3,500
7. Shop equipment - $15-20,000

2 Site acquisition costs were omitted since the City may be able to use existing public land.

Table 5-5

Estimated Total Capital Costs, Alexandria Mini-Transit System

Expense Item	Estimated Cost
12 New AC-25 Passenger Mini-Buses	$300,000
Garage and Maintenance Facility	317,800
Service Vehicles:	
1 - Sedan (from City Motor Pool)	0
1 - 3/4 Ton Pick-up truck	5,000
Operators' Uniforms and Equipment	1,400
Fare Boxes for Revenue Vehicles	6,000
Passenger Waiting Shelters	20,000
Bus Stop Signs	1,000
Mobile Radio Equipment	9,600
TOTAL	$660,800
80% UMTA SHARE	$528,640
20% LOCAL SHARE	$132,160

Table 5-6 presents the estimated operational costs for the system for both 1978 (the first year of operation) and for 1980 (the planning target year for the study). A comparison between the estimated operating costs of the system and the fare box revenues over the first five years of the service (i.e., 1978 through 1982) is shown on Table 5-7. All of these costs are in 1975 dollars with the effects of inflation not considered.

Table 5-6

Estimated Operating Expense

	1978	1980
1. Equipment Maintenance and Garage Expense		
1.1 Maintenance of Buildings & Grounds	$ 2000	$ 2700
1.2 Operation and Maintenance of Service Equipment	450	600
1.3 Shop & Garage Expense	9300	12,700
1.4 Repairs to Revenue Equipment	25,800	35,000
1.4.1 Labor	18,430	25,000
1.4.2 Parts	7370	10,000
Subtotal:	$37,550	$51,000
2. Transportation Expense		
2.1 Supervision	$ 11,550	$ 15,600
2.2 Operator's Wages	116,700	158,700
2.3 Fuel and Oil	7,350	10,100
2.4 Advertising and Promotion	6,550	8,800
2.5 Other Transportation Expense	6,300	8,550
Subtotal	$148,450	$201,750
3. General Administration		
3.1 Personnel Administration	4,300	5,900
3.2 Office Expenses	4,450	6,000
3.3 General Administration Expenses	10,000	13,750
Subtotal	$18,750	$25,650
Grand Total:	$204,750	$278,400

Table 5-7

Estimated Annual Operating Revenue, 1978-1982 (1)

Year	Annual Revenue Passengers	Passenger Revenue (2)	Estimated Operating Costs (3) @ $1.32/Mile	Estimated Operating Costs (3) @ $1.75/Mile	Annual Surplus or (Deficit) @ $1.32/Mile	Annual Surplus or (Deficit) @ $1.75/Mile
1978	631,200	$157,800	$154,700	$204,750	$ 3,100	($47,000)
1979	714,300	178,600	154,700	204,750	23,900	($26,150)
1980	719,900	180,000	210,000	278,400	(30,000)	(98,400)
1981	749,100	187,300	210,000	278,400	(22,700)	(91,100)
1982	784,875	196,200	210,000	278,400	(13,800)	(82,200)

Notes:

(1) "Mini-Transit" Component Only.

(2) Average Passenger Revenue = $0.25

(3) All costs shown are in 1975 dollars and thus do not consider the effects of cost increases due to inflation.

Conclusion 12. Several different funding sources are available from which to finance the implementation and operation of the proposed mini-transit system. With regard to capital expenditures, revenue sources include the City of Alexandria (general obligation bonds), the Virginia Department of Highways and Transportation (capital assistance grants), and capital assistance grants by the U.S. Department of Transportation's Urban Mass Transportation Administration (under the provisions of Sections 3 and 5 of the Urban Mass Transportation Act of 1964, as amended). The final decision on the question as to who should actually own and operate the recommended system will influence the appropriateness of using each of these funding sources.

Operating revenues will accrue from three basic sources:

1. The fare box revenues

2. Financial assistance from the City of Alexandria, either in the form of general funds or monies generated by a special transit operations tax, (perhaps on parking fees or vehicle registration stickers).

3. Financial assistance from UMTA under the provision of Section 5 of the Urban Mass Transportation Act of 1969, as amended.

As is the case with capital costs, the agency selected to operate the service will, to a large degree determine what operating assistance funding sources can be tapped.

It should be noted, however, that the receipt of Federal financial assistance necessitates adherence to federal regulations with respect to such items as labor protection and maintenance of local support. These federal restrictions could adversely impact the operating costs associated with the Mini-Transit system.

Conclusion 13. The Mini-Transit system cannot effectively function in a vacuum divorced from the other elements of the regional transportation system in the Alexandria area. Since the provision of public transportation is an important community service, neither can the mini-transit system be considered independently from the other programs of the City of Alexandria aimed at the improvement of the quality of life within the city. Maximum coordination and cooperation must therefore be particularly maintained between the Mini-Transit System, the other departments of the City of Alexandria, the Virginia Department of highways and Transportation, the Northern Virginia Transportation Commission (NVTC), and Metro, so as the ensure that the maximum possible benefits accrue from the operation of Mini-Transit.