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file

February 10, 1076

Dear Bob,

Because of the many conflicting reports and misleading positions taken by certain local politicians concerning the planned METRO rail system, and in view of the demands being made upon the Administration for increased federal funding, I thought you might be interested in this copy of a report which Jack Faucett Associates has just completed for the Congressional Research Service of the Library of Congress. An awareness of the contents of this report might save the Administration some embarrassment when it comes to taking a position on further federal funding for the METRO system.

(The Fiscal Affairs Subcommittee of the House District Committee has scheduled a hearing on this question for Tuesday, February 17, 1976.)

Sincerely,

Jerry

Mr. Robert T. Hartmann
Counselor to the President
The White House

THE WASHINGTON AREA METRO RAIL SYSTEM:
A CURRENT PERSPECTIVE
AND A
PRELIMINARY APPRAISAL OF ALTERNATIVES

A report prepared for the

CONGRESSIONAL RESEARCH SERVICE

THE LIBRARY OF CONGRESS

January 30, 1976

by

JACK FAUCETT ASSOCIATES, INC.

5454 Wisconsin Avenue
Chevy Chase, Maryland 20015

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Damian J. Kulash, Study Director

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I. INTRODUCTION

Subway systems are an integral part of the transport infrastructure in the world's largest and busiest cities. Paris, Tokyo, London, Moscow, Madrid, New York and more than 30 leading cities across the globe enjoy the ease of travel provided by rail rapid transit systems. The need for improved public transportation capability in the Washington, D.C. metropolitan area goes hand-in-hand with its growth in size. As auto ownership and usage climb, and as public reluctance to permit further expansion of auto facilities mounts, the vision of a convenient, fast, and economical alternative becomes highly attractive.

The Washington Metropolitan Area Transit Authority (WMATA) and its predecessor agencies were established to provide such an alternative. The 98-mile METRO rail system which was adopted in 1969 is shown in Figure 1. Since it was decided that the METRO rail rapid transit system should be built, however, there have been changes in the cost of building and operating rail systems, changes in population growth, location, and public transportation usage, as well as changes in the developmental goals of many of the area's jurisdictions. In view of these changes, it is reasonable at this point to question whether or not the rationales behind the original system plan are valid today. In particular, it is desirable to question whether modifying or eliminating segments of the system which are not yet constructed might better serve the people and economy of the region. This study and report were undertaken to provide a preliminary, objective appraisal of possible alternatives to the currently planned METRO system.

OBJECTIVES AND SCOPE OF THIS STUDY

The aim of the present study is to analyze the changes in the area's growth patterns and policies which have occurred since the 98-mile Adopted Regional System (ARS) was approved and to explore how these influence the patronage, capital costs, operating costs, revenues, and related aspects of METRO service. The study also examines how well alternative shortened rail systems would affect these same characteristics.

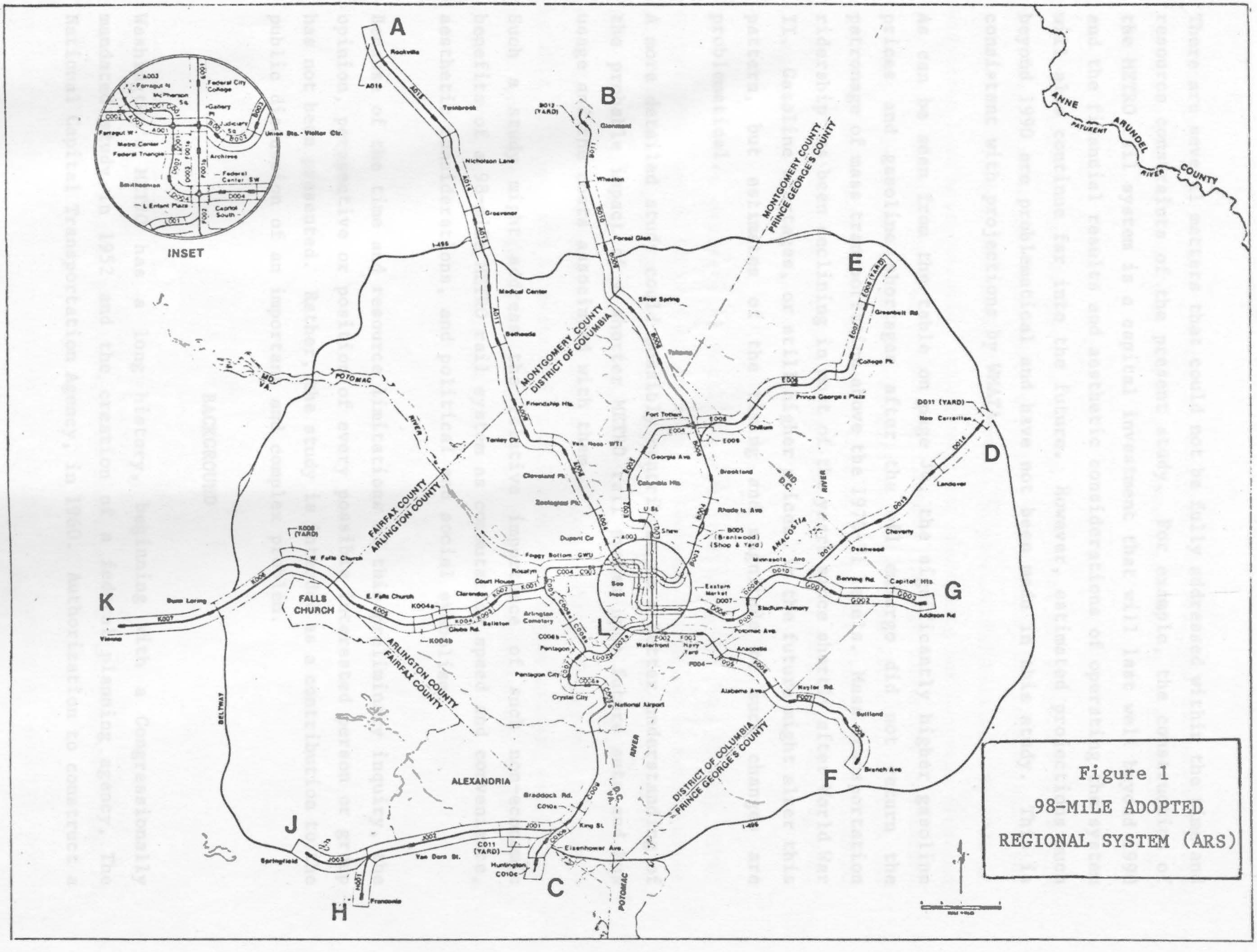

Figure 1
98-MILE ADOPTED
REGIONAL SYSTEM (ARS)

There are several matters that could not be fully addressed within the time and resource constraints of the present study. For example, the construction of the METRO rail system is a capital investment that will last well beyond 1990 and the financial results and aesthetic considerations of operating the system will also continue far into the future. However, estimated projections much beyond 1990 are problematical and have not been made in this study. This is consistent with projections by WMATA.

As can be seen from the table on page 36, the significantly higher gasoline prices and gasoline shortages after the oil embargo did not return the patronage of mass transportation above the 1970-71 levels. Mass transportation ridership has been declining in most of the years since shortly after World War II. Gasoline shortages, or still higher prices, in the future might alter this pattern, but estimates of the timing and magnitude of such changes are problematical.

A more detailed study could possibly contribute to a better understanding of the probable impact of a shorter METRO rail system upon future auto and bus usage and the costs associated with them.

Such a study might address the relative importance of such non-economic benefits of a 98-mile METRO rail system as commutation speed and convenience, aesthetic considerations, and political and social symbolism.

Because of the time and resource limitations of this preliminary inquiry, the opinion, perspective or position of every possible interested person or group has not been presented. Rather, the study is intended as a contribution to the public discussion of an important and complex problem.

BACKGROUND

Washington's METRO has a long history, beginning with a Congressionally mandated study in 1952 and the creation of a federal planning agency, The National Capital Transportation Agency, in 1960. Authorization to construct a

25-mile rail system was granted by Congress in 1965, and increased to the currently planned 98-mile system under the National Capital Transportation Act of 1969.

The 1969 legislation was based on an estimated total net project cost of $2.5 billion, of which the local share was to be $.6 billion, the federal share was to be $1.1 billion, and revenue bonds were to provide $.8 billion. By 1972 it was clear that this financial arrangement was inadequate and Congress extended the total funding to $2.98 billion, largely through federally guaranteed revenue bonds of which the federal government provided about $.3 billion and the local governments provided about $.15 billion. The federal role in METRO financing remains unchanged today with the exception of Interstate Highway Fund withdrawals discussed later.

In 1974 WMATA's estimate of total construction costs for the 98-mile METRO system grew from $2.98 to $4.5 billion, reflecting inflation in construction costs and more detailed design information. According to WMATA, 45 percent of this latest increase is attributable to "real" cost factors such as unexpected rock formations, changes in tunnel requirements, etc.; 38 percent is attributable to delay, and 17 percent is attributable to higher prices, especially steel products.[1] As of December 1975, WMATA's estimate of total METRO construction costs was $4.651 billion.

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[1]*Samuel H. Cohn, working group director, "1976 Budget: Alternatives and Analyses," Report to the Committees on the Budget of the U.S. Congress, April 15, 1975, p. 130.*

II. ALTERNATIVE METRO SYSTEM DESIGNS

OBJECTIVE IN SELECTING A RAIL SYSTEM DESIGN

The benefits to be derived from rail transport service have been argued in considerable detail. Among the most frequently cited are:

- to provide faster, more economical service. Most public transportation patrons are persons who come from households with cars available, but they opt for the lower cost, shorter travel times, or reduced tension which many experience from rapid transit use. Commuters comprise the principal share of such patrons on most rapid transit systems.

- to reduce automobile related nuisance. As more people ride public transport in preference to using their own cars, fewer cars congest, pollute, make noise, consume gasoline, and require additional roadway facilities.

- to serve disadvantaged groups. The poor, the old, the handicapped, the young, and others who cannot own or operate automobiles are often highlighted as a special group of rapid transit patrons. For them, transit is often not just a better way to go but the only way to go.

- to promote developmental objectives. Rail transit can help to channel concentrated development to designated points within the region.

Putting a value on benefits such as reduced air pollution or shorter travel time is a difficult task and one for which there is little agreement among experts concerning appropriate procedures. On the other hand, it should be noted that many of the benefits of rail service are likely to be proportional to patronage, among them reduced air pollution, less traffic noise, reduced traffic congestion, possible fuel savings, and benefits to the travellers themselves. Aggregate patronage totals, by themselves, provide very little insight into the benefits to disadvantaged groups, although examination of the income characteristics of areas served by public transport can help to identify and disaggregate such benefits.

While few would argue that transit does not play a key role in guiding development patterns within the area, there is little concensus on whether this is a benefit or a disbenefit. Some of the jurisdictions served by METRO are weighing or implementing policies to blunt the system's developmental impacts.

The benefits of rail transit service must somehow be weighed against costs if reasonable economic efficiency is to be achieved. These costs include those needed to build and operate the area's transport network -- including rail, bus, and highway modes. Curtailment of the METRO rail system would affect the operations of other modes as well. One extreme response to rail system curtailment would be to hold bus operations and highway capacity fixed at the levels planned to accompany the full rail system, with the result that pollution and congestion would increase beyond the levels associated with the 98-mile ARS. An opposite extreme would be to respond to curtailment by furnishing enough additional bus service to keep auto traffic from increasing beyond the level projected to accompany the full rail system. In actuality, the outcome of a reduced METRO rail system is likely to involve some combination of elements of each of the above possibilities. A thoroughly reliable prediction cannot be made at this point concerning exactly what that combination would be or what it would cost. Correspondingly, the primary focus of this analysis is on the costs, patronage, and revenues of possible alternative rail systems, although rough estimates are also made of the associated need for bus service and effects on automobile congestion.

Before postulating alternative rail systems for further analysis, it may be helpful to review some of the economic and demographic factors which bear on that rail network design. The review consists of two parts. The first examines areawide trends in population density, income, construction to date and patronage. The second part examines some of the area characteristics which relate to specific lines within the 98-mile ARS.

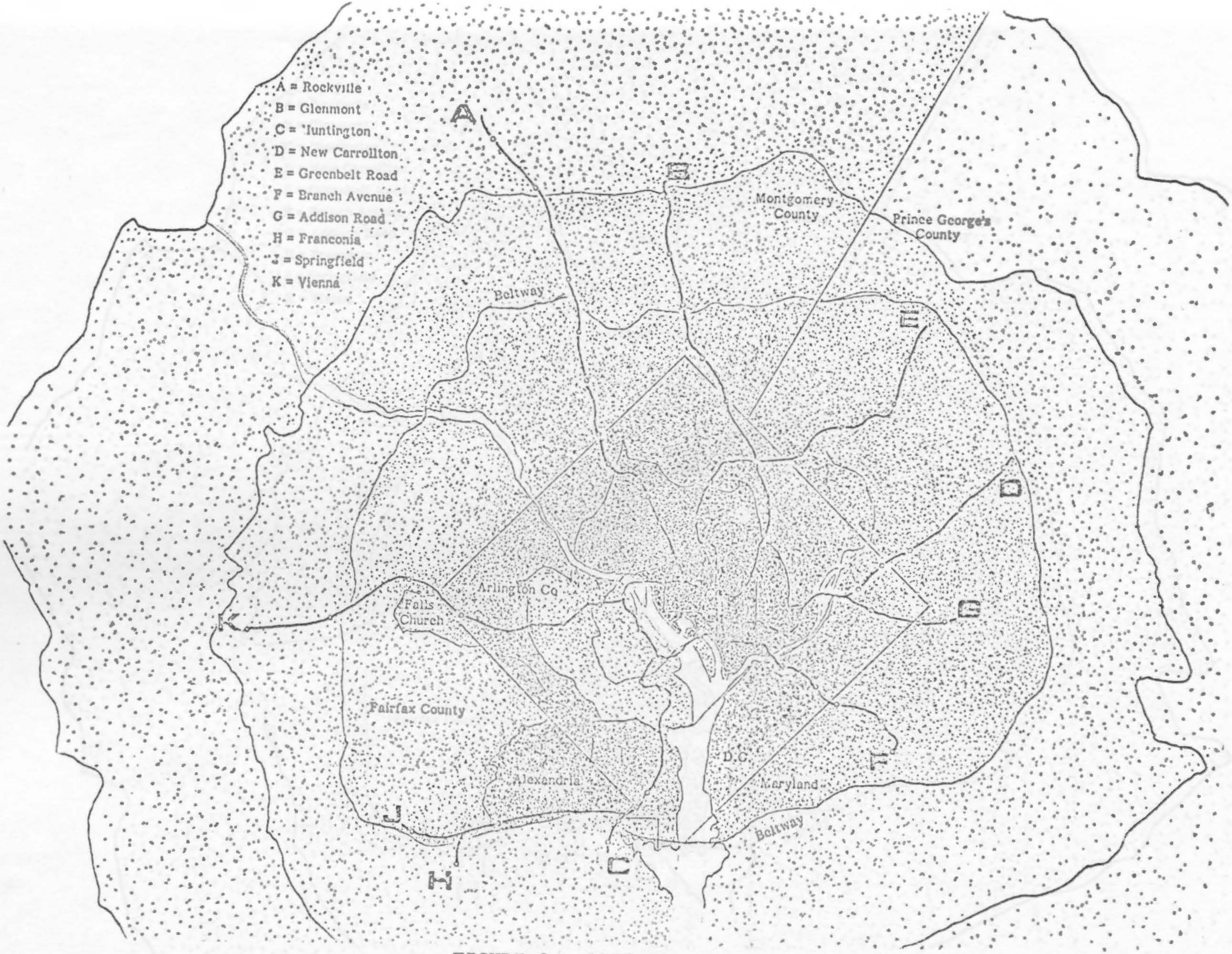

FIGURE 2. 1976 POPULATION PROJECTION
(1 dot = 100 persons)

Source: *Metropolitan Washington Council of Governments, Alternative 6.2 Modified Forecasts, March 1974.*

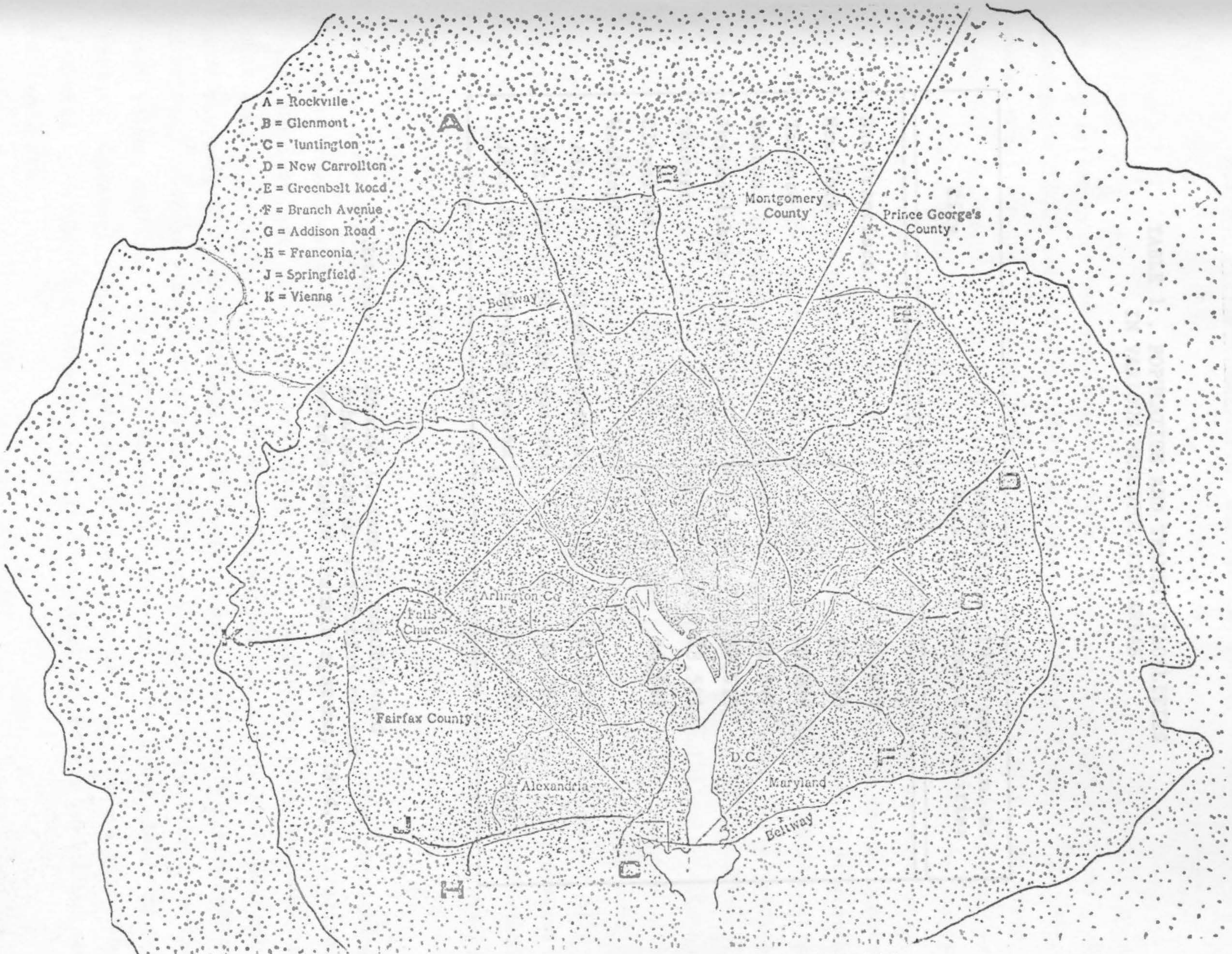

FIGURE 3. 1992 POPULATION PROJECTION
(1 dot = 100 persons)

Source: Metropolitan Washington Council of Governments, Alternative 6.2 Modified Forecasts, March 1974.

TABLE 1 . POPULATION AND TRANSIT FACILITIES
IN VARIOUS METROPOLITAN AREAS

City	Population (1970) per k.m. of Rail Rapid Transit Facilities
San Francisco	25,913
New York	29,740
Toronto	60,000
Boston	71,842
Philadelphia	20,515
Chicago	48,521
Cleveland	66,885
Washington:	
Alt. 1 : 41-mile system	43,615
Alt. II : 68-mile system	26,297
Alt. III : 98-mile system	18,252

Source: *Edmond L. Kanwit, unpublished tabulation of statistics on the world's rapid transit systems, 1974.*

GENERAL PATTERNS UNDERLYING ALTERNATIVE SYSTEM DESIGNS

Population Density

The population densities projected by the Metropolitan Washington Council of Governments (COG) for 1976 and 1992 are shown in Figures 2 and 3. In most cases, densities taper off gradually with distance from the core. An exception, in forecasts for both 1976 and 1992, is the City of Alexandria, which is densely populated for its radial distance from the core. Also, the inner parts of Arlington County, in 1976, are less densely populated than the outer ring, but that condition is expected to change by 1992 according to the forecasts shown here. It should be pointed out that recent trends in population growth indicate that the inner jurisdictions are now growing less rapidly than anticipated in the forecasts shown in the figures, and that outer jurisdictions are generally growing more rapidly. The effect of this trend, if it continues, would be to diminish somewhat the apparent decrease in population density as distance from the core increases. In any case, the 98-mile regional rail system would reach into areas remarkably sparse for this form of public transportation. Table 1 compares the Washington area's population per kilometer of rail service to selected other cities with rail rapid transit systems. The Washington area's population per track mile would be among the smallest of any transit system in the world, highlighting the unusual population sparsity of some of the areas to be served by METRO.

Figures 2 and 3 indicate that the inner stations will have greater population per unit area than will the outer stations. Dense population concentrations near stations not only represent more persons within walking distance of stations, but also represent areas where feeder bus operations are relatively more economical. Because of parking limitations at all currently planned METRO stations, stations with good walking access and bus access are likely to be the high volume stations, and such stations are more apt to be found closer to the center. Terminal stations represent an exception to this pattern since the potential patronage for those stations is drawn from many points beyond the end of the system.

Income

The need for public transportation service is closely tied, among other things, to the rate of automobile ownership, and automobile ownership drops sharply in the low income region. Figure 4 shows the fraction of the area's population falling into the lowest income quartile. Generally speaking, areas to the east of downtown house a much larger percentage of low income persons than do areas to the west. All of the District of Columbia (except for the area west of Rock Creek Park) and all of Alexandria City also have high fractions of low income population. Similar patterns are projected to persist past 1990.[1] On the basis of income groups served, the A, B, H, J, and K lines are relatively high income lines, while C, D, E, F, and G are lower income lines.

Along each line it is generally true that the farther from the urban center a station is located, the more affluent are its patrons. For example, the K line to Vienna first passes through the District of Columbia, where the average worker earned $6,190 per year in 1970,[2] then through Arlington County where the corresponding figure is $7,440, and finally Fairfax County where the corresponding figure is $8,672. This pattern is even sharper among persons who come into the District of Columbia to work, and these persons are likely to be the foremost source of METRO patronage. The earnings profile of persons working in the District of Columbia is $6,156 for Washington residents, $8,576 for Arlington County residents, and $12,392 for Fairfax County residents. It is apparent from the area's earnings profile shown in Table 2 that extension of the METRO rail system to the outermost reaches of the 98-mile ARS would be largely for the benefit of some of the area's, and indeed some of the nation's,[3] most affluent commuters.

These factors suggest that lower income persons who need public transport service would be better served by completing inner segments of the E and F routes rather than by extending lines into distant suburbs.

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[1] *Metropolitan Washington Council of Governments, Alternative 6.2 Modified Forecasts, March 1974.*

[2] *1970 Census of Population.*

[3] *Montgomery and Fairfax Counties were among the nation's top four in 1970 with respect to earnings per capita.*

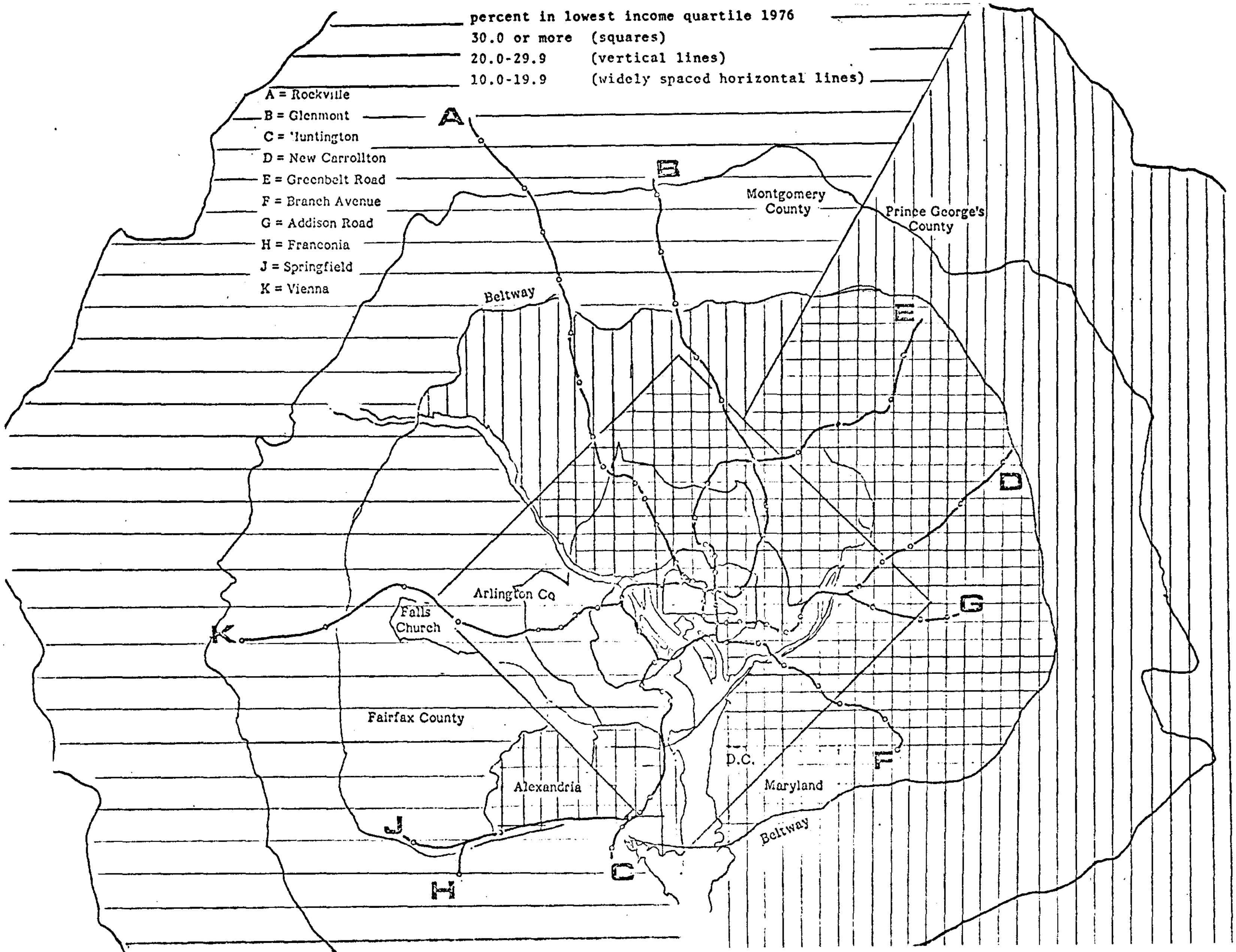
TABLE 2 . MEDIAN EARNINGS BY JURISDICTION OF RESIDENCE

AND JURISDICTION OF EMPLOYMENT: 1970

(dollars per year, 1970)

Live \ Work	Washington D.C.	Montgomery Cty., Md.	Prince George's Cty., Md.	Arlington Cty., Va.	Fairfax Cty., Va.	Loudoun Cty., Va.	Prince William Cty., Va.	Alexandria City, Va.	Fairfax City, Va.	Falls Church City, Va.	Region
Washington, D.C.	6156	5931	6166	6940	7007	-	6828	6458	6027	6746	6190
Montgomery County, Md.	11885	6766	9514	15227	12488	-	-	13039	9824	8952	8819
Prince George's County, Md.	8247	7379	5899	9786	9076	-	9384	8907	10525	9414	7284
Arlington County, Va.	8576	9822	8376	6038	7479	7930	6575	6722	6451	4995	7440
Fairfax County, Va.	12392	11017	11388	11120	5552	9022	7931	7279	6973	6174	8672
Loudoun County, Va.	11165	11140	-	8440	6990	4324	-	8990	5708	5739	5846
Prince William County, Va.	10760	9957	9072	10194	8065	8588	4684	8690	7585	8298	7284
Alexandria City, Va.	8183	8909	8764	6978	6812	-	7500	5384	6897	5857	6877
Fairfax City, Va.	12471	11083	-	12216	7156	-	-	9040	5106	8418	8418
Falls Church City, Va.	10205	8737	-	8278	6364	-	-	10045	5444	4668	7822
Region	7803	6922	6300	8299	6456	5158	4991	6637	6543	6276	7268

Source: U. S. Bureau of the Census, Census of Population: 1970, SUBJECT REPORTS, Final Report PC(2)-6D, Journey to Work.



Source: Metropolitan Washington Council of Governments, Alternative 6.2 Modified Forecasts, March 1974.

FIGURE 4 . DISTRIBUTION OF LOWEST INCOME QUARTILE: 1976

Construction Status at Current Time

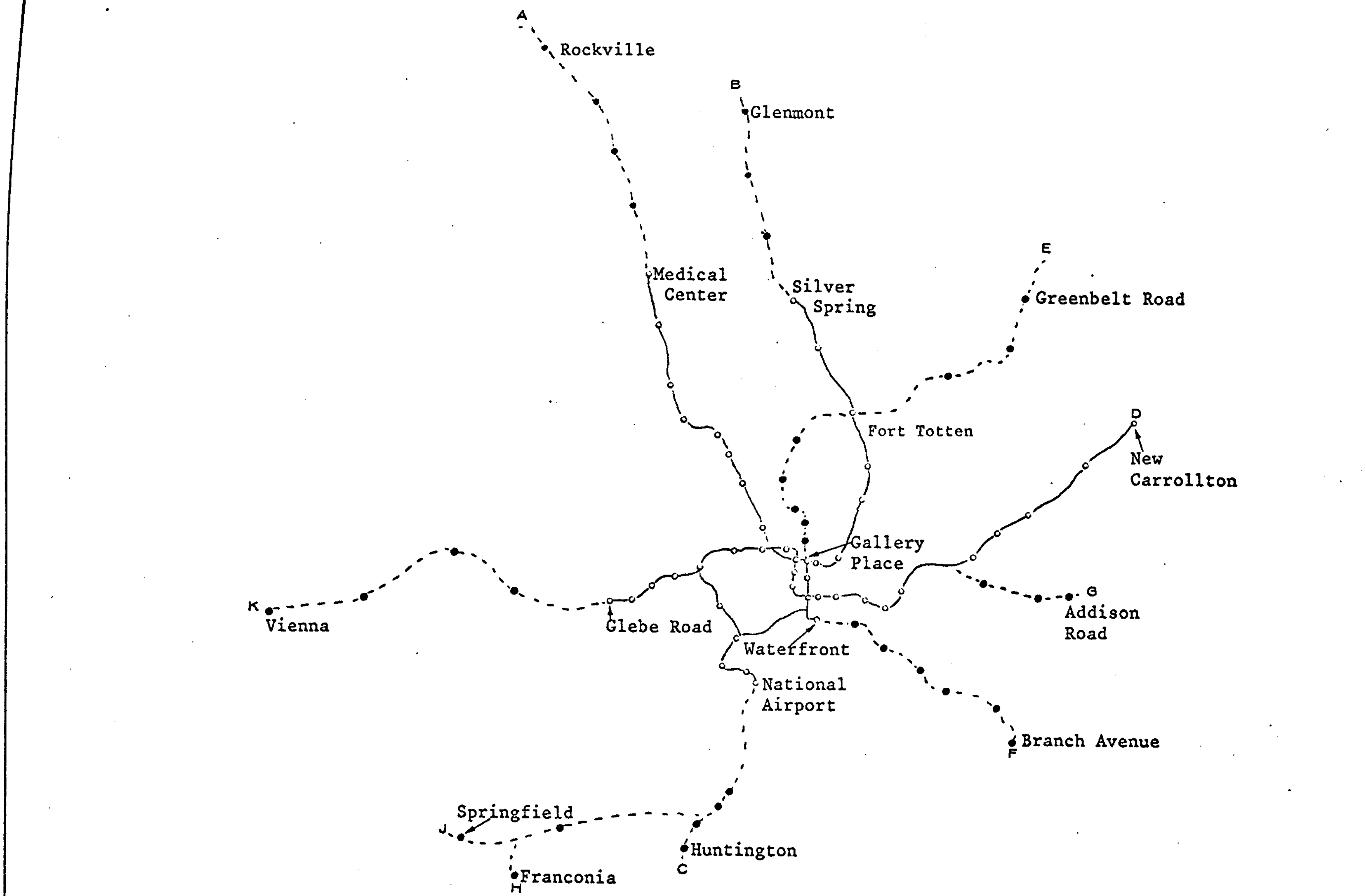
As of December 1975, METRO construction was under contract along the portions of the network shown in Figure 5. Only one line -- the D line to New Carrollton -- was under construction in its entirety. At the other extreme is the E line to Greenbelt on which no construction has begun. Branches to Addison Road (G line), Huntington (C line), Franconia (H line), and Springfield (J line) are also not under construction at this time. The Branch Avenue (F line) is only barely begun, with construction reaching to Waterfront Station. The Rockville (A) and Glenmont (B) lines have slightly more than half of their length under construction, and the Vienna line (K) has somewhat less than half of its length under construction.

Within this analysis it has been assumed that those parts of the system currently under construction represent a minimum system which will be built and operated. It should be pointed out, however, that much of this construction has barely begun and that curtailment of some portions of the system now classified as being under construction may be possible.

Projected Patronage

WMATA forecasts of station-to-station travel on the 98-mile ARS network indicate considerable variations in use along various parts of the system. As a rough index for determining areas of heavy patronage, the station pairs projected by WMATA to exchange more than one thousand round trips per average weekday in 1990 are shown in Figure 6. These indicate a heavy volume of rail traffic within Northeast Washington from Fort Totten Station inward, suggesting that there is merit in building the E line up to that point. There is also a buildup of traffic along most of the other lines as they come closer to the core. The New Carrollton and Addison Road lines are projected to have relatively light usage. While the New Carrollton line is essentially complete at this point, the Addision Road branch is just now going into the contract stage.

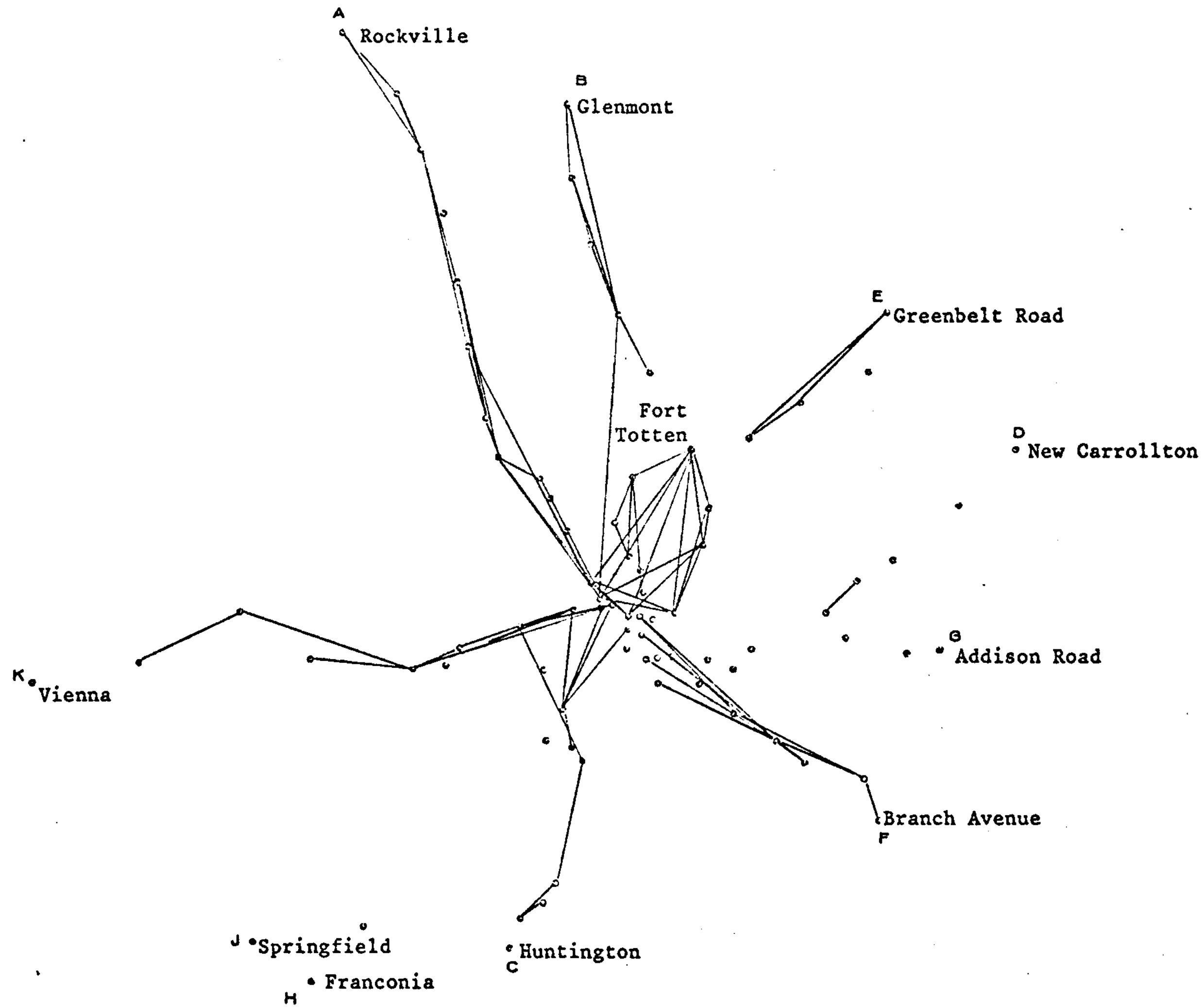
FIGURE 5 . METRO CONSTRUCTION CURRENTLY UNDERWAY
(November 1975)



Note: Solid line indicates construction under contract; dotted lines indicate planned ARS alignment. Not all contracted construction is substantially underway.

Source: WMATA Office of Construction and WMATA Office of Program Control.

Note: Each line represents an origin/destination pair which WMATA forecasts indicate will generate 1000 or more round trips per weekday in 1990.



Source: WMATA, UMATRIX Report, October 9, 1975.

FIGURE 6 . AREAS OF HEAVY PROJECTED RAIL TRAVEL

FEATURES OF SPECIFIC LINES RELATED TO DESIGN OF ALTERNATIVES

A - Rockville

The Rockville line as programmed in the ARS would follow Wisconsin Avenue from the D.C. line out to the Beltway, and from there along the Rockville Pike to Randolph Road. At that point, the METRO route would join with the Balitmore and Ohio Railroad right-of-way and proceed along it to Rockville. Because of the extensive economic development beyond Rockville, there now appears to be a strong sentiment in Rockville, Montgomery County, and the State of Maryland that the A line should continue beyond Rockville along the rail right-of-way out to Gaithersburg. This extension would alleviate the need for METRO storage and inspection facilities in the City of Rockville as well as reduce the pressure for expanded parking facilities there. This extension would add approximately four miles to the 98-mile ARS. It is not addressed in this analysis because it would be funded from State funds and Federal Interstate Highway withdrawals and does not represent a part of the original 98-mile ARS.

Most of the A route would be underground as far as the junction with the Baltimore and Ohio right-of-way, the only surface line in that portion being a segment of approximately one mile located at the Beltway and Rock Creek.

If the A route were terminated at Medical Center Station, the B route could be extended to serve much of the territory formerly covered by the A route. While this change would eliminate almost five miles of the A route, only two stations would be eliminated (Grosvenor and Nicholson Lane). Grosvenor has the lowest projected passenger volume of the eleven METRO stations to be located outside the Beltway and is one of the lowest volume stations in the entire ARS network.[1] Furthermore, while Nicholson Lane is expected to be among the busiest of the stations outside the Beltway, more than half of its patronage is projected to arrive by bus. This volume would probably not be seriously affected by relocating the station a half mile to the east along the Baltimore and Ohio right-of-way. This alignment is discussed next as an alternative course for the B route which is currently under construction out to Silver Spring.

[1] *Based on 1990 24 hour projections made by WMATA. (UMATRIX report 1, October 9, 1975.)*

B - Glenmont

The Glenmont line is slated, in the ARS plan, to continue underground north of Silver Spring for a distance of over four miles. It is one of the most expensive portions of the system yet to be built on a per mile basis. One of the possible alternatives considered later in this study would shift this alignment to the west along the Baltimore and Ohio (B&O) right-of-way. This shift would lead to substantial cost savings. Terminating this line at Silver Spring Station may not be workable because of the congestion and land use implications of such an action. Furthermore, a series of computer analyses conducted by the Maryland National Capital Park and Planning Commission (M-NCPPC) found no significant patronage effects would be felt by shifting the B route alignment as indicated.[1]

One of the alternatives (Alt. II) presented later in this report assumes that the B line is realigned along the B&O right-of-way to Twinbrook, with stops at University Boulevard and Nicholson Lane. It then continues along the B&O right-of-way to Rockville, utilizing the alignment of the A route in the ARS.

C, H, J - Huntington, Franconia, and Springfield

The Springfield and Franconia extensions of this line are likely to be highly redundant in view of the excellent transit service already present in that corridor due to the Shirley Highway reserved bus lanes. Original METRO plans were made before the Shirley Highway bus plans were finalized, and the J and H extensions inherent in those plans are thus not fully reflective of today's needs. The outlying stations on this route are relatively poor transit traffic generators, as apparent from Figure 6. WMATA station-to-station patronage forecasts show that all of these stations are well beneath the average patronage of the system. Termination of this line at Huntington or Eisenhower Stations would make the line accessible to the Beltway and would help alleviate the traffic congestion in Alexandria which is already a problem and likely to be worse if this line is terminated too close to Washington.

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[1] M-NCPPC, *Transportation Integrated Modelling System, Montgomery County Sub-Area Study: Test Results, December 13, 1974.*

JFA

D - New Carrollton

This line is currently under construction contracts for its entire length. As of the end of November 1975, parts of this route east of the Anacostia River ranged from 28 to 52 percent complete.

E - Greenbelt

The future of the Greenbelt line is currently being debated in Prince George's County. Numerous realignments have been proposed with widely varied cost implications. Concerns about the environmental and developmental implications of building this line appear to be at the heart of the controversy. In view of the radially-oriented highway network in the area involved, there appear to be possibilities for express bus and feeder bus service to a terminal station located at Fort Totten or Chillum.

F - Branch Avenue

The F line is currently under construction only as far as Waterfront Station, and both the District of Columbia and Prince George's County are seriously reconsidering its alignment from there, the District apparently preferring an alignment to the south of that indicated on the ARS plan. Because of the high patronage potential, low income of persons served, and poor auto access to downtown of the areas involved, some extension of the F line beyond Waterfront Station would appear to be relatively attractive when compared to further construction along most other parts of the ARS.

G - Addison Road

This branch is currently entering the construction contract stage. Relative to most other parts of the system, this branch has high costs, both capital and operating, per incremental passenger attracted to METRO.

K - Vienna

Construction on the K line currently stops beyond Glebe Road Station. The remainder of the line appears to be tied to the I-66 highway controversy. One recent proposal called for a four lane highway to replace I-66 and that this facility be reserved during peak hours for buses, carpools, trucks, etc. If such a highway plan were adopted, the continuation of METRO rail service beyond Glebe Road in the very same corridor could prove to be an expensive duplication of service. If service were terminated at Glebe, the station would apparently require modification because of the additional patronage it would serve. In view of the current state of construction at that site, such a modification could be accomplished without damage to work already in place. Furthermore, tunneling already in place to the west of Glebe Road could provide the storage and inspection facility needed for that line.

Alternatively, service could be continued one or two stops farther out to reduce the volume of bus and automobile traffic generated near Glebe Road. Some extension beyond Glebe Road might also help to increase bus productivity by allowing buses from distant parts of Fairfax County to make a second (or third) round trip during peak periods.

ALTERNATIVES TO BE ANALYZED

Three possible alternative rail systems were selected for analysis based on the previous discussion. These are briefly described below.

Alternative I - Minimal System

This system would terminate at the point where construction is currently underway. It would result in a network of 41 miles of service and 46 stations. This alternative would follow the route structure shown by the solid lines in Figure 5, on page 15.

Alternative II - Intermediate System

This system would enlarge the system described in Alternative I by extending the B route to Rockville, the C route to King Street in Alexandria, the E route to Fort Totten, the F Route to Naylor Road,[1] and the K route to East Falls Church. The design for Alternative II is shown in Figure 7, on page 22. It includes 68 miles of rail service and 62 stations. It includes many of the extensions judged to be desirable in the preceding discussion.

Alternative III - 98-Mile ARS

This alternative includes the 98 miles of the original Adopted Regional System as shown by the solid and dotted lines in Figure 5, on page 15. It contains 82 stations.

Major characteristics of these three alternatives are compared in Table 3. These three systems will form the basis upon which patronage, revenues, capital costs, and operating costs are computed in later sections.

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[1] *This extension is illustrative only. Other alignments now under consideration may be equally desirable, but comparable data were not available for purposes of patronage, revenue, and cost analysis.*

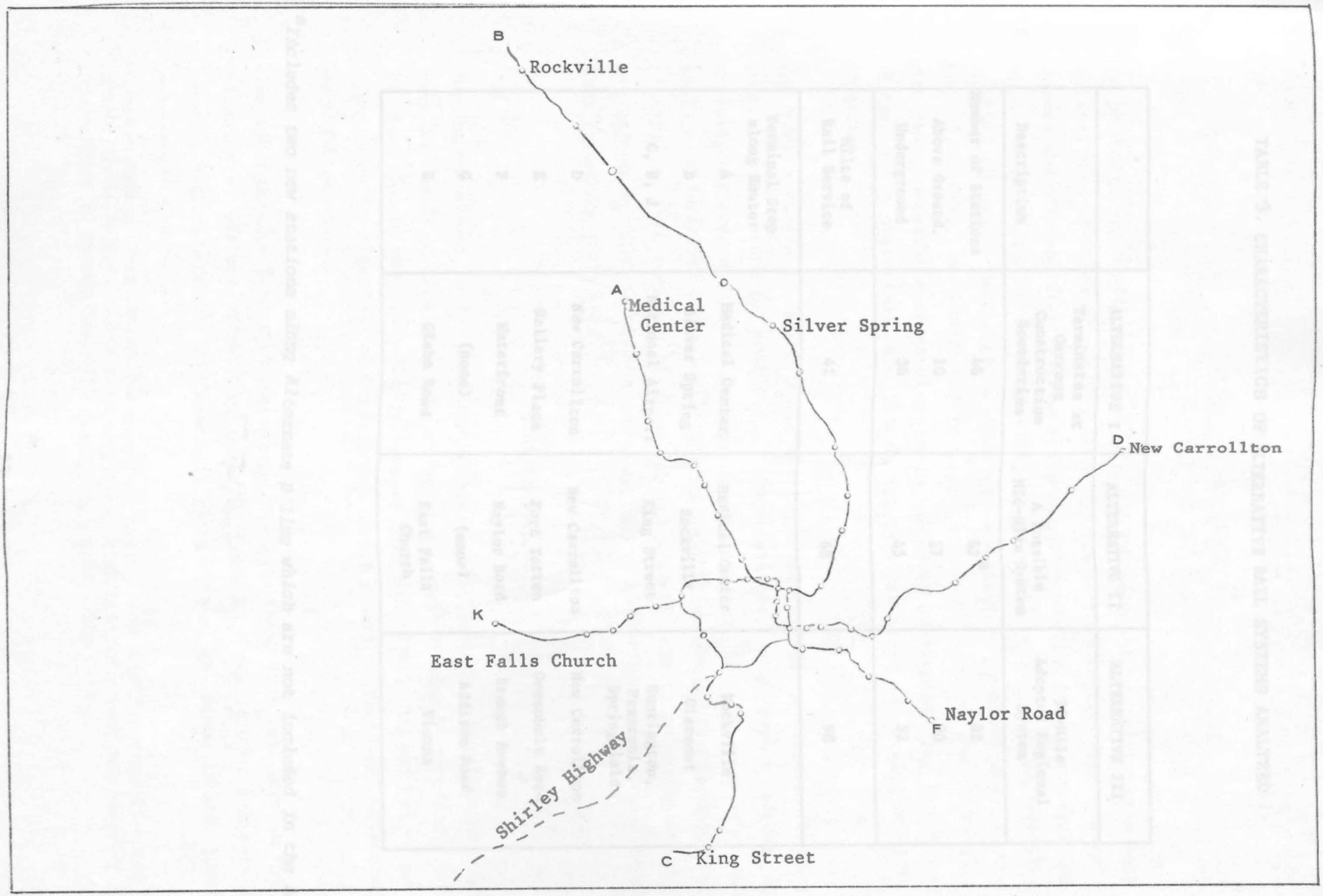

FIGURE 7. ALTERNATIVE II: SYSTEM DESIGN

TABLE 3. CHARACTERISTICS OF ALTERNATIVE RAIL SYSTEMS ANALYZED

	ALTERNATIVE I	ALTERNATIVE II	ALTERNATIVE III
Description	Terminates at Current Construction Boundaries	A Possible Mid-Size System	98-Mile Adopted Regional System
Number of Stations	46	62 [a]	82
Above Ground	10	17	30
Underground	36	45	52
Miles of Rail Service	41	68	98
Terminal Stop along Route:			
A	Medical Center	Medical Center	Rockville
B	Silver Spring	Rockville	Glenmont
C, H, J	National Airport	King Street	Huntington, Franconia, Springfield
D	New Carrollton	New Carrollton	New Carrollton
E	Gallery Place	Fort Totten	Greenbelt Road
F	Waterfront	Naylor Road	Branch Avenue
G	(none)	(none)	Addison Road
K	Glebe Road	East Falls Church	Vienna

ncludes two new stations along Alternate B line which are not included in the ARS.

III. PATRONAGE

The patronage which will be drawn to the METRO system is dependent upon many factors, some of which are difficult to foresee at this point. These factors include the site and distribution of the future population of the metropolitan area, the concentration of commercial and industrial activity in the vicinity of METRO stations, the degree to which future population growth clusters around rail facilities, the hours and frequency of subway service, the METRO fare structure, automobile congestion levels, downtown parking prices, the extent of feeder bus operations, and the availability and price of parking at METRO stations.

The very presence of METRO would influence many of these factors, further complicating patronage projection. Nevertheless, some recent trends in activity patterns within the metropolitan area suggest that the population and employment forecasts which underlie existing METRO patronage forecasts are out of date and that revision of these forecasts would lead to a less optimistic projection of METRO patronage, revenues, and operating cash flow requirements than currently envisioned.

TOTAL POPULATION

Population growth in the Washington metropolitan area in recent decades has been the result of high rates of in-migration as well as high birth rates. Both of these forces changed markedly between 1970 and 1974.[1] These changes have significant implications on overall population growth patterns and ultimately on METRO patronage.

The total metropolitan area population forecasts which have been used in WMATA planning at various stages are shown in Table 4. The 1971 estimate is 17 percent higher than the 1969 forecast, reflective of the surge in area growth

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[1] George Grier, *"Population Forecasts Currently Used for Sewerage Planning in Major Local Jurisdictions of Metropolitan Washington," paper prepared for the Government of Prince George's County, Maryland, June 1975.*

TABLE 4. WASHINGTON, D.C. METROPOLITAN AREA POPULATION FORECASTS USED IN WMATA NET INCOME ANALYSES

Date of Net Income Analysis Report	1990 Population Forecast Used	Implied Rate of Population Growth, 1970-1990[a]
February 1969	4,225,000	1.97 percent/year
February 1971	4,952,000	2.78 percent/year
1975/1976	4,341,000[b]	2.11 percent/year

[a] *Growth rates are computed based on the 1970 Census total metropolitan area population of 2,861,123.*

[b] *Based on logarithmic interpolation between values presented for 1984 and 1992.*

Source: W. C. Gilman & Co., Inc. and Alan M. Voorhees & Associates, Inc., Traffic, Revenue, and Operating Costs, report prepared for the Washington Metropolitan Area Transit Authority, revised February 1969, p. 4; W. C. Gilman & Co., and Alan M. Voorhees & Associates, Inc., Traffic, Revenue, and Operating Costs, report prepared for the Washington Metropolitan Area Transit Authority, revised February 1971, p. xvi; and Metropolitan Washington Council of Governments, "COG Estimates Derived from Local Forecasts (Alt. 6.2 Modified March 1974)."

which is in evidence up to 1970. The high rates of population growth embodied in the 1971 forecast have not been borne out by recent experience, and the Net Income Analysis which is now nearing completion by WMATA is slated to include a more conservative population growth rate, as shown at the bottom of the table. Even this growth rate tends to overstate the population increase, however. A survey of the area's population in 1974 by the Washington Center for Metropolitan Studies showed that the metropolitan area population in 1974 totaled 3,061,000, corresponding to a growth rate of 1.28 percent per year between 1970 and 1974,[1] a rate smaller by a third than the smallest of the three growth rates employed in the WMATA Net Income Analyses.

The choice of an appropriate population growth rate for future years is necessarily speculative. A key factor in determining the area's population is the future course of Federal employment in the Washington region. One out of four workers in the Washington area was employed by the Federal Government in 1970, and much of the remaining employment in the area is closely keyed to Federal activities and to providing goods and services to the employees of government and related industries. Washington is essentially a single-factory town, and trying to chart its future clearly involves considerable uncertainty.

DISTRIBUTION OF POPULATION

The projection of future METRO patronage is further complicated by uncertainty concerning where residents will locate within the region. There is at the present time no concensus among planning organizations in the Washington area on this question, although the Council of Governments is currently working with the area governments in a program entitled "The Cooperative Forecasting Process" to develop a set of forecasts which reflect local growth policies and overall demographic trends. Forecast results from this process will not be available for another month or two. Of available population forecasts, the COG Alternative 6.2 Modified Forecasts are probably the ones most reflective of local policies and overall growth trends, and they will be drawn upon at

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[1] *The Washington Center for Metropolitan Studies, Washington Region 74, Population and Housing Data from the Washington Area Census Updating System, May 1975.*

several points in this analysis. These forecasts, by area jurisdiction, are shown in the first column of Table 5. The second column shows the annual growth rates implicit in these forecasts. The actual growth rates monitored from 1970 - 1974 are provided for comparison in the third column, and the projected percent of workers using public transportaiton (rail or bus) is shown in the rightmost column. These data illustrate two trends in the population distribution which have critical implications on METRO patronage. First, the jurisdiction with the highest forecast growth rates are those whose residents are least able to benefit from METRO service. Fairfax, Loudoun, and Prince William counties are expected to be the three fastest growing counties. They are also the three with the lowest projected per-capita transportation usage, even assuming completion of the full 98-mile ARS. Second, the areas with the greatest projected per-capita public transportation usage are those which, in very recent years, have shown declining population or very limited growth. The three counties which lost population (the District of Columbia, Arlington and Prince Goerge's) are three of the heaviest generators of public transportation patronage on a per-capita basis. Alexandria City, also expected to be a source of high rate public transport usage, has shown a recent growth rate far beneath those incorporated in METRO planning.

While it is extremely difficult to project the future distribution of the population within the region, the above analysis indicates that the effect of using current population forecasts to project METRO patronage is to produce overly optimistic estimates of future METRO patronage. The rates of growth observed in the inner jurisdictions during the fifties and the sixties probably will not continue, as experience since 1970 has shown. If population growth is concentrated at the outskirts of the area, estimated METRO patronage will fall accordingly. Each worker who locates in Fairfax County instead of the District of Columbia represents a loss of at least .38 transit work trips from the estimates. If the area grows in such a way that population levels off at the current point in the District of Columbia, Arlington and Prince George's Counties, and Alexandria -- jurisdictions which collectively lost 12,000 persons between 1970 and 1974 -- then computations using the data in Table 5 show that the 1990 METRO patronage estimate would fall by more than ten percent from the levels currently forecast by WMATA.

TABLE 5. PROJECTIONS OF POPULATION AND PUBLIC TRANSPORT PATRONAGE, BY JURISDICTION

	Forecast 1992 Population[a]	1970-1992 Forecast Annual Growth Rate[b]	1970-1974 Observed Annual Growth Rate[c]	WMATA Forecast for 1992: % of Residents Using Public Transport to Work[d]
District of Columbia	821607	0.38	-1.0	60
Montgomery County	882070	2.41	2.0	27
Prince George's County	1060430	2.17	-0.6	26
Arlington County	230707	1.28	-1.1	56
Alexandria City	155034	1.53	0.6	52
Fairfax County	901965	3.16	5.0	17
Loudoun County	111750	5.13	n.a.	7
Prince William County	343199	5.26	n.a.	7
Total, Washington Region	4506762	2.09	1.2	33

n.a. = not available

[a] *Metropolitan Washington Council of Governments, Alternative 6.2 Modified Forecasts, March 1974.*

[b] *All 6.2 Modified Forecasts for 1992 compared with 1970 Census figures.*

[c] *Washington Center for Metropolitan Studies, Washington Region '74, May 1975.*

[d] *Based on data from WMATA Net Income Analysis, 1975.*

SOME PERSPECTIVES ON WMATA PATRONAGE FORECASTS

Work Trips

Work trips are expected to be the chief source of METRO system patronage. As noted in Table 6, work trips account for more than half of all patronage anticipated.[1] Furthermore, WMATA expects residents to use METRO for about one out of three of their work trips, as opposed to one out of ten or fifteeen for the other trip purposes shown in the table.

The per-capita use of public transportation for work travel has been declining in the Washington area in recent years. In 1960 the Census indicated that 26 percent[2] of the Washington metropolitan area's residents used some form of public transport to get to work. A home interview survey conducted by the Metropolitan Washington Council of Governments in 1968 found that 20 percent of work trips were carried by public transport. The 1970 Census indicated that this had fallen to 17 percent by that time. This trend is not surprising, given that there were similar trends in virtually every major metropolitan area in the country, reflecting increasing suburban development and automobile ownership. This trend does, however, bring into question the reasonableness of the 34 percent figure which enters WMATA forecasts.

The most recent WMATA projection becomes even more questionable when compared to previous WMATA Net Income Analyses. In 1969, WMATA forecasts indicated that 28 percent of the area's work trips would be made by public transport,[3] a figure very close to 1960 Census findings. WMATA's 1971 analyses showed 26 percent of workers using public transport,[4] down slightly from the previous

[1]Statistics drawn from the WMATA 1974/1975 Net Income Analysis are preliminary. A draft of that report has not yet been released as of this writing.

[2]In keeping with a convention used in WMATA Net Income Analyses, the public transportation ratios given in this section will exclude persons working at home, walking to work, and persons using taxi or modes other than auto or conventional public transportation.

[3]W. C. Gilman and Co., Inc., and Alan M. Voorhees and Associates, Inc., <u>Traffic, Revenue, and Operating Costs</u>, report prepared for the Washington Metropolitan Area Transit Authority, Revised February 1969, p. 51. Hereafter, this report and revisions of it are referred to as the Net Income Analyses with the appropriate year noted.

[4]Net Income Analysis, 1971.

TABLE 6. COMPOSITION OF PATRONAGE IN WMATA FORECASTS: 1992

Trip Type	Percent of All Trips of this Type Using Public Transportation	Percent of Public Transportation Trips Represented by this Trip Type
Home-Based Work Trips	33.8	55.6
Home-Based Non-Work Trips [a]	11.2	35.8
Non Home-Based Trips	6.3	8.6
All Trip Types	16.1	100.0

[a] *Home-based non-work trips comprise shop, other, and college-oriented school trips.*

Source: COG/TPB - September 3, 1974.

forecast. Then, in 1974, the projected fraction jumped up to 34 percent, even though Census results which became available during that period indicated a current public transportation usage rate of only half that amount. Furthermore, the Washington area has had a decline in public transport patronage since 1970[1] so that Census patronage figures are high relative to today's experience.

While it is reasonable to expect METRO rail to boost public transport patronage somewhat, it is also reasonable to expect the trend toward increased automobile usage to continue. Looking at other metropolitan areas which have rail rapid transit systems will help to give a rough idea of realistic rates of public transport patronage. Table 7 shows the percentage of work trips using public transportation for all five U. S. cities which had rail transit systems in 1970. With the exception of New York City, which has a uniquely extensive rail network as well as exceptionally expensive auto commuting costs, the other transit cities show a pattern of transit use for work trips between 14 and 22 percent.

Against this background, the recent WMATA projection indicating that 34 percent of workers will use public transport in 1990 appears unrealistic and unsupportable. If metropolitan areas of comparable size cannot approach such a ridership today, it is extremely unlikely that Washington -- a relatively dispersed metropolitan area for its population size -- will achieve it in 1990 when automobile ownership and use are apt to be higher than today's and when urban sprawl may have advanced still farther. A more realistic work trip transit usage figure would appear to be 20 percent or less. On this basis, a more likely forecast of METRO work travel would be 59 percent, or less, of the level projected by WMATA.

Non-Work Trips

There is a relatively strong incentive for workers to use public transport to get to their jobs. Auto congestion is at its peak during commuting hours and

[1] *WMATA and the District of Columbia Government, "Draft Final Application for an Urban Mass Transportation Administration Capital Assistance Grant," July 25, 1975, p. B5.*

TABLE 7. 1970 RATES OF PUBLIC TRANSPORT USE IN METROPOLITAN AREAS WITH RAPID RAIL SYSTEMS

City	Percent of Workers Using Public Transportation [a]
Boston	21
Chicago	22
Cleveland	14
New York	51
Philadelphia	20
San Francisco	17 [b]
Washington	17 [c]

[a] *Computed from 1970 Census ignoring trips classified as "walked to work," "worked at home," and "other means (including taxicab)." These categories were ignored so that results would be comparable to WMATA figures.*

[b] *Prior to opening of BART system.*

[c] *Prior to opening of METRO system.*

average parking costs are higher for work trips due to the central location of workplaces and to the lengthy duration of parking space occupancy which work travel involves. Non-work trips do not, in general, face similar travel characteristics. Travel of this sort is varied in terms of its timing, duration, purpose, and special requirements. Correspondingly, non-work trips are less transit-oriented and more difficult to categorize. They are also more difficult to estimate since, unlike work trips which are monitored by the Census, there is no comparable, nationwide measurement of non-work trips.

However, a large number of cities have conducted surveys of non-work trips taken by their public transport patrons and examined, among other things, the reasons such trips are taken. Some of these results are shown in Table 8. These figures indicate that transit operations typically serve a work-trip-oriented market. Even 15 years ago, work trips accounted for about 65 percent of overall transit patronage. Washington had one of the more work-trip-oriented public transportation systems with 67.9 percent of its transit travel being between home and work. This trend seems to typify the experience of the new transit systems as well. For instance, about 65 percent[1] of the BART system patrons were going to and from work, and patronage on the Lindenwold Line in the Philadelphia region consists of 86 percent work travel.[2]

WMATA forecasts, by contrast, show that work trips will comprise only 56 percent of METRO's ridership. The volume of non-work travel which this estimate represents appears to be unrealistically high in the light of experience in other areas. It implies that each work trip would be matched by .80 non-work trips instead of .54 (or less) as implied by patronage profiles elsewhere. The <u>number</u> of non-work trips forcast by WMATA would thus be almost 50 percent[3] too high, even if WMATA's projected number of work trips were accurate. But given that the number of work trips forecast by METRO appears to be high itself, a likely number of non-work trips would fall beneath .4 of the number forecast by WMATA.

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[1] *San Francisco Bay Area Rapid Transit District, 1975 Passenger Profile Survey.*

[2] *Delaware River Port Authority, Engineering Planning Division, 1970 Lindenwold Line Passenger Survey. The result presented is based on the six outer stations. Comparable data were not available for the inner stations.*

[3] $.80 \div .54 = 1.48$.

TABLE 8. COMPOSITION OF TRANSIT TRAVEL IN SELECTED CITIES: 1950-1960

	Percent of Transit Travel by Purpose		
Metropolitan Area	Work Trips	Shopping and Business Trips	Social - Recreational Trips
Chicago	57.0	28.3	14.7
Detroit	66.6	22.7	10.7
Washington	67.9	24.2	7.9
Pittsburgh	62.2	30.8	7.0
St. Louis	61.3	25.4	13.3
Houston	66.8	23.6	9.6
Kansas City	53.8	31.6	14.6
Phoenix	58.2	32.5	9.3
Nashville	56.8	22.2	12.0
Fort Lauderdale	66.1	19.7	14.2
Charlotte	69.4	20.9	9.7
Reno	46.3	35.0	18.7

Source: *Computed from data in Wilbur Smith and Associates, Future Highways and Urban Growth, 1961.*

Effect of Gasoline Price Increases

Public transportation patronage has generally been falling in the U.S. since shortly after World War II. The slight increase in 1973 patronage probably resulted from shifts created by the Arab Oil Embargo. While the upward trend continued into 1974, it is possible that it stemmed as much from system improvements and subsidies as from gasoline price increases. In any case, 1975 public transportation figures, when they become available, are expected to fall well under 1970 levels in absolute terms.

Since population has grown by about 5 percent since 1970, there seems little doubt that the 1970 per capita rates of public transport usage presented elsewhere in this section are higher than current experience, even allowing for the effect of higher gasoline prices. Correspondingly, it is not felt that experience following the recent increases in gasoline prices requires any revision of the general conclusion that WMATA patronage forecasts are unrealistically high, especially when viewed alongside available evidence from other metropolitan areas with rail transit systems.

Total METRO Rail Travel

While any patronage forecast involves considerable uncertainties, the evidence reviewed here tends to suggest that work trips will probably be less than 59 percent[1] of the level forecast by WMATA, and that non-work trips will probably be less than 40 percent[2] of the level forecast. Together these imply that, at a maximum, total patronage will amount to only 51 percent of the WMATA forecast.

The last three WMATA Net Income Analyses have indicated that by 1990 the annual patronage on the rail system will approach, or reach, 300 million. About 182 million of these patrons will also use bus for part of their trips and another 167 million public transport patrons will use buses exclusively. It can be seen from Table 10 that these ridership estimates are quite likely greatly

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[1]*Please refer to discussion on pages 29 - 31.*

[2]*Please refer to discussion on pages 31 - 34.*

TABLE 9. TREND IN URBAN PUBLIC TRANSPORT PATRONAGE NATIONWIDE AND WASHINGTON METROPOLITAN AREA

Year	Revenue Passengers Nationwide (millions)	Revenue Passengers Washington Area (millions)
1950	13,845	n.a.
1955	9,189	n.a.
1960	7,521	n.a.
1965	6,789	n.a.
1970	5,932	137
1971	5,497	129
1972	5,253	124
1973	5,294	125
1974	5,606 (preliminary)	126

Source: *American Public Transportation Association and WMATA and District of Columbia Government, "Draft Final Application for an Urban Mass Transportation Administration Capital Assistance Grant," July 25, 1975, p. B5.*

TABLE 10. METRO COMPARED TO OTHER RAIL RAPID TRANSIT SYSTEMS [d]

Metropolitan Areas	Central City		Central Business District [e] Employment (thousands)	Approximate Number of Transit Stations:1970		Total Rapid Transit Patronage 1970 (millions/year)	Total Extra Patronage[c] 1970 (millions/year)
	Area (sq.mi.)	Density (1970) (thousands/sq.mi.)		Central City	SMSA		
New York	299.9	24.4	818	481	about 500	1258	409
Chicago	222.6	12.2	213	about 150	over 160	106	about 330
Philadelphia	128.5	15.2	110	over 61	about 65	63	157
Boston	46.0	13.9	80	47	about 80	101	96
Cleveland	75.9	9.9	67	17	17	14	86
Washington, D.C.	61.4	12.3	129	35[a]	82[a]	300[b]	167[b]

[a] *1990 METRO ARS.*

[b] *WMATA estimate for 1990, fare system no. 1.*

[c] *Consists chiefly of bus trips which do not use rail for any part of the journey.*

[d] *San Francisco's BART is not included because it was not in operation in 1970.*

[e] *Central Business District definition and data are drawn from the 1970 Census of Population.*

overstated -- especially those for the 98-mile rail transit system. The WMATA forecast suggests that the METRO rail transit system will attract three times more trips per year than do the existing rapid transit systems in Chicago, Philadelphia and Boston -- despite the fact that these other cities have higher central city densities, more intensive and well developed cores, and better downtown and central city transit system coverage. Given the additional fact that most downtown workers (those who represent the majority of rapid transit users) tend to live close to downtown and generally within the central city rather than in the suburbs, and that Washington's rail system will have fewer rail stations located within the central city (in both absolute and relative terms) than the rail systems in Chicago, Philadelphia and Boston, the WMATA projection for 1990 rail patronage seems even less creditable.

In view of these considerations, we feel that the factor of .51 developed above to scale down the WMATA estimates indicates the maximum possible ridership that can realistically be expected.

PATRONAGE ON THE THREE ALTERNATIVE SYSTEMS

In order to determine the effect on patronage of a shortened rail system, this study examined detailed WMATA station-to-station patronage forecasts and identified those trips which would not be affected,[1] those which would be affected at one end, and those which would be affected at both ends as a result of rail system curtailment. This analysis is done in percentage terms relative to the ARS. Alternative I, the minimum system, was found to continue to provide full rail service to 47 percent of the estimated ARS patronage. Alternative II, the intermediate system, would continue to serve without alteration 70 percent of ARS patronage.

The percentage loss of patronage attributable to system truncation would be less than the percentage of patronage affected, since some travellers would adjust their routing to utilize the shortened rail network. It is difficult to

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[1] *A trip is not considered to be affected by truncation if both its origin station and destination station remain in the network following truncation.*

estimate how many potential patrons would adjust their travel patterns in a fashion which is consistent with the original WMATA forecast without recourse to computer models which were not available within the resources of this study. Some simple procedures were applied, however, to estimate an approximate upper bound on the volume of patronage lost by truncation. The assumptions applied to estimate this limit were that all unaffected trips would continue to use the shortened rail system; that no trips affected at both ends would continue to use the shortened network; and that trips affected at one end would continue at some reduced rate as discussed below.

Of trips affected at one end, the forecast percentages by mode of access to the station were used as a basis to estimate the trips which continued after system curtailment. It was assumed that no walking trips would continue since the large distances between truncated stations would make such a walk too long to be acceptable. Similarly, "kiss-and-ride"[1] trips are likely to be discouraged by greater access distances, and it was assumed that only 10 percent of these would shift to remaining stations. Fifty percent of "park-and-ride"[2] trips were assumed to continue, and 80 percent of all bus-access trips. A relatively high rate was felt to be appropriate for bus trips since those persons would be making a transfer under any rail alternative being analyzed, and the slight increase in bus travel time and corresponding decrease in rail travel time is not likely to have a major effect on patronage. These factors are necessarily judgemental, but the values chosen probably understate the fraction of potential users of each access type that would use a shortened rail system.

The above assumptions were applied to each station using data from the 1969 WMATA Net Income Analysis. (Later Net Income Analysis results available to this study did not have mode of access details.) On the basis of these assumptions, 54 percent of partially affected[3] trips would continue on the Alternative I system, and 58 percent would continue on the Alternative II system. The impact on relative patronage levels on the three systems analyzed

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[1] *"Kiss-and-ride" paggengers are users who are dropped off, by automobile, at METRO stations.*

[2] *"Park-and-ride" passengers are users who drive to METRO stations, park, and use the rail service.*

[3] *By "partially affected" is meant affected at one end of the trip only.*

here is shown in Table 11. The estimated patronage for the minimum system is 65 percent of the ARS patronage, while that of the intermediate is 85 percent of the ARS patronage.

IMPACT OF THE THREE RAIL ALTERNATIVES ON AUTOMOBILE AND BUS USAGE

The figures in Table 11 also provide a basis for estimating the scale of impact which METRO rail system curtailment would have on other modes. This will be done in three steps. The first assumes that all METRO rail trips which are eliminated because of rail system truncation shift to automobile. The second assumes that all diverted rail trips shift to bus, and the third assumes that both bus and auto are selected, in typical proportions, to serve the trips which would have used METRO rail in the absence of curtailment.

If all of the patronage diverted from METRO rail were to continue to travel using automobiles instead, then the total additional automobile person trips generated would be around 187 thousand per day for Alternative I and around 80 thousand per day for Alternative II. Total daily automobile travel for 1990 would be about 9.5 million person trips a day.[1] Relative to the projected auto traffic in 1990 if the ARS were built, the increase in auto travel generated would be less than one percent for Alternative II and under 2 percent for Alternative I. The number of vehicle miles travelled on urban streets in the United States grew by 6.5 percent per year from 1962 to 1972,[2] implying that the maximum impact of METRO curtailment, even at its most extreme level, represents a jump in urban automobile traffic equivalent to about four months of normal growth. Furthermore, most of this additional traffic would be in outlying areas where congestion problems tend to be less severe than in the center.

Alternatively, WMATA forecasts show that for each six trips using rail for part of their route in 1990, there are seven bus trips using bus for part of their

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[1] *Based on WMATA, Net Income Analysis, 1974-1975, adjusted for transit patronage overstatement.*

[2] *U. S. Department of Transportation, Summary of National Transportation Statistics, June 1974, p. 23.*

TABLE 11. ESTIMATED RELATIVE PATRONAGE ATTRACTED BY THE THREE ALTERNATIVE RAIL NETWORKS

ALTERNATIVE	I Minimal System	II Intermediate System	III ARS
1. Percent of travel not affected by truncation	47	70	100
2. Percent of travel partially affected by truncation	34	26	0
3. Percent of partially affected travel which would continue to be drawn to a truncated system	54	58	-
4. Total percent of ARS traffic attracted by truncated system $(4.) = (1.) + \frac{(2.) \times (3.)}{100}$	65	85	100

route. If all of the trips diverted from METRO rail were to be carried by bus, bus volumes would increase by up to 30 percent for Alternative I and by up to 13 percent for Alternative II.

Most likely, the extra traffic to be carried by bus and auto if METRO rail is truncated would be split in roughly the same proportion as overall modal usage, with under 10 percent of all travel going by transit and the remainder by automobile. The effect on bus patronage would thus be an increase of about 3 percent for Alternative I and about 1.3 percent for Alternative II, and the increase in automobile traffic would be under 2 percent for Alternative I and under 1 percent for Alternative II.

No effort has been made to attempt to translate these automobile traffic levels into additional highway requirements. It was not felt that this could be done reliably in view of the uncertainties involved in identifying exactly where the increased traffic would occur. However, it should be noted that since the additional automobile traffic attributable to METRO truncation is under a third of the annual increase which has been experienced for many years, the truncation of METRO by itself would have relatively minor consequneces on the need for new highway infrastructure within the region.

IV. REVENUE

The findings of the preceding section have profound effects on the expected revenues of ARS and the alternative systems examined in this study. If METRO were a flat fare system, then the previously identified overstatement of patronage would lead to proportional overstatement of revenues, and the forecast 1990 METRO system (bus and rail) revenues of $457 million would in fact be under $238 million. Since METRO has a graduated fare structure,[1] the revenue impact attributable to patronage overstatement may not be directly proportional. If the patronage overstatement is greatest among trips from the suburbs to downtown, then the revenue impact is likely to be more than proportional since more high fare patrons would be "lost" than low fare patrons. It is extremely difficult to identify, in geographic terms, where the WMATA overestimation falls above or below the average overstatement. Some partial answers to this difficult question can be found by examining trip patterns, both past and projected, to find where the greatest discrepancies between them lie, and to assess whether or not those discrepancies are likely changes attributable to the provision of METRO rail service. Tables 12, 13, and 14 show public transport usage rates for work trips observed in the 1970 Census, those implicit in WMATA projections for 1992, and the differences between them, respectively. One key to pinpointing the location of the passenger overstatement would be to look at those areas which have exceptionally large increases in transit usage. The greatest increases tend to come from Arlington County and Alexandria, two suburbs relatively close to the center. The work trips within Washington reflect one of the smaller growth rates. These factors may suggest a pattern of patronage overestimation at the suburban end, with its correspondingly large impact on revenue.

On the other hand, the trends in population patterns discussed earlier suggested that the faster growth is occurring in the relatively distant suburbs, and that WMATA forecasts do not fully reflect this trend. This factor would suggest that central jurisdiction patronage could be a key source of the total patronage overestimate.

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[1] *Current WMATA plans for 1976-77 call for a base fare of 40 cents for a trip of three miles or less plus 10 cents additional fare for each mile beyond three.*

TABLE 12. ACTUAL 1970 RATES OF PUBLIC TRANSPORT USE (WORK TRIPS)

(Entries represent the percentage rates with which trips between the areas shown utilize public transportation.)

From \ To	D.C. Core	Montgomery	Prince George's	Arlington	Alexandria	Fairfax	Loudoun	Prince William	D.C. Non-Core	Total Region
Washington	41	31	21	32	25	17	35	9	57	42
Montgomery County	9	3	2	3	0	2	7	0	21	7
Prince George's County	9	3	2	6	2	1	12	0	21	7
Arlington County	24	6	12	19	8	5	0	4	54	23
Alexandria	20	6	5	23	13	6	6	0	46	19
Fairfax City-County	8	0	1	7	3	3	1	1	18	6
Loudoun County	1	0	0	1	0	0	1	0	3	1
Prince William County	2	0	0	4	0	0	0	1	5	1
Total Region	25	6	4	14	8	4	1	1	37	17

***Source:* Computed from 1970 Census of Population.**

TABLE 13. WMATA FORECAST OF 1992 RATES OF PUBLIC TRANSPORT USE (WORK TRIPS)

(Entries represent the percentage rates with which trips between the areas shown utilize public transportation.)

From \ To	D.C. Core	Montgomery	Prince George's	Arlington	Alexandria	Fairfax	Loudoun	Prince William	D.C. Non-Core	Total Region
Washington	55	52	44	68	50	34	0	0	68	60
Montgomery County	40	17	13	39	19	9	1	0	51	27
Prince George's County	37	24	12	38	17	8	3	0	49	26
Arlington County	57	41	35	53	46	35	16	0	69	56
Alexandria	57	42	29	64	35	31	13	0	68	52
Fairfax City-County	24	13	6	32	15	7	1	0	39	17
Loudoun County	15	3	3	22	6	2	0	0	32	7
Prince William County	15	8	3	20	10	1	0	0	27	7
Total Region	45	21	15	46	25	9	1	0	57	33

***Source:* WMATA Net Income Analysis, 1974, based on Fare System #1.**

TABLE 14. INCREASES IN PUBLIC TRANSPORT USE: 1970 - 1992 (WORK TRIPS)

(AS FORECAST BY WMATA)

(Entires represent changes in the percent of work trips using public transport between 1970 and 1992.)

From \ To	D.C.-Core	Montgomery	Prince George's	Arlington	Alexandria	Fairfax	Loudoun	Prince William	D.C. Non-Core	Total
Washington	14	21	23	36	25	17	-35	-9	9	18
Montgomery County	31	14	11	36	19	7	-6	0	30	20
Prince George's County	28	21	10	32	15	7	-9	0	28	19
Arlington County	33	35	23	34	38	30	16	-4	15	33
Alexandria	37	36	24	31	22	25	7	0	22	33
Fairfax City-County	16	13	5	25	12	4	0	-1	21	11
Loudoun County	14	3	3	21	6	2	-1	0	29	6
Prince William County	13	8	3	16	10	1	0	-1	22	6
Total	20	15	11	32	17	5	0	-1	20	16

Furthermore, inspection of detailed WMATA forecasts on a station-to-station level suggests another source of patronage overestimation: trips from suburban locations to nearby suburban locations. There are currently many trips of this sort being made, as evidenced by the diagonal of Table 15. However, it is also clear from Table 12 that these trips are not as heavy in their use of public transportation as are trips to the core. Such trips might be drawn to rail service in large numbers by 1990, if concentrated development were permitted around suburban METRO stations, and WMATA forecasts indicate a remarkably large number of such trips. Table 16 examines WMATA projected patronage from the terminal station on each line to the two nearest inbound stations as well as to an illustrative group of stations located downtown or near large employment centers. The volume of travel to nearby suburban stations typically far exceeds travel to major central locations. Given that suburb to suburb travel of this sort tends to occur on relatively uncongested roads and to involve relatively low parking charges, and given that transit travel between the same points would typically involve one or more transfers, the WMATA forecasts appear much too high. Extremely concentrated development within walking distance of suburban stations would probably be needed to generate WMATA's levels of suburb to nearby suburb transit travel, and local zoning policy in many jurisdictions is currently opposed to such development. Under a graduated fare structure, patronage overstatement of this sort of travel would tend to have a less than proportionate effect on revenue.

In view of the above factors, it is difficult to determine what the net effect of patronage overestimation is in terms of revenues. This problem is compounded in the analysis of alternative METRO rail configurations since overestimation of patronage on curtailed parts of the system will tend to exaggerate the impact of curtailment. Indeed, examination of the very high patronage between outlying points along the same route suggests that a bias of this sort exists in current WMATA forecasts. Correspondingly, the estimates of the <u>relative</u> patronage loss attributable to system curtailment are considered to be the maximum losses, and that the <u>relative</u> patronage on curtailed systems may be greater than that estimated below.

In the estimation of the relative effects of truncation on revenues, two assumptions are applied separately. The first is that the revenue generated

TABLE 15. PATTERNS OF COMMUTATION IN THE WASHINGTON REGION

(Entries in Columns 1 - 11 correspond to percents of residents working in various jurisdictions)

From \ To	Washington D.C.	Montgomery Cty., Md.	Prince George's Cty., Md.	Arlington Cty., Va.	Fairfax Cty., Va.	Loudoun Cty.,Va.	Prince William Cty., Va.	Alexandria City, Va.	Fairfax City, Va.	Falls Church City, Va.	Total Region	Total Workers
Washington D.C.	82.2	6.2	4.8	4.4	1.2	.1	.1	.8	.1	.1	100	261,118
Montgomery County, Md.	34.7	54.9	5.7	2.7	1.2	.1	.1	.4	.1	.1	100	193,233
Prince George's County, Md.	41.0	8.3	45.0	3.3	1.2	0	.1	.9	.1	.1	100	235,161
Arlington County, Va.	43.0	2.6	1.3	41.0	6.3	.2	.2	3.5	.5	1.4	100	82,171
Fairfax County, Va.	27.0	2.8	1.8	17.3	36.3	.7	.7	8.1	3.0	2.3	100	166,303
Loudoun County, Va.	9.0	3.3	.8	6.6	14.2	60.9	.5	1.4	1.9	1.4	100	12,412
Prince William County, Va.	10.8	1.5	1.1	8.7	18.8	1.0	49.3	5.5	2.2	1.1	100	35,466
Alexandria City, Va.	33.9	1.7	1.5	19.1	11.8	.2	.4	29.9	.6	.9	100	48,495
Fairfax City, Virginia	19.9	3.3	1.5	12.9	24.6	1.2	1.3	2.9	28.8	3.6	100	7,872
Falls Church City, Va.	29.3	3.8	1.6	20.7	17.6	.7	.3	3.7	3.1	19.2	100	4,447
Total Region	46.1	14.4	12.8	9.8	8.7	.9	1.9	3.7	.9	.8	100	1,046,694

Source:* *1970 Census of Population.

per trip is the same, on the average, regardless of where the trip originates. The second is that the revenue produced by a home-based trip increases as the distance between downtown and the stop on the home end of the trip increases.[1] This assumption reflects the experience of the many transit operations that have found they are serving a predominantly core-oriented market. These two assumptions are applied to projected patronage losses in Table 16 to determine the possible revenue implications of truncation in Table 17. It is apparent from Table 17 that the differences in revenues attributable to these two assumptions are relatively small when compared to the effect of patronage overstatement generally.

The information needed to compute bus and rail revenues separately was not available for use in this effort. Assuming that revenues are proportional to patronage, and allocating joint bus/rail trips evenly to both modes, it is possible to obtain some very rough approximations of likely system revenues. This computation is shown in Table 17. The figures for the ARS are taken from the 1974-1975 WMATA Net Income Analysis and scaled down to 51 percent of that value to adjust for patronage overstatement. The estimates for each alternative are then estimated using the percentages in the top two rows of the table. The results of this exercise are considered to be rough approximations. They indicate that the impact of system curtailment on METRO rail revenues would be a loss of about $24 million per year from the ARS level for Alternative I and about $11 million for Alternative II.

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[1] *This was estimated using the 1976-77 METRO fare structure of 40 cents for the first three miles or part thereof and ten cents per mile thereafter. Distances to the center were approximated by taking the airline distance to Metro Center Station.*

TABLE 16. PROFILE OF WMATA TRAVEL FORECASTS FROM TERMINAL STATIONS: 1990

To / From: Terminal Station	Suburban Stations				Selected Central Stations				
	Next Station Inbound		Second Station Inbound		Metro Center	Federal Triangle	Union Station	Rosslyn	Pentagon
Rockville	Twinbrook	1135	Nicholson Lane	1369	403	0	108	99	95
Vienna	Dunn Loring	518	West Falls Church	634	250	364	111	403	335
Springfield	Van Dorn St.	504	King Street	361	0	0	87	214	588
Branch Avenue	Suitland	1003	Naylor Road	180	0	0	127	84	240
New Carrollton	Landover	715	Cheverly	149	245	313	53	63	130
Greenbelt Road	College Pk.	861	Prince George's Plaza	1203	36	0	414	84	161
Glenmont	Wheaton	1523	Forest Glen	495	402	0	283	57	85

Note: Entries represent the number of daily round-trips between the stations shown.
Source: WMATA projections for 1990 travel for a typical 24 hour weekday, station-to-station origin/destination tables, based on fare system 2. (UMATRIX report 1, October 9, 1975.)

TABLE 17. APPROXIMATE REVENUES OF ALTERNATIVE SYSTEMS ($1976)

	ALTERNATIVE SYSTEM I (Minimum)	II (Intermediate)	III (ARS)
Rail System: Revenues as Percent of ARS Revenues:			
assuming equal trip length	65	85	100
assuming core-oriented travel	60	81	100
Approximate Rail System: Revenues in millions of 1976 dollars[a]:			
assuming equal trip length	42.0	54.9	64.6
assuming core-oriented travel	38.8	52.3	64.6
Approximate System Revenues (millions of 1976 dollars)--Bus and Rail	120.1	133.3	144.3

[a] *Based on WMATA Net Income Analysis, 1974, Fare System No. 1. Rail system revenues were approximated by allocating total revenues to bus and rail on the basis of patronage. Combined bus/rail trips were counted as one half trip for each mode. Total revenues were scaled down to 51 percent of the value reported by WMATA to adjust for average patronage overstatement.*

V. CAPITAL COSTS

ADOPTED REGIONAL SYSTEM (ARS)

The estimates of total capital costs required to complete the METRO system are subject to many uncertainties. The exact form of the system to be completed has yet to be determined; changes in route alignment and substitution of tunnel for surface facilities are still being debated by the jurisdictions to be served by METRO. Also, the quality of existing cost estimates for different segments varies depending upon the extent of analysis which underlies them. Some estimates are based upon final design estimates, and reflect the most recent information available. Others are based upon fairly coarse estimation procedures applied when the system was first being designed.

In addition, the remainder of METRO construction would require at least several years to complete regardless of the specific alternative designs selected. Projecting system costs thus requires projecting the rates of increase for key construction inputs during that period. Finally, any set of cost estimates makes assumptions about some factors which cannot be fully understood until construction is underway, so that even the best of estimates carries with it some degree of uncertainty. In its evaluation of METRO capital costs, the General Accounting Office warned that it is impossible to project with any degree of certainty how much the total costs of constructing METRO will increase because of the uncertainties inherent in the estimates.[1] Nevertheless, the GAO report did indicate that the 98-mile system probably could not be built at WMATA's estimated cost, and went on to identify some of the possible sources of additional costs. These are reviewed briefly below.

Underestimation Inherent in Early WMATA Estimates

The GAO found that WMATA's accuracy at cost estimation had improved with time, but that many of the estimates still used by WMATA date back to the period when underestimation was more frequent. Based on WMATA's actual cost expenditures compared to estimated costs, GAO found that upward contingency factors ranging from 0 to 2.5 percent are appropriate for constuction projects now underway, a source of additional costs of up to $34 million.[2]

[1] *Comptroller General of the United States, "Evaluation of the Capital Cost Estimate for the Metro Rapid Rail Transit System," May 8, 1975, p. 7.*

[2] *ibid., p. 10.*

For projects not yet put to bid, a higher contingency factor was suggested. A figure of 0 to 10 percent was recommended, leading to additional costs of up to $231 million.[1] This source of potential METRO cost increases is exclusive of those discussed below.

Contractor Claims

The GAO analysis found reasonable consistency between the Bay Area Rapid Transit District and WMATA with respect to contractor claims arising from unanticipated costs. These were expected to be around 5 percent of construction costs for underground construction segments and around 2 percent for other types. For projects now underway, an estimated $34 million in claims are anticipated, and those associated with unbid work may run from $46 to $115 million.[2]

Route Realignments

Recognition of changes in area development since METRO was originally designed as well as increased awareness of shortcomings of the current system plan have caused many Washington area jurisdictions to reconsider the details of the design within their boundaries. The cost implications of some of the alternative designs being considered are shown in Table 18. While the resolution with respect to any of these realignments has yet to be made, the impact of all of the realignments would be to add an estimated $273 million to total METRO construction costs.[3]

Delays

WMATA cost forecasting procedures do not provide for delays attributable to lawsuits, strikes, and adverse weather. Some delays of this sort appear inevitable, and the GAO report examines some illustrative cases. As an indicator of the importance of delays, however, GAO estimated that all construction falling behind by one year could cause an additional $54 million of cost, and that a second year of delay could cause an additional $65 million.[4]

[1] *ibid.*, p. 11.
[2] *ibid.*, p. 12.
[3] *ibid.*, pp. 13-17.
[4] *ibid.*, p. 20

TABLE 18. CAPITAL COST IMPLICATIONS OF ROUTE ALIGNMENTS NOW UNDER CONSIDERATION BY LOCAL JURISDICTIONS

Route Letter	Route Name	No. of Alignments Being Considered	Incremental Cost of Alternative
B	Glenmont	2	-\$20 million
E	Greenbelt	Several	+\$227 million[a]
F	Branch Avenue	2	+\$69.5 million
J & H	Springfield & Franconia	2	-\$3.5 million
K	Vienna	-	?

[a]*Most expensive alternative is shown.*

Source: Comptroller General of the United States, "Evaluation of the Capital Cost Estimate for the Metro Rapid Rail Transit System," May 8, 1975.

Because METRO construction stretches across many years, the funds expended at different points in time reflect different purchasing power. To some extent, the increased costs attributable to delay are offset by the fact that the higher costs can be paid with future dollars. Since METRO has been able to invest funds not expended at interest rates of 6.5 to 9 percent, some of the increased costs of delay are offset by interest earnings on funds which would have been spent earlier had delays not occurred.

Price Escalation

WMATA cost estimation procedures attempt to anticipate future price increases by incorporating price escalation factors. These factors are inherently uncertain, and GAO attempted to put some error brackets on them. Their conclusion was that actual cost experience could vary from -4 to +11 percent of the total estimated costs of $4.45 billion, or from -$170 million to +$488 million.

Total Capital Cost

Based on these factors, the total cost of METRO construction could range from $4,457 million to $5,790 million. Because of the nature of the contingencies underlying this range, an estimate toward the upper end seems relatively likely. Table 19 summarizes the cost factors identified by GAO and presents a possible case where cost elements total $5.5 billion. This figure and the WMATA estimate are used below to estimate costs for alternative systems.

CAPITAL COST ESTIMATES FOR ALTERNATIVE SYSTEMS

WMATA furnished to this study a segment-by-segment breakdown of their expected capital costs for the portions of the ARS not yet under construction. These were used without modification to construct one of the sets of capital cost estimates applied to estimate the cost of building alternative rail networks. A second set of estimates was developed by examining the construction component of these costs and by scaling it upward to allow for some of the contingencies

TABLE 19. AN ESTIMATE OF POSSIBLE METRO CAPITAL COSTS
(millions of dollars)

	Summary of GAO Estimate	A Possible Outcome
WMATA estimate of ARS costs 12/30/75[b]	4,651.[a]	4,651
Possible Underestimation, Projects Currently Underway	0 to 34	34
Possible Underestimation, Unbid Projects	0 to 231	231
Contractor Claims, Projects Currently Underway	0 to 34	34
Contractor Claims, Unbid Projects	0 to 115	115
Route Realignments	-24 to 118[a]	100
Delays	54 one year	
	119 two years	335
Price Escalation	-170 to 488	
Total Estimated Costs	$4,457 to $5,790	$5,500

[a] *Differs from GAO report by incorporating revised WMATA total cost and E route costs.*

[b] *Furnished in correspondence by WMATA.*

identified in the GAO report. This second set of estimates reflected construction costs 12.5 percent higher than WMATA's for construction costs based on final design estimates, and 20 percent higher for elements not based on final design estimates. On this basis, two sets of cost estimates were prepared for each of the three alternative rail networks analyzed.

Tables 20 and 21 show the savings in capital cost associated with the Alternative I and II shortened rail networks, respectively. The first column shows WMATA estimates, the second column shows a higher set of estimates based on contingency allowances of the magnitude identified by GAO. The line next to the bottom of each table reduces the estimated capital savings by five percent to allow for station enlargement, facility relocation, etc., attributable to system reduction. The estimates of overall capital cost reductions under each set of assumptions are shown at the bottom of the tables. According to this analysis, Alternative I, the minimal system, would result in savings of $1.9 billion to $2.2 billion. Alternative II, an intermediate system, would yield savings of $1.0 billion to $1.14 billion.

The corresponding total estimated capital costs are compared in Table 22. The minimal system would require $2.7 to $3.3 billion, about 60 percent of the capital expenditure of the 98-mile ARS. The intermediate system would require $3.7 to $4.4 billion, roughly 79 percent of the ARS cost which, on comparable assumptions, lies between $4.6 and $5.5 billion.

TABLE 20. ESTIMATED DECREASE IN CAPITAL COST:
ALTERNATIVE I VERSUS ADOPTED REGIONAL SYSTEM

(ALTERNATIVE I: MINIMUM SYSTEM)

Route	Segments Deleted[a]	ARS Costs less Alternative I Costs	
		WMATA Estimate[b]	Revised Estimate[c]
A-Rockville	A013-A016	215,401	242,928
B-Glenmont	B009-B012	283,883	331,590
C-Huntington	C009-C011	194,414	214,534
E-Greenbelt	E001-E008	527,064	606,753
F-Branch Avenue	F003-F009	325,364	376,342
G-Addison Road	G001-G003	184,579	205,682
H-Franconia	H001	21,364	24,938
J-Springfield	J001-J003	91,978	105,078
K-Vienna	K004-K008 (portion)	184,500	214,634
Total Capital Costs of Truncated Portions		2,028,547	2,322,479
Less: Contingency Allowance for Relocation of Storage Yards, etc. (Estimated @ 5% of above total)		101,427	116,124
Total Estimated Reduction in Capital Costs of Alternative I Compared to ARS		1,927,120	2,206,355

[a] *Please refer to Figure 1 for location of segments.*

[b] *Based on WMATA data furnished to this study.*

[c] *Based on WMATA data but scaled upward to account for contingencies identified by GAO.*

TABLE 21. ESTIMATED DECREASE IN CAPITAL COST:
ALTERNATIVE II VERSUS ADOPTED REGIONAL SYSTEM

(ALTERNATIVE II: INTERMEDIATE SYSTEM)

Route	Segments Deleted	ARS Costs less Alternative II Costs	
		WMATA Estimate	Revised Estimate
A-Rockville	A013-A014 [a]	134,234	150,062
B-Silver Spring	B009-B012 (B&O Alignment Added)	283,883 (169,649)[b]	331,590 (195,096)[e]
C-Huntington	C0101-C11	107,489 [c]	118,593
E-Greenbelt	E005-E008	183,164	214,145
F-Branch Avenue	F008-F009	80,349	93,787
G-Addison Road	G001-G003	184,579	205,682
H-Franconia	H001	21,364	24,938
J-Springfield	J001-J003	91,978	105,078
K-Vienna	K005-K007 (portion)	132,151 [d]	153,416
Total Capital Costs of Truncated Portions		1,049,542	1,202,195
Less: Contingency Allowance for Relocation of Storage Yards, etc. (Estimated @ 5% of above total)		52,477	60,110
Total Estimated Reduction in Capital Costs of Alternative II Compared to ARS		997,065	1,142,085

[a] *Segments A015 and A016 are not deleted because these form part of the Alternative II B-route. Please refer to Figure 1 for location of segments.*

[b] *WMATA estimate prepared for GAO.*

[c] *Assumes that subsequent C010a represents one third of the total costs of segment C010.*

[d] *Assumes that 20 percent of segment K005 represents the portion beyond East Falls Church.*

[e] *Includes escalation allowance of 15 percent.*

TABLE 22. ESTIMATED CAPITAL COSTS OF ALTERNATIVE METRO RAIL SYSTEMS

	ALTERNATIVE I	ALTERNATIVE II	ALTERNATIVE III
	(Minimal System)	(Intermediate System)	ARS
Total Capital Costs: WMATA (billions of dollars)	2.724	3.654	4.651
As percent of ARS Capital Costs	59	79	100
Total Capital Costs: Revised (billions of dollars)	3.294	4.358	5.500
As percent of ARS Capital Costs	60	79	100

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VI. OPERATING COSTS

For public works projects of this magnitude, the attention tends to focus almost solely on the capital costs and thus to ignore the expenses of operating and maintaining the facilities once they are in place, not to mention those for replacing rail cars, buses, or other items. Further, as the system ages, the unit operating and maintenance expenses will increase.

In the case of METRO, it appears that the total capital outlays will range somewhere between $5 and $6 billion, or have equivalent annual costs of about $250 to $500 million, depending on the interest rate chosen. To these capital costs must be added those for operating and maintenance, the latter of which will be at least $200 million annually by the year 1990 for both rail and bus service if the present WMATA plans are followed. Thus the estimated METRO operating and maintenance costs (not to include those for facility and equipment replacement) are potentially of the scale of annualized capital costs.

Three points should be made at the outset: (1) By WMATA projections, about one-third of the maintenance and operating costs will be extended for bus services and the remainder for rail service on the adopted 98-mile regional rail system. With bus operations usually being more labor intensive than rail, it is reasonable to expect the bus costs to become a larger proportion of the total if transit wages for large city operations continue to rise as fast as has occurred during the last two decades. As a consequence, there may be considerable pressure in future years to trim bus service below levels anticipated by WMATA. This seems especially true since policy makers seem reluctant to trim rapid transit service once the heavy costs of fixed facilities are in place. (2) With under one-half of the rail portion of METRO under construction, the opportunity exists now for effecting operating and maintenance costs (both rail and bus services, not to speak of effecting capital outlays for way, structures and rolling stock) by a reduction in the planned 98-mile rail transit system. That is, if the METRO rail system were to be shorter than 98 miles, not only could capital requirements be decreased, but also the costs for providing a certain amount of rail car mileage and ancillary bus mileage can be eliminated. With under one-half the rail system completed, the discussion in Chapter V indicated that about one-third of the fixed costs could be eliminated by severe curtailment, in addition to a reduction in the variable costs associated with rail and bus mileage. If alternatively the METRO rail system were extended no farther than at present, then at least $60 million annually could be saved in rail operating and maintenance costs. (3) The above maintenance and operating costs (about $125 million annually for rail and $75 million for bus) are the latest[1] WMATA estimates for the level of service to be provided in 1990 but stated in 1976 constant dollars. However, if WMATA experience in the future follows that for other large scale public transit agencies in which increases in real wages and prices have been substantial and in excess of those in the private sector over the past twenty years, even higher real maintenance and operating cost levels can be expected. While no attempt to measure these increases has been made, some indication of the possible effects can be gauged by noting that real annual earnings for transit employees for the nation increased by about 25 percent between 1960 and 1974.[2]

It is not possible within this study to include a detailed analysis of the operating and maintenance cost data for the WMATA rail and bus operations or of their basis. The calculations are far too lengthy and time consuming. Also, the procedures and breakdown initialized for determining labor, materials, and in turn costs were changed (by WMATA or their consultants) from study to study, thus invalidating certain comparisons. As a consequence, only overall general statements can be made with respect to the reasonableness of WMATA's expected maintenance and operating costs for the authorized regional system in 1990 (even though the costs are stated in 1976 current dollars).

The three most recent WMATA etimates for bus and rail services indicate the following unit costs for 1990:

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[1] *The figures shown are preliminary but WMATA indicated that final values would fall within a few percent of these.*

[2] *Jack Faucett Associates, "Inflation and the Transportation Sector: Trends, Problems, and Opportunities for Improvement," report prepared for the Office of the Secretary, U. S. Department of Transportation, October 30, 1974.*

Cost Item	1969 Net Income Analysis (1968 $'s)	1971 Net Income Analysis (1970 $'s)	1975 Net Income Analysis (1976 $'s)
Rail Cost per Revenue Car Mile	$.6041	$.7357	$2.58
Bus Cost per Revenue Bus Mile	$.8179	$1.1177	$2.05

Given the fact that the rail service is to be air-conditioned and that vehicles will be over ten years old by 1990, the most recent unit cost figure for rail (about $2.58 per car mile) appears to be closer to the mark than earlier forecasts (without including any future increases in real wages and prices above the 1976 constant dollar scale). It is almost meaningless to compare this unit cost figure to that of other existing rail transit systems because of differences between operating characteristics (such as mileage between stations, speed, load factors, age of rolling stock and way, etc.) and other aspects (such as air-conditioning for METRO, local cost of power, etc.). However, simplistic comparisons do indicate that the 1975 WMATA estimate falls within the range of current unit costs for the larger rail systems and thus is not without merit. For instance, in 1973 the operating cost per car mile for rail rapid transit systems in New York was about $1.60, in Chicago about $1.20, in Boston about $3.70, and in Philadelphia about $1.40. With operating cost increases for these systems currently running about 8 to 10 percent annually, we may estimate that, measured in 1976 dollars, an additional 25 percent may be added to unit cost figures for other cities to make them comparable with the earlier cited $2.58 WMATA operating cost per car mile.

The operating costs for the alternative METRO rail systems analyzed here have been estimated using a unit cost of $2.58 per car mile corresponding to the WMATA estimate. The number of rail car miles required for each of the alternative systems has been assumed to be proportional to its track mileage. This probably tends to overstate the costs of Alternatives I and II since not only would proportionally fewer miles be served by each train, but fewer trains would be required since there is some drop in estimated patronage (15 percent for Alternative II, 35 percent for Alternative I). However, no reductions beyond the proportion indicated above were assumed since these would partly be offset by the fact that some components of operating cost are tied to track miles as opposed to car miles (maintenance of way expense, for example); others are related to deadheading and turn-around costs and these might not drop proportionally; and others are due to minimum service frequencies at off-peak times and these costs would continue to be generated even if patronage dropped somewhat.

Table 23 shows estimates of operating costs. The first line of the table shows the relative operating costs of the three systems. The second line shows WMATA estimated operating costs for the ARS and operating costs for the other alternatives based on this figure and the percentages in line 1.

The bus operating costs shown in Table 23 are based on the impacts on bus system operations sketched at the end of Chapter III.

Total operating costs thus estimated range from $213 million (in 1976 dollars) for Alternative I to $284 million for Alternative III.

TABLE 23. ESTIMATED 1990 OPERATING COSTS FOR ALTERNATIVE SYSTEMS

	ALTERNATIVE I (minimum)	ALTERNATIVE II (intermediate)	ALTERNATIVE III ARS
Rail Operating Costs as a Percent of ARS Operating Cost	41.8	69.4	100.0
1990 Annual Rail Operating Cost (millions of 1976 dollars)	53.5	88.8	127.9
1990 Annual Bus Operating Cost (millions of 1976 dollars)	159.3	157.6	156.3
Total 1990 Operating Costs (millions of 1976 dollars)	212.8	246.4	284.2

VII. DEVELOPMENTAL ISSUES

PARKING

WMATA forecasts indicate that 28 percent of persons using public transit to get to work will use their automobile to get to transit facilities. Nineteen percent of non-work home-based transit usage will also be of a "park-and-ride" nature.[1] While these statistics apply to all transit travel and not just to rail service, it is likely that the vast bulk of it will be directed toward METRO rail stations. The parking currently planned at these stations will fall far short of being able to deal adequately with the parking load generated by METRO. Table 24 shows the effect of various transit patronage estimates on the adequacy of parking, assuming the current plans for approximately 27,250 spaces at METRO stations. Under WMATA's projection, there is only one space available for each 3.8 cars needing a space during the day. Because WMATA's patronage projection is judged to be high, the second column of the table shows the corresponding statistics assuming the maximum patronage level developed in Chapter III. Even under these assumptions, there is still only one space per 2.2 cars attracted to METRO stations.

This excess of "park-and-ride" METRO patrons compared to the available parking poses a situation which is basically unworkable: either parking will be added or METRO patronage will fall beneath levels because of inadequate "park-and-ride" access. Because of the need for convenient access for feeder bus and "kiss-and-ride" passengers, on-street parking in the vicinity of METRO stations will be virtually non-existent, and existing commercial facilities are not expected to be sufficient to serve the excess of parking demand created by METRO. The result, if nothing is done to rectify the situation, would be further erosion of the projected patronage. However, the combination of crowded parking facilities and low overall METRO system patronage due to access inadequacy is likely to create considerable pressure for expansion of parking

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[1] *For comparison, 32 percent of San Francisco BART patrons drove their cars alone to transit stops, and 53 percent of Lindenwold Line passengers drove alone to stops.*

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TABLE 24. ESTIMATED PARKING REQUIREMENTS FOR METRO STATIONS

	WMATA Patronage Estimate[a]	Revised Patronage Estimate[b]
Daily Transit Work Trips	921,623[a]	543,758
Daily Transit Non-Work Trips (Home-Based)	593,314	237,326
Daily Transit Work Trips Using Parking	251,727	148,519
Daily Transit Non-Work Trips Using Parking	110,679	44,272
Estimated Peak Parking Load at METRO Stations[c]	104,706	58,622
METRO Parking Demand per Space Available	3.8	2.2

[a]*WMATA estimates from 1974 NIA, fare system No. 2.*

[b]*WMATA estimates scaled down to reflect experience of other areas.*

[c]*Based on 70 percent of total transit work trips using parking and 30 percent of total home-based transit non-work trips using parking.*

facilities, possibly to be financed by the local jurisdictions. Alternatively, it is likely to lead to increased development of commercial parking facilities, an option at variance with zoning directions in many of the jurisdictions involved.

LAND USE IMPACTS OF METRO

It is probably fair to say that the greater the extent to which public funds are involved in the building and operating of METRO, the greater the public interest in its land use impact. The land use pressures which will be exerted by the presence of METRO ought to be consistent with and acceptable to the jurisdictions where the impacts are felt and consistent with their planning for community development. These propositions are not seriously arguable and have not been since the inception of planning for the METRO project; the problem for citizen groups, planners, and elected officials has been rather to determine what community interests are and how they would be affected by METRO. Ideally, a community would arrive at a long-run consensus about community objectives which would then be clearly expressed to elected officials whose only intent would be to serve the public's desires. The task for planners then would be to analyze and describe alternative ways and associated costs of achieving the public's objectives.

There are two fundamental difficulties involved. One is that the process by which the public begins to understand and appreciate the impact of such a facility as METRO works very slowly, regardless of how comprehensive the information may be which is initially provided. The second difficulty is that the public may change its mind. The two may or may not be related. In the case of METRO it appears that in the Washington area communities there was not a general recognition of the land use impact of a rapid rail system oriented to the metropolitan core. Most people saw it as a means of decongesting the highway radials, without foreseeing that in fact METRO would be providing an increase in capacity which would permit corridor flows to be that much greater.

It was chiefly when zoning cases for property near planned METRO stations began to arise in the various jurisdictions that the land use impact of METRO was perceived. The reactions, in suburban jurisdictions at least, were negative to the point of questioning the desirability of completing some parts of the rapid rail transit system, notably the Greenbelt line in Prince George's County. Concomitantly, especially in the high income jurisdictions in Maryland and Virginia, the public began to express resistance to the high growth policies which hitherto had dominated land use planning in those jurisdictions. Putting these circumstances together with the prospects of spiraling public costs for METRO has resulted in considerable public interest in a re-evaluation of the size and extent of the METRO system.

Recognition of these changing public attitudes suggests several questions of public policy which have not been sufficiently explored to date:

1. How would METRO patronage be affected by lower growth rates and more or less permanently lower (than expected) densities in the suburban jurisdictions?

2. In light of the large public expenditures by all jurisdictions, including the federal, should land use objectives, which would be affected by METRO, be more explicitly stated and should they be placed in a broader public interest setting?

3. Finally, should the size of the system and the location of stations be re-evaluated in terms of changed public views about land use in the Washington metropolitan area?

Estimating the likely consequences of METRO curtailment on development is not possible in the presence of so much uncertainty concerning local goals and directions. It should be noted, however, that the patronage and revenue forecasts now employed in WMATA planning are based on development policies which may not be acceptable to the jurisdictions involved. If these zoning policies are taken as a firm indication of local preference, then the feasibility of METRO should be reviewed in that light. Alternatively, a condition for building METRO into areas falling beneath a critical trip density might be their willingness to adopt compatible zoning measures.

VIII. JURISDICTIONAL IMPACTS

TRANSFER OF INTERSTATE HIGHWAY FUNDS

The Federal-Aid Highway Act of 1973 (P.L. 93-87) allows states to transfer funds from discontinued Interstate Highway projects to transit uses, subject to meeting various federal planning requirements and contingent upon Federal Highway Administration and Urban Mass Transportation Administration approval. Transfers of this sort involve 80/20 matching, i.e., four dollars of federal money for each dollar of local money. Amendments to the Act which were passed in 1974 (P.L. 93-643) increased the level of funding potentially achievable through Interstate Highway fund transfers by adjusting planned highway costs upward to account for inflation. (The 1973 legislation had been phrased in terms of 1972 Interstate Highway costs and its transfer provision had not allowed for likely cost increases after 1972.)

The amount of METRO funding potentially available through Interstate transfer provisions is shown in Table 25. Because of the relatively high level of federal matching associated with Interstate highway fund transfers, these present a fairly attractive alternative to the local jurisdictions searching for additional METRO capital cost contributions. The matching ratio of 80/20 is more attractive to local jurisdictions than the two-third/one-third written into existing WMATA legislation, and further Congressional action generally would not be needed to release these highway funds.[1] However, the Interstate transfer provisions require that requests for funds of this sort be joint state/local applications, and in some cases the states surrounding Washington have indicated that they have more attractive uses than METRO for which to expend transfer funds. Furthermore, some state authorities have indicated that they believe that future legislation may create greater flexibility in Interstate Highway transfer provisions and that more attractive alternative uses of transfer funds may appear in the future. Another potential problem is that the availability of transfer funds to the jurisdictions involved is

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[1] *Appropriating the local share for D.C. transfers would apparently require Congressional approval.*

TABLE 25. INTERSTATE TRANSFER FUNDS POTENTIALLY AVAILABLE FOR METRO CONSTRUCTION
(Preliminary Maximum Amounts)

State	Interstate Route Number	Federal Share[a] ($000,000)	Local Share[a] ($000,000)	Total[a] ($000,000)
D.C.	I-95	400	101	501
	I-705	101	25	126
	I-66	284	71	355
	I-295	204	51	255
	I-695	115	29	144
	I-266	141	35	176
	Total D.C.	1,245	311[b]	1,556[b]
MD.	I-70S	152	38	190
	I-95	119	30	149
	Total MD.	271	68	339
VA.	I-66	139	35	174
	I-266	18	5	23
	Total VA.	157	39[b]	196[b]
Total, 3 STATES		1,673	418[b]	2,091[b]

[a] *1972 Cost esimate with escalation to 1/75. Amounts are approximate and depend on the timing of withdrawals and careful review of project designs.*

[b] *Totals may not add exactly because of rounding.*

Source: Department of Transportation Staff Report on METRO (The "Coleman Report"), July 16, 1975, p. IV-2.

unequal and not necessarily in proportion to current METRO obligations of the local jurisdictions. Finally, the local share would require substantial additional local commitments, and moves in this direction are likely to be slowed by threats of further increases in METRO capital costs, deficits attributable to METRO bus and rail operating costs, and the possibility of revenue bond obligations which cannot be met through operating revenues as originally planned.

In view of these factors, it appears most unlikely that the full level of Interstate transfer funds shown in Table 25 would be diverted to METRO construction. Even if withdrawals from the Interstate system are made and funds diverted to METRO, all of these would most likely not be applied to completion of the basic 98-mile ARS. Maryland, in particular, has applied for a withdrawal of Interstate funds for I-705 and I-95, but stated in its application that these would be applied to the costs of extending the Rockville line to Shady Grove and shifting the Greenbelt line north of Prince George's Plaza to a more environmentally-benign alignment, both of these changes reflecting costs beyond those envisioned for the 98-mile system as adopted.

The feasibility of diverting Virginia's I-66 and I-266 funds exclusively to METRO use is also questionable. A compromise measure in the I-66 corridor which appears to be gaining increased local support is the construction of a four lane highway with METRO sharing the right-of-way. Even if Virginia transferred all of its Interstate funds to this project, not all would be available for rail construction since part of the funds would go to construction of the I-66 roadway.

The resolution of the Interstate transfer question has yet to be reached. However, it is unlikely that Interstate transfers, by themselves, would provide sufficient funds to complete the 98-mile ARS. While the maximum funding theoretically obtainable from Interstate transfers would exceed WMATA's current estimate of total construction costs, it is unlikely that the jurisdictions involved would elect to use enough of their transfer funds to cover the costs of the ARS. Furthermore, while any projection of costs involves inherent uncertainties, there is some likelihood that the cost of

METRO rail construction could exceed $6 billion. In such a case, not even the sum of potentially accessible Interstate withdrawals would suffice to cover construction costs. The region appears to be at a point where, because of financial necessity, major decisions on the future of METRO are imminent.

In short, the months ahead will require that substantial new steps toward financing the 98-mile ARS be taken or that appropriate alternative system designs be adopted. It appears reasonable to ask that the steps to be taken reflect, as much as possible, the changes in the region's needs, values, and priorities which have become evident since the 98-mile ARS was approved.

JURISDICTIONAL FINANCIAL ARRANGEMENTS

The significant impacts on local government budgets which would result from rail system curtailment are impossible to estimate at this point. The agreement between the jurisdictions with regard to the capital costs of the 98-mile ARS does not set a procedure by which capital contributions can be recomputed should any curtailment occur. The 98-mile ARS is different in this respect in that the existing agreement does define how its total capital costs are to be borne. This division is done at the state level according to the "four factor" formula which is computed as follows:

	Factor	Weight Given to Factor After Computation
1)	Proportion that the estimated con-- struction cost computed on a 1967 base within each signatory's area bears to the total estimated construction cost	40%
2)	Proportion that service provided, as measured by estimated 1990 train miles and number of stations within each signatory's area, bears to the total service provided	30%
3)	Proportion that the estimated 1990 ridership originated in each signatory's area bears to the total estimated system ridership for 1990	15%
4)	Proportion that the estimated population of each signatory's area in 1990 bears to the total estimated population of the Transit Zone for 1990	15%

The 1974-1975 Net Income Analysis would form the basis for recomputing the ingredients in the four-factor formula. Thus, even the jurisdictional distribution of ARS costs is still partly undecided. Furthermore, a final agreement has apparently not been reached yet on the distribution of rail operating deficits. In view of these factors, little can be said about the jurisdictional implications of METRO rail curtailment in that curtailment would undoubtedly require renegotiation of some distribution formula, both for past costs and future costs.

For purposes of illustration, the cost and revenue estimates presented elsewhere in this report can be broken into the jurisdictional shares according to the current allocation formula.[1] While such a formula would in all likelihood not be appropriate for some of the alternatives described, it does serve to illustrate the implications of the various systems in terms that the local jurisdictions have become accustomed to dealing with.

Also, it should be noted that METRO deficits are likely to exceed the level of support afforded by any Federal subsidy program, and that large operating deficits are not only a probable outcome of future years but are very apparent even now. The full METRO system in 1990, including the 98-mile rail network, would produce estimated operating revenues of $144 million (in 1976 dollars) while the costs of operating the bus and rail systems are estimated to be around $290 million, leaving an operating deficit of $146 million. The prospect of a deficit of this magnitude, huge as it is, becomes more believable when it is noted that the operating costs anticipated for METRO bus operations in fiscal 1976 are expected to exceed revenues by 71.6 percent and result in a deficit of $53.6 million on total operating expenses of $128.4 million.[2]

Given that there exists a variety of possible ways to fund the completion of the METRO rail system, among them transfers of Interstate Highway funds, special Congressional action appropriating additional funds at current federal/local shares, or actions that would retroactively change the federal

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[1] *Bus operation deficits are currently allocated on a separate formula based on bus miles.*

[2] *WMATA, Fiscal Year 1976 Budget Estimates, Volume 1, "Metrobus Operations," p. 1.*

share from two-thirds to eighty percent, it is necessary to make some assumptions concerning on what terms federal funds will be available before the local shares can be worked out. For illustrative purposes, the breakdown set out here assumes that federal funds beyond the $2.98 billion already authorized are made available on terms of 80 percent federal/20 percent local, and that the revenue bonds are also retired using 80/20 matching. On these assumptions, illustrative jurisdictional impacts are shown in Table 26.

TABLE 26. ILLUSTRATIVE METRO RAIL IMPACTS ON JURISDICTIONAL FINANCES[a]

ALTERNATIVE	I (Minimum)	II (Intermediate)	III ARS
Rail Capital Costs (millions of dollars)	3,294	4,358	5,500
District of Columbia	372	450	535
Virginia	286	346	411
Alexandria City	55	67	80
Arlington County	107	129	153
Fairfax City	4	5	6
Fairfax County	119	144	171
Falls Church	1	1	1
Maryland	348	421	501
Montgomery County	193	234	278
Prince George's County	155	187	223
1990 Operating Deficit (Millions of 1976 dollars)			
District of Columbia	4.8	13.0	23.4
Virginia	3.7	10.0	18.0
Alexandria City	.7	1.9	3.5
Arlington County	1.4	3.7	6.7
Fairfax City	.1	.1	.3
Fairfax County	1.5	4.2	7.5
Falls Church	-	-	.1
Maryland	4.5	12.2	21.9
Montgomery County	2.5	6.8	12.1
Prince George's County	2.0	5.4	9.7

[a]*Assumptions:*

- *Capital costs and deficits estimated as discussed in Chapters IV, V, and VI.*
- *Includes federal interest stations, a very small component of overall costs.*
- *Excludes expenditures for facilities for handicapped.*
- *80 percent federal assistance on existing revenue bonds.*
- *80 percent federal funding for remainder of system, not retroactive.*
- *Original jurisdictional allocation process.*
- *Maryland costs paid fully by counties.*

(Totals may not add due to rounding.)

IX. SUMMARY

Since its inception, Washington's METRO has enjoyed considerable popular support. The vision of travel in a comfortable, air-conditioned, high speed public facility compared favorably with that of crowded roads, noisy traffic, and polluted air. Furthermore, in the long-run METRO promised a way to restructure development within the area so that automobiles were less essential.

Even though concerns about congestion and the environment have greater basis today than ever before, there is increasing evidence that suggests questioning at this juncture whether the benefits of the full METRO system outweigh its costs. This evidence is of essentially three types: shifts in the area's overall growth and developmental patterns, escalation in the capital costs of building METRO, and the prospect of substantial operating deficits in future years. There is also mounting evidence that METRO, as planned, may not be well suited to the requirements of one potential user group that is likly to need it most -- persons without automobiles.

The 98-mile Adopted Regional METRO system approved by Congress in 1969 was based on the premise that urban growth and travel could be channeled in a coordinated, mutually supportive pattern. Since its adoption, however, a number of events have reshaped the key assumptions in that premise. The use of automobiles has generally continued to rise and, with the exception of a slight upturn in 1973, public transport patronage has continued to erode and remains beneath 1970 levels. The wedge and corridor planning concepts which were anticipated to bring concentrations of population, employment, and commerce within reach of METRO stations have not developed and do not appear likely to develop. Indeed, local zoning policy in many of the area's jurisdictions is adamantly opposed to intense development in the neighborhood of METRO stations. New transportation facilities, such as the Shirley Highway bus on freeway, have come to play major roles in the area's public transport. Increased public awareness of the environment, parking, traffic, and developmental implications of METRO have highlighted problems of the original plan and have generated numerous proposals for route realignments, most notably in the Silver Spring, College Park, and Anacostia areas.

Only recently has the problem of public transport operating subsidies come to be fully realized in the Washington areas. With a fiscal year 1976 operating deficit for METRO bus operations expected to be in excess of $53 million, the jurisdictions in the region might well question whether METRO rail service will compound or alleviate the need for further public transport subsidies.

Furthermore, recognition of the fiscal implications of METRO has given rise to questions concerning the priority of this project compared with other public projects. The total costs of building the rail system, when conceived, were estimated to be under half of what they are now anticipated to be. At the same time the Washington area, like most of the nation's major metropolitan areas, has experienced a sharp decline in the growth rates of earlier decades. Thus, there are more costs to pay, fewer than projected passengers to carry, and a smaller than expected population base to support the project. These changes are of sufficient magnitude to call into question the merits of constructing the full system at this time.

This study explores some of the changes in the Washington region's growth and activity patterns which have occurred since METRO was conceived as well as shifts in the projected costs of building and operating the system. An analysis of alternative systems is conducted to explore whether the 98-mile Adopted Regional System is the most efficient way to provide the area's public transport.

Three possible alternative rail systems are selected for examination. These are:

Alternative I - a minimum rail system of 41 miles incorporating only those segments where construction is now underway.

Alternative II - an intermediate rail system of 68 miles.

Alternative III - the 98-mile Adopted Regional System.

Considering the time and resource limitations of this preliminary study, the procedures employed in this analysis necessarily involved making some assumptions and judgements which are discussed in the body of the report. It is felt that the procedures employed were objective and reasonable, and that the results reached give rise to some serious questions about the relative merits of the 98-mile Adopted Regional System.

The results of the analysis of these three systems are shown in Table 27. These results are based on the findings of Chapter III - VI, and the reader is referred to those sections for supporting details and assumptions.

From the Table, it is clear that both capital costs and operating deficits tend to increase as the size of the rail system increase. Estimated capital costs range from $3.3 billion for the shortest rail system analyzed up to $5.5 billion for the largest alternative considered. Estimated 1990 operating deficits range from $13 million for the shortest rail alternative considered to nearly 5 times that much for the 98-mile ARS. Furthermore, these deficits assume that operating costs remain constant, in real terms, between now and 1990, an assumption which probably understates future operating costs when it is considered that real transit labor costs and real energy costs, two key inputs to urban public transportation operating costs, have risen in real terms in recent years. The deficit figures shown also reflect an assumption that fares will remain unchanged, in real terms, from now to 1990. This assumption may also understate operating deficits, since political pressures tend to inhibit increases in rapid transit fares.[1]

Table 27 does not highlight the incremental merits of expanding the METRO rail system, however. Rather, it examines the average costs, revenues, and patronage of the three alternatives. If instead we look at the additional costs and additional patronage which result from extending the system beyond the portion already under construction (i.e., beyond Alternative I), then the relative merits of extending the METRO rail system appear considerably more questionable.

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[1] *A ten cent fare in 1940 would correspond, in real terms, to a 38 cent fare in 1975 if the Bureau of Labor Statistics' Consumer Price Index is used as a basis.*

TABLE 27. SUMMARY OF ANALYSIS OF METRO RAIL ALTERNATIVES
(for the year 1990)

ALTERNATIVE	I	II	III
DESCRIPTION	Includes Portions Now Under Construction	Intermediate System	98-Mile Adopted Regional System
Length (mi.)	41	68	98
Number of Stations	46	62	82
Capital Cost ($ billions)[a]	3.294	4.358	5.500
Operating Cost ($ millions)[b]	53.5	88.8	127.9
Revenues ($ millions)[b]	40.4	53.6	64.6
Trips (millions/year)	100.1	130.2	153.0
Passengers Per Average Weekday (thousands of round trips)	175	228	268
Annual Operating Deficit[a] ($ millions)	13.1	35.2	63.3
Operating Deficit Per Trip[b]	.13	.27	.41
Capital Cost Per Average Weekday Passenger[a]	18,823	19,114	20,522

[a] *in "escalated dollars" as used WMATA.*
[b] *in 1976 dollars*

Table 28 examines the incremental operating deficits, capital costs, and patronage which are associated with building and operating the systems described here as Alternative II and Alternative III. The second column of Table 28 shows the extra operating deficits, capital costs, and patronage generated by Alternative II, assuming that Alternative I were already built and operating. Similarly, the rightmost column shows the corresponding characteristics for Alternative III on the assumption that Alternative II is already in place. The advantage of computing the costs and patronage figures on this basis is that they permit the relative performance of rail system extensions to be viewed by themselves, without the characteristics of the minimum system being averaged in. As apparent from Table 28, the operating deficit per trip for Alternative I, the minimum system, is 13 cents, while the additional deficit per additional trip implicit in Alternative II, the intermediate system, is 73 cents. Similarly, the extra trips and extra operating deficits generated by selecting Alternative III, the ARS, over Alternative II, the intermediate system, result in additional deficits per additional trip of $1.23.

It should also be noted that the primary beneficiaries of system extension, especially from Alternative II to Alternative III, tend to be areas with considerably higher than average income.

It is difficult to estimate what impacts the smaller rail system might have on automobile traffic and bus volumes. One plausible set of assumptions set out in the report suggests that the increase in traffic caused by going from Alterative III to Alternative I is under two percent, equivalent to about a third of a year's growth at recent traffic growth rates. The corresponding effect on bus operations is estimated to be an increase in patronage of about three percent. The effect of curtailment on rail system costs and operations appears likely to outweigh the adverse impacts created on other modes.

The specific network alternatives analyzed here are preliminary: detailed design considerations and local transportation and development policies would undoubtedly require considerable revision of such network concepts to make them

TABLE 28. INCREMENTAL EFFECTS OF RAIL SYSTEM EXPANSION BEYOND PORTIONS NOW UNDER CONSTRUCTION

(for the year 1990)

		Increment on which characteristics are computed	
	Alternative I (minimal system)	Alternative I to Alternative II	Alternative II to Alternative III
Additional Capital Cost ($ billions)[a]	3.294	1.064	1.142
Additional Operating Deficit ($ millions)[b]	13.1	22.1	28.1
Additional Trips (millions/year)	100.1	30.1	22.8
Additional Passengers Per Average Weekday (thousands of roundtrips)	175	53	40
Incremental Operating Deficit per Trip[b]	.13	.73	1.23
Incremental Capital Cost per Average Weekday Passenger[a]	18,823	20,075	28,550

[a] *in "escalated dollars" as used by WMATA*

[b] *in 1976 dollars*

fully acceptable. However, the results of this analysis suggest that alternative rail networks with less mileage than the Adopted Regional System could produce comparable net benefits for a lesser amount of public resource commitment.

SUPPLEMENT

CONCLUSIONS OF THE ADVISORY PANEL

CONCLUSIONS OF THE ADVISORY PANEL

An advisory panel was assembled for the study reported above. Its purpose was to suggest questions which the study should address as well as to recommend procedures for answering them. This panel met on two occasions during the course of the study to discuss findings and to review draft sections of the report. In view of the preliminary evaluation of METRO rail systems set out in the attached report, the advisory panel feels that the following conclusions are justified.

1) Enough serious questions currently exist concerning the relative merits of the 98-mile METRO rail system to warrant a thorough alternatives analysis prior to proceeding to construct new segments of that system. Any further federal project approvals should be premised upon this careful alternatives analysis. In our view, simply requiring that new projects represent "operable segments" as called for in the recent Federal Budget may not provide adequate assurance that the fraction of the system thus built will reflect reasonable overall transport priorities. We understand that deferring further decisions on new METRO rail construction may lead to delays in construction of some system segments, but do not feel that substantial hardship would be created by delaying further construction by six to nine months, while the benefits to the rail system which finally emerge could be considerable. In essence, it is a question of whether rational priorities or fiscal constraints whose implications are poorly understood will dictate the final design of METRO. In our judgement, the potential gains of a systematic approach more than outweigh the cost and inconvenience of the associated delay. Of special concern in this regard is the Addison Road Branch which is just now entering the construction contract stage.

   The alternatives analysis recommended here should be conducted in greater depth than that consonant with the resource limitations of the investigation presented in the preceding report. It is also essential that the alternatives analysis be undertaken with more objective oversight than has characterized previous Washington Metropolitan Area Transit Commission Net Income Analyses.

Part of this analysis should be an objective and thorough review of the expected costs of operating alternative METRO rail systems and the revenues likely to be produced by them. This review should identify the fare levels needed for break-even operations of bus and rail services. Recognizing that political prerogatives tend to inhibit fare increases, this examination should also identify the subsidy requirements if fares remain unchanged at current levels.

2) Upon completion of the alternatives analysis, there would be a sounder basis for determining what the future federal posture with respect to METRO should be. At that point, an indication of the total federal commitment to METRO could be made and state and local jurisdictions could re-evaluate their system plans and financial arrangements accordingly.

3) In preparation for this reassessment, regional and local planning agencies should intensively review the developmental pressures that are likely to accompany METRO rail system expansion, as well as the level of development required to make METRO service a reasonable public investment. This review should address parking and commercial and residential development, and should indicate the compatibility of the level of development thus projected with local planning objectives and zoning regulations.

4) In light of the much greater involvement of public funds that have been and seem likely to be needed in order to construct and operate the METRO rail system, especially those which are of federal origin, a more careful determination should also be made of the amount and incidence of expected non-farebox benefits and unrecoupable costs of

METRO rail throughout the Washington metropolitan area. Such a determination should take into consideration the trip types and user groups who would be the chief beneficiaries of METRO and should identify them on a jurisdictional basis, as well as developmental, environmental, and other non-user benefits stemming from METRO rail service. The cooperative forecasting process now underway at the Council of Governments forms a logical starting point for such an examination, and COG may be the appropriate agency to conduct it.

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