LRT

Metropolitan Council
OF THE TWIN CITIES AREA

Hiawatha Avenue Corridor

Light Rail Transit Feasibility Study

April 1981

LIGHT RAIL TRANSIT FEASIBILITY

IN THE

HIAWATHA AVENUE CORRIDOR

Prepared For:

City of Minneapolis
Minnesota Department of Transportation
Hiawatha Avenue Task Force

As Input To:

The Metropolitan Council's

LIGHT RAIL TRANSIT FEASIBILITY STUDY

Prepared By:

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March 16, 1981

FOREWORD

BRW, working for the City of Minneapolis and the Minnesota Department of Transportation, started the Hiawatha Avenue Location and Design Study in the fall of 1979. The purpose of the study is to complete a detailed analysis of transportation alternatives and to assist the Hiawatha Avenue Task Force in identifying the most appropriate solution for recommendation to the Minneapolis City Council after considering all factors. In the summer of 1980, Sanders and Thomas was retained by the Metropolitan Council to complete a Regional LRT Feasibility Study. The scope of the study, the time schedule, and the budget were considerably less than the Hiawatha Study.

The Metropolitan Council agreed to include the results of the Hiawatha Avenue Study with the Regional Study. In order to present comparable data for Hiawatha and the four corridors being studied in the Regional LRT Study, the methodology used in the Regional Study was duplicated. Thus, unit costs, assumptions, methodology, approach, etc. are directly comparable. In many cases more detailed data or a different methodology was being used in the Hiawatha Study; however, in all cases, similarity to the Regional Study was preserved. Thus, when BRW completes the analysis of transportation alternatives for the Hiawatha Avenue Location and Design Study Reports, some differences in findings may result.

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SUMMARY

The Regional Light Rail Transit (LRT) Feasibility Study, being conducted by the Metropolitan Council, has eight overall objectives. Summarized below are characteristics of the LRT Alternative and the All Bus Alternative in the Hiawatha Corridor as related to seven of the objectives. The eighth objective is "to identify the conditions necessary for LRT to be feasible in the Metropolitan Area;" obviously, the Metropolitan Council will address that study objective.

ITEM		LRT ALTERNATIVE	ALL BUS ALTERNATIVE
Operational Characteristics			
• Express Length		7.55 miles	N/A
• Hours of Service		5:00 AM-1:00 AM	5:00 AM-1:00 AM
• Peak Period Headways		5 minutes	5 minutes
• Average Travel Speed		17.8 mph	12 mph
• Average Stop Spacing in Corridor		LRT: 0.6 miles Feeder Bus: 1 block	1 block
Ridership			
• Annual	LRT	7,539,000	-
	Local Bus	7,657,000	12,987,000
	Total	15,196,000	12,987,000
• Daily	LRT	25,600	-
	Local	26,000	44,100
	Total	51,600	44,100
• % Total Corridor Travel via Transit:	LRT	3.1%	-
	Local Bus	3.1%	5.3%
	Total	6.2%	5.3%
• % Transit in Corridot Via:	LRT	50%	-
	Local Bus	50%	100%
	Total	100%	100%
Impact on Urban Development			
• Population		8,000 to 16,000 greater	No measurable impact due to transportation improvements.
• Employment		5,700 to 6,400 greater	No measurable impact due to transportation improvements.
• Base Corridor Development (1990-2000)		1,809 acres	1,809 acres

ITEM	LRT ALTERNATIVE	ALL BUS ALTERNATIVE
• Additional Transit Induced Development	340 acres	No measurable impact due to transportation improvements.

Energy

- Annual Consumption (million BTU's)

LRT/Feeder Bus System	72,033	-
Local Bus System	53,895	120,422
Additional Auto Travel	-	23,759
Total	125,928	144,181

- Annual Petroleum Fuel Consumption (gallons)

Feeder Bus System	183,000	-
Local Bus System	388,000	868,000
Additional Auto Travel	-	190,000
Total	571,000	1,058,000

• Efficiency	8,300 BTU's/ passenger carried	9,500 BTU's/ passenger carried

Environment

- Annual Air Pollution Burden (000's lb.)

LRT/Feeder Bus System	260	-
Local Bus System	130	229
Additional Auto Travel	-	492
Total	390	721

• Air Quality Impact	Minimizes air quality impacts within the corridor.	Produces significant amounts of carbon monoxide and hydrocarbons in metropolitan area, aggravating already critical problems
Interface of LRT with Other Transportation Systems	The nature of LRT and of the service proposed in Hiawatha corridor (frequent stops and park and ride lots) make it fully compatible with in place transportation facilities	-

ITEM	LRT ALTERNATIVE	ALL BUS ALTERNATIVE
Capital and Operating Costs		
• Construction Cost ($ million)	$ 79.5	none
• Capital Cost ($ million)		
LRT/Feeder Bus System	$ 102.7	$ -
Local Bus System	15.8	29.8
Total	$ 118.5	$ 29.8
• Capital Cost/Route Mile ($ million)	$ 13.6	N/A
• Annualized Capital Cost ($ million)		
LRT/Feeder Bus Sytem	$ 10.0	$ -
Local Bus System	2.1	3.9
Total	$ 12.1	$ 3.9
• Annual Operating and Maintenance Cost ($ million)		
LRT	$ 1.3	$ -
Feeder Bus System	1.7	-
Subtotal	3.0	-
Local Bus System	3.6	7.4
Total	$ 6.6	$ 7.4
• Annual Revenue ($ million)		
LRT/Feeder Bus System	$ 3.8	$ -
Local Bus System	3.8	6.5
Total	$ 7.6	$ 6.5
• Annual Surplus (Deficit) Without Capital Cost ($ million)		
LRT/Feeder Bus System	$ 0.8	$ -
Local Bus System	0.2	(1.0)
Total	$ 1.0	$ (1.0)
• Annual Surplus (Deficit) With Capital Cost ($ million)		
LRT/Feeder Bus System	$ (9.3)	$ -
Local Bus System	(1.9)	(4.9)
Total	$ (11.2)	(4.9)

ITEM	LRT ALTERNATIVE	ALL BUS ALTERNATIVE
Performance Measures		
• Operating Surplus (Deficit) per Passenger	$ 0.063	$(0.073)
• Surplus (Deficit) per Passenger	$ (0.734)	$(0.376)
• O & M Cost/Passenger Carried		
LRT	$ 0.175	-
Feeder Bus	$ 0.482	-
Local Bus	$ 0.473	$ 0.573
Composite	$ 0.437	$ 0.573

Hiawatha Avenue Task Force Comments

In reviewing this report, the Hiawatha Avenue Task Force (HATF) expressed concern that the analysis was extremely numerically oriented, while many of the benefits and impacts are not subject to numerical analysis. Therefore, the HATF offered the following additional comments:

- LRT offers an advantage in that it provides a transportation system that is less vulnerable to petroleum supply shortfalls or rationing.

- LRT would be of great benefit in servicing the HHH Metrodome; this ridership has not been included in the revenue projections.

- The neighborhood surrounding the Hiawatha corridor have pockets that are subject to potential deterioration; LRT could be a positive force in preserving these neighborhoods and in stimulating new development.

- One of the key elements in the comparison of the LRT Alternative and the All Bus Alternative is whether the lower operating cost over the life of the system justifies the additional capital investment required to build LRT. In performing this analysis, the uncertainty of cost elements associated with bus operation (e.g. cost of diesel fuel, labor costs, costd of buses, etc.) must be taken into account.

- This facility, and the new development which it would encourage, offer an opportunity to provide an attractive, modernizing influence on an old city fabric.

- Independent contacts with transit agencies in other cities which are building LRT indicate that some of the unit costs may be high.

- The final report to the State Legislature should include a complete cost-effectiveness analysis, including the impact of inflation.

INTRODUCTION

Background

The Metropolitan Council is currently conducting a study to determine the feasibility of light rail transit (LRT) in the Twin Cities metropolitan area. The study was ordered by the Minnesota State Legislature and will assist the Metropolitan Council in its review of the Transportation Policy Plan.

In the Regional LRT Study, the concept of "feasibility" is presented as follows:

> "Feasibility, for purposes of this study, is defined as the capability of LRT to be carried out, as well as used and dealt with successfully in comparision with other transit alternatives and its ability to facilitate the attainment of regional transportation goals.
>
> "The capability of LRT to be carried out can be equated to the reasonableness of implementing an LRT line from a technical, economic, institutional and financial standpoint. The 'capability to be used or dealt with' refers to the potential of an LRT line to be operated and used successfully."

The methodology used to assess LRT feasibility is a comparison of an LRT line serving a corridor with another type of transit alternative serving that corridor. Four corridors were selected for analysis in the Regional Study using a three stage procedure described in that study. The four corridors are :

- Minneapolis West/Southwest
- Minneapolis Northwest
- St. Paul West-Minneapolis East
- St. Paul Northeast

The Hiawatha Avenue corridor was not considered a candidate for analysis in the Regional Study because the Hiawatha Avenue Location and Design Study, which includes analysis of an LRT alternative, is being conducted concurrently. Inclusion would have resulted in a duplication of effort. In order to present as complete a picture as possible of LRT feasibility, however, the Metropolitan Council will present to the State Legislature a parallel analysis of the Hiawatha Avenue corridor along with the analysis of the other corridors. The purpose of this report is to present the analysis of the Hiawatha corridor.

It is imperative that it be understood that the Hiawatha Avenue Task Force (HATF), which has been charged by the Minneapolis City Council with the responsibility of recommending a transportation solution for the Hiawatha Corridor, has made no decision or judgment regarding light rail transit or any other transit improvement alternative in the corridor. Portions of the analysis conducted for the Hiawatha Avenue Location and Design Study are presented here to assist the Metropolitan Council in assessing the feasibility of light rail transit in the Twin Cities metropolitan area.

Hiawatha Avenue Corridor

Hiawatha Avenue (Minnesota Trunk Highway 55) is an at-grade arterial which is located in the south part of Minneapolis and connects downtown Minneapolis with the International Airport. Hiawatha Avenue serves trips to and from the airport, trips oriented to the residential areas through which it passes, and some through travel on TH 55. (See Figure 1)

The Hiawatha Avenue Location and Design Study is the most recent of a long history of efforts to identify an acceptable solution in the Hiawatha Corridor which will meet future area transportation needs and serve the neighborhoods through which Hiawatha Avenue passes.

The Minnesota Department of Transportation and the City of Minneapolis have joined together to manage this study. The Minneapolis City Council created the Hiawatha Avenue Task Force (HATF) and gave it the authority and the responsibility to recommend a transportation implementation plan for the Hiawatha Corridor to the Mayor and City Council. HATF is made up of representatives of neighborhood planning districts, business and labor.

A second committee was also formed, the Hiawatha Avenue Technical Committee (HATC). This committee is composed of staff representatives of federal, state, metropolitan, and local agencies which will review or approve actions proposed for the corridor. This committee was formed to give input to HATF regarding concerns of the represented agencies and to review all HATF actions as they are made for consistency with agency policies and regulations. Represented agencies include:

- Metropolitan Council
- Hennepin County Department of Transportation
- Transportation Advisory Board
- Metropolitan Transit Commission
- Minnesota Energy Agency
- Metropolitan Airport Commission
- City of Bloomington
- University of Minnesota
- Federal Highway Administration
- Urban Mass Transportation Administration
- Minnesota Pollution Control Agency
- Minneapolis Park and Recreation Board

The objective of the Hiawatha Avenue Location and Design Study is to develop a solution for upgrading Hiawatha Avenue which effectively responds to:

- Roadway and transit needs
- Socio-economic and environmental needs
- Needs/concerns/objectives/policies of all affected residents, business persons, institutions, and agencies.

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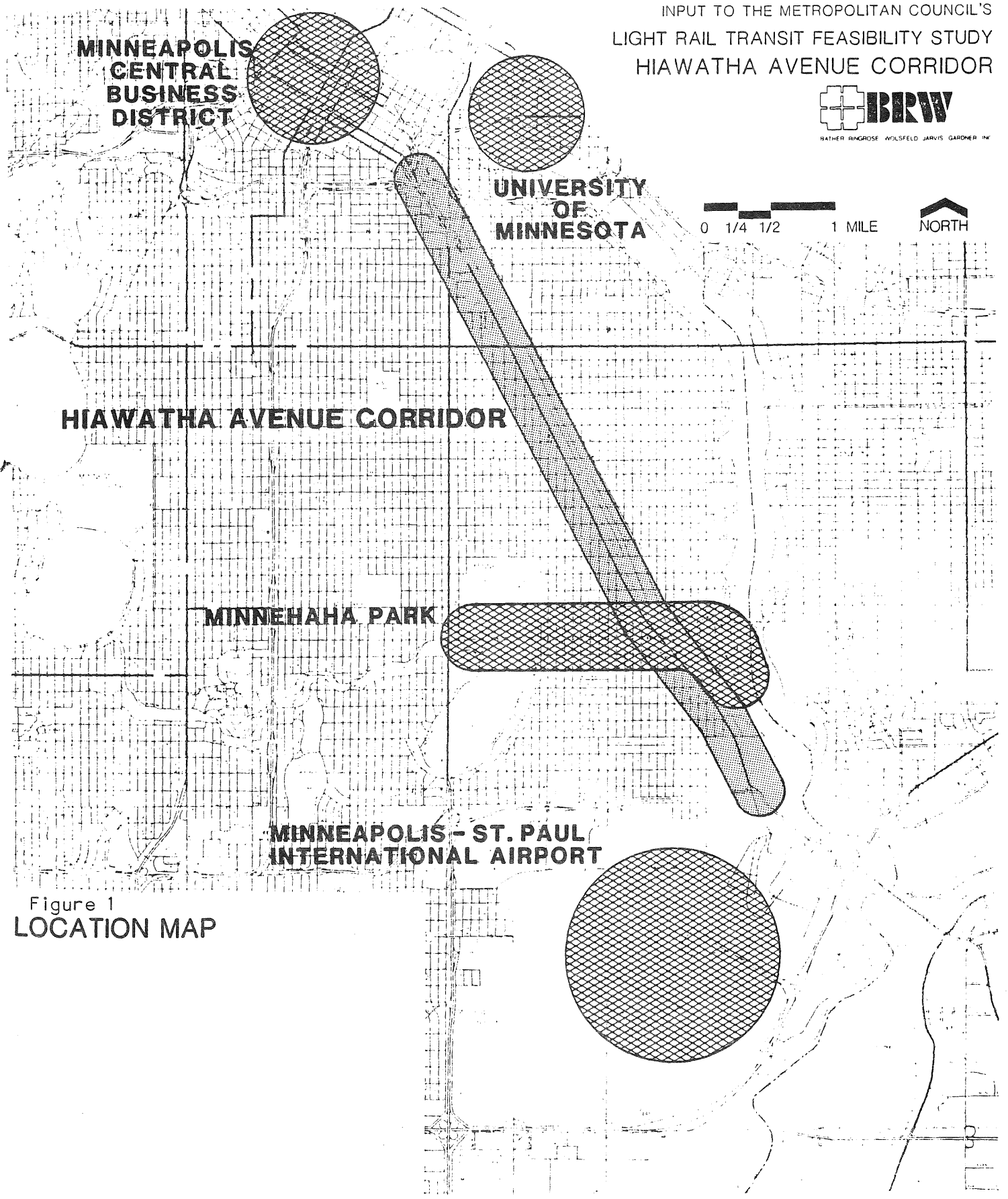

Figure 1
LOCATION MAP

The HATF has met regularly since November, 1979 to discuss issues and alternatives relevant to the Hiawatha Avenue Study. The HATF has identified issues critical to the study and alternatives most able to address these issues. The HATC has met to review HATF's activities and has found them consistent with their respective agency's policies and regulations.

The one possible exception to the above statement concerning consistency with agency policies is the light rail transit (LRT) alternative and the Metropolitan Council's policy opposing a regional fixed guideway transit system for the Twin Cities Metropolitan Area. HATF was specifically directed to consider LRT by the Minnespolis City Council resolution which created the Task Force; the Commissioner of the Minnesota Department of Transportation also believed that LRT should be considered as one of the transit alternatives. In addition, the Metropolitan Council is currently reviewing its policy relative to fixed guideway transit as part of the review of its entire Transportation Policy.

Alternatives Considered

The Hiawatha Corridor Location and Design Study is currently analyzing the following five transit alternatives for applicability to the corridor:

- Improved bus system
- H.O.V. lanes at-grade
- H.O.V. lanes grade separated
- LRT
- Maintain existing bus system

The Scoping Process, completed in June, 1980, reduced the original 120 discrete transit/roadway alternatives to the above listed transit options, each in combination with a four-lane, divided at-grade arterial with signalized intersections at approximately one-half mile spacing. Thus, the only roadway alternatives currently being studied are the four lane arterial and the no-build.

The "LRT" and "Improved Bus System" alternatives will be compared for input to the Regional LRT Feasibility Study. The reasons for selecting the bus alternative for comparison to LRT are 1) that better data is available and 2) that for any alternative to be feasible it be more cost-effective than the bus system.

Objectives of Hiawatha Avenue Location and Design Study

The HATF, after consideration of stated policies and goals of regional, municipal and neighborhood organizations, formulated a listing of project goals and objectives which has guided their decision making. The complete list of goals and objectives includes 33 statements grouped within categories of Transportation, Land Use, Energy and Environment.

Given below are five general objective statements which, although lacking in the detail contained in the complete list of goals and objectives, express the intent of the Hiawatha Avenue Task Force.

Objective 1 - COORDINATION OF DEVELOPMENT AND TRANSPORTATION SERVICE

The HATF feels that close attention must be given to the coordination of the planning for the transportation alternatives and the development and redevelopment plans for the area. The transportation alternative in the corridor must be chosen to support the desired development.

Objective 2 - REASONABLE CAPITAL COST

The HATF recognizes that a serious shortage of funds for roadway and transit capital improvements exists at this time, and that this shortage will probably continue for the foreseeable future. The HATF will look for low cost alternatives which meet the basic needs of the corridor. The Hiawatha Avenue corridor clearly needs improvement, and seeking a level of improvement for which funding will never be available could result in no improvement at all.

Objective 3 - PREFERENCE TO RIDE-SHARERS AND TRANSIT RIDERS

If a conflict exists between improving transportation service for single occupant vehicles and improving transportation service for ride-sharers and transit riders, the latter should have priority. The HATF feels that this ordering of priorities will result in a more efficient transportation system, a stronger metropolitan center, the conservation of and a decrease in dependence on petroleum products, and a reduction in the adverse air quality, noise and aesthetic impacts associated with a transportation system.

Objective 4 - NEIGHBORHOOD ACCESSIBILITY

The transportation facility placed in the Hiawatha Corridor should be available for use by people living in the neighborhood through which it passes, and should not separate segments of those neighborhoods from each other.

Objective 5 - PRESERVE AND ENHANCE EXISTING PARKS AND HISTORIC SITES

Every reasonable precaution should be taken to avoid adverse impact on parks and historic sites in the corridor. Every reasonable effort should be made to utilize implementation of this project to improve the parks and historic sites in the corridor.

Review of Regional LRT Study Assumptions

The Regional LRT Study made many assumptions for the purpose of the comparison of alternatives. Within this section, these assumptions will be reviewed for consistency with Hiawatha Avenue Location and Design Study objectives and findings, and for applicability in the Hiawatha Avenue Corridor. Some differences are expected due to differences in the intents of the two studies. One is a regional feasibility analysis and the other is analysis of a specific corridor. For each assumption, a determination is presented which describes the use or modified use of the assumption within the Hiawatha Avenue corridor analysis.

Assumption	Determination
There will be no catastrophic cut-off of external petroleum supplies (p.7).[1/]	COMMENT. Agree to use this assumption, however, this is an impossible situation to predict. The viability of LRT, however, should not rely on this occurrence.
There will be no widespread breakthrough in alternative automobile power technology (p. 7).	COMMENT. Agree to use assumption for same reason as above.
There will be no major changes in the highway network or metro center parking capacity other than what is currently under construction (p. 7).	COMMENT. Changes expected, however, will not significantly affect this analysis.
Self-service fare collection will be employed on the LRT line (p. 8).	AGREE
(The following are assumptions made in the sketch planning model use for LRT patronage estimates for preliminary alignment selection:)	
Express line (LRT) headway of 3.0 minutes for use in the preliminary alignment selection (p.11).	NOT APPLICABLE.
Express transit speed of 25 mph on exclusive ROW and 15 mph for on-street operations for use in the preliminary alignment selection (p. 11).	NOT APPLICABLE.
Same fare assumptions for all corridors (p. 11).	AGREE.
Walking distances up to 1/2 mile (p. 11).	AGREE
Circuity factors of 1.35 for local transit and 1.10 for express transit (p. 11).	AGREE

1/ Location of assumption in the original draft report prepared by Sanders and Thomas.

Assumption	Determination
Same auto operating costs for all corridors (p. 11).	AGREE
Local transit speed of 12 mph (p. 11).	AGREE
Costs in 1980 dollars (p. 16).	AGREE
Vehicle costs based on recent bids for the Boeing Standard Light Rail Vehicle (p. 16).	AGREE
Operating costs based on Light Rail Transit, A State of the Art Review, US DOT, 1976 (p. 16).	AGREE
The infrastructure for the non-LRT system in the TH12 corridor will be built in either case (p. 16).	NOT APPLICABLE
Electrical power for LRT will be 100 percent coal produced (p. 17).	AGREE
Most automobiles will be gasoline powered (p. 17).	AGREE
Automobile fleets will have a ten-year lifespan (p. 17).	AGREE
Automobile efficiencies will continue to improve past the end of current guidelines in 1985 (p. 17).	AGREE
An LRT line would be built and operating January 1, 1990, with no speculative LRT-induced development preceding that date (p. 19).	AGREE
Only one LRT line would be constructed, that one being the particular alignment being studied at the time (p. 19).	COMMENT. This requires allocation of total cost of downtown distribution system to each corridor when it could serve more than one. Also, the Downtown Council has stated that if only one corridor is served by LRT, the line should not penetrate the CBD.
LRT-induced land use impacts would occur during the decade 1990 to 2000 (p. 19).	AGREE
No measurable LRT-induced land use impacts would occur within either the Minneapolis or St. Paul CBD (p. 19).	COMMENT. If LRT were deployed, measurable LRT-induced land use impacts would result in the CBD.

Assumption	Determination
Prevailing subregional land development patterns would continue through the end of the century (p. 19).	AGREE
The Metropolitan Council's development framework and individual community comprehensive plans would not be dramatically revised before the year 2000 (p. 19).	COMMENT. Dramatic should mean more than 20%.
Local zoning codes and density allowances would not be changed drastically before the year 2000 (p. 19).	COMMENT. Drastic should mean more than 20%.
The only land use impacts considered would be direct consequences of LRT development (The study does not consider indirect and fiscal impacts.) (p. 19)	AGREE
The Metropolitan Council data base accurately projects development growth in the subregion (p. 20).	COMMENT. Agree if amended to include 115,000 jobs in the Minneapolis CBD and given that LRT is not deployed
The analysis of land along the West alignment (TH 12) assumes adoption of the proposed I-394 route alignment changes (p. 20).	DOES NOT APPLY
LRT will have signal preemption capability at 50 percent of all signalized intersections when operating on city streets. With signal preemption the LRT operator will be able to change the traffic signal in his favor (p. III-2).	AGREE
When LRT operates on city streets it will be physically separated from automotive traffic through the use of low concrete medians, railings, plantings, or the like. This will minimize traffic conflicts and help improve LRT operating speed (p.-III-2).	AGREE
LRT will operate seven days a week including holidays. Weekday and Saturday operations will begin at 5:00 AM and continue until 1:00 AM. On Sundays and holidays service will begin at 7:00 AM and continue until 11:00 PM (p. III-2).	AGREE

Assumption	Determination
Capital Costs $150,000 per bus (12 year life) Maintenance facility @ $43,560/bus Overhaul facility @ $11,660/bus (p. III-3)	AGREE
For operations the pollutant impacts of an LRT system are based on the amount of electrical energy consumed, and, for the non-LRT alternative, on the gallons of gasoline or diesel fuel consumed by the additional cars and buses that would be needed if no LRT existed (p. III-4).	AGREE

LRT ALTERNATIVE - HIAWATHA CORRIDOR

Alignment and Stop Locations

The general alignment of the Hiawatha Corridor and the LRT Stop locations are shown in Figure 2. Stop #1 is a layover high platform stop at the terminal end of the 5th and 6th Streets one-way LRT loop. Stops #2i, #3i and #4i are inbound stops on 5th Street; stops #2o, #3o and #4o are outbound stops on 6th Street. Stops #2 through #4 are operationally the same as stops located in the two-way LRT alignment. Stop #5 is located north of the Hubert H. Humphrey Metrodome and could serve as a transfer station to Washington Avenue/University Avenue transit service. Stops #6, #8, and #12 are high-level platform stops and would have characteristics similar to an LRT Station in order to accommodate pedestrian access adequately. High-level platform stops are those which have platforms at the same level as the floor of the LRT vehicle. All stops other than the four listed above (#1, #6, #8, & 12) would be low-level stops. These would consist of a curb height platform (8" $\pm$ above grade). In addition, there would be a small section of high-level platform accessible by ramp for use by the elderly and handicapped. Within the Minneapolis downtown, LRT stops are located about every three blocks (1200' $\pm$). In the Hiawatha Corridor, stops are located about 0.6 mile apart.

The total length of the LRT alignment is 7.55 miles or 39,860 feet of double track system. Each end of the alignment will have a loop for turning LRT vehicles around. The yards and shops could be located at existing CMStP&P R.R. diesel engine refueling yards between Cedar and Hiawatha Avenues just south of I-94.

In the corridor, at-grade street crossings would be protected by automatically actuated signals, signs, and gate arms. The crossing protection would be interconnected with the Hiawatha Avenue traffic signals in order to allow non-conflicting traffic movements to continue. Minor streets on the west side of Hiawatha would be closed. With some exceptions, this LRT alignment is at-grade open track with simple stops. This is the simplest, most uncomplicated LRT system that can be designed.

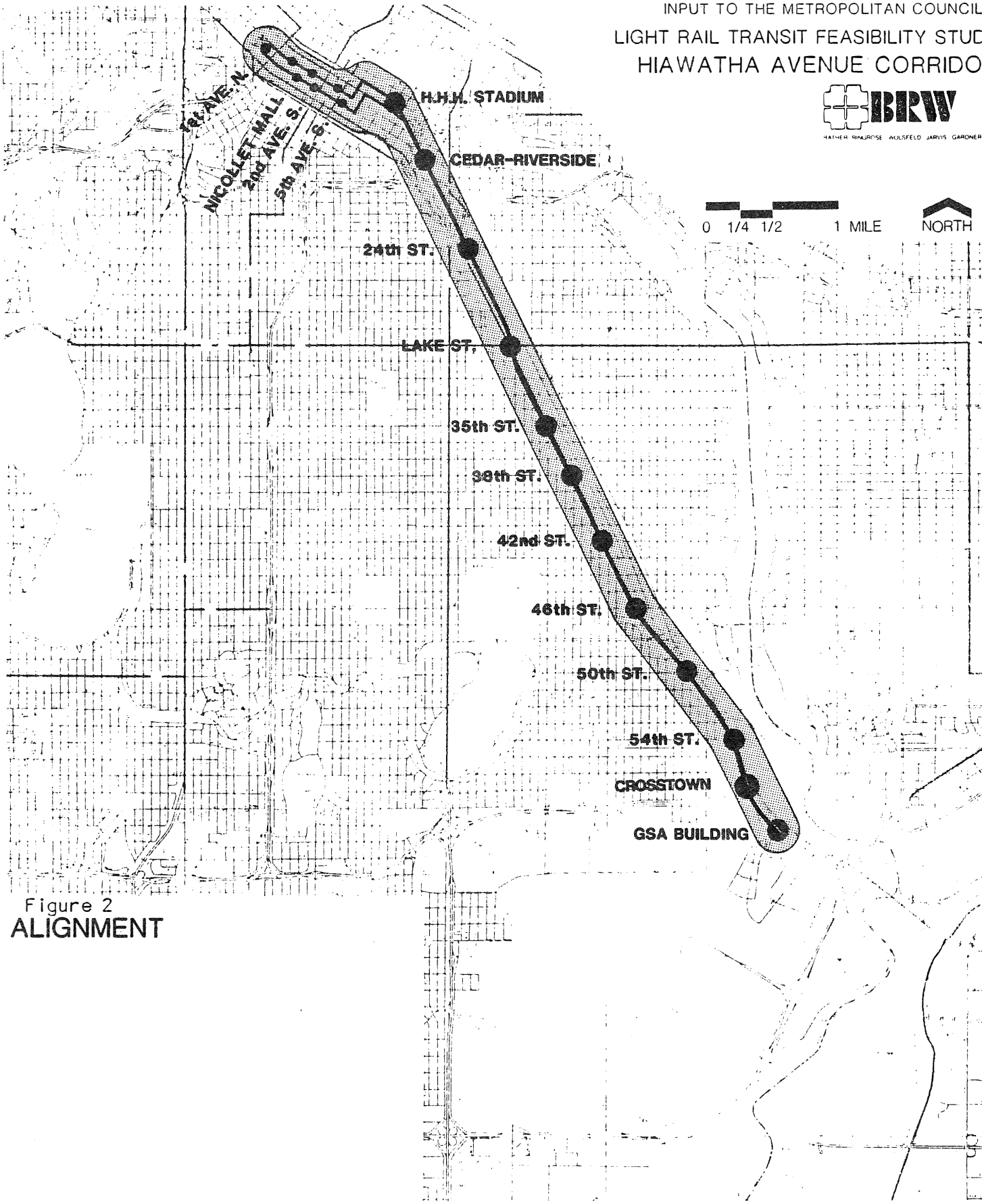

Figure 2
ALIGNMENT

TABLE 1

PROPOSED LRT STOPS - HIAWATHA CORRIDOR

STOP		LOCATION
*1.	1st Avenue N.	- 1st Avenue N. between 5th & 6th Streets
2i.	Nicollet (inbound)	- N.W. corner of Nicollet & 5th St.
2o.	Nicollet (outbound)	- S.E. corner of Nicollet & 6th St.
3i.	2nd Avenue S. (inbound)	- N.W. corner of 2nd Avenue S. & 5th St.
3o.	2nd Avenue S. (outbound)	- S.E. corner of 2nd Avenue S. & 6th St.
4i.	5th Avenue S. (inbound)	- N.W. corner of 5th Avenue S. & 5th St.
4o.	5th Avenue S. (outbound)	- S.E. corner of 5th Avenue S. & 6th St.
5.	Stadium	- Between 3rd Street & 4th Street at 9th Avenue S.
*6.	Cedar/Riverside	- West side of C.M.St.P.&P. R.R. at 16th Avenue S.
7.	24th Street	- East side of Hiawatha Avenue at 24th St.
*8.	Lake Street	- Lake St. and Hiawatha Avenue intersection
9.	35th Street	- West side of Hiawatha Avenue at 35th St.
10.	38th Street	- West side of Hiawatha Avenue at 38th St.
11.	42nd Street	- West side of Hiawatha Avenue at 42nd St.
*12.	46th Street	- West side of Hiawatha Avenue at 46th St.
13.	Minnehaha Park	- West side of Hiawatha Avenue at 50th St.
14.	V.A. Hospital	- West side of Minnehaha at 54th St.
15.	Crosstown Park & Ride	- East side of Minnehaha Avenue at 57th St.
16.	G.S.A.	- East side of Minnehaha Avenue at G.S.A. Building

* High-platform stations; all other locations are simple stops.

Operating Characteristics

Transit Operating Plan

The operating plan for the LRT consists of a 20-hour service day (5:00 AM to 1:00 AM) six days a week and a 16-hour service day (7:00 AM to 11:00 PM) on Sundays and holidays. The frequency of service during the weekdays is geared to commuter travel for work and has short waiting times (headways) between vehicles during the AM and PM peak travel periods. Table 2 shows the schedule of the LRT in the Hiawatha corridor.

This plan is further detailed in Table 3 which shows the schedule of a typical run during a weekday PM peak period from downtown to the GSA building. This detailed schedule is important since the entire system is designed and operated on the basis of peak period demands. During the peak hour, the total running time of 25.4 minutes is governed basically by the number and length of stops made. It takes less than 14 minutes to travel the entire line, but it takes an additional twelve minutes to load and unload passengers and slow or accelerate the vehicle for each stop. During non-peak hours the service frequency is governed by policy and not necessarily by ridership demand.

A supporting bus system will complement service by LRT in two ways. Buses will pick up and distribute LRT users in areas too far from the LRT stations to allow pedestrian access. Buses will also be used to provide transit service between areas which cannot be satisfactorily served by the combination of LRT and feeder bus service.

Vehicle Miles

The total miles covered by the entire LRT fleet during a year is a measure of the cost of operating and maintaining the system. The total annual vehicle miles traveled is 468,800 which consists of 453,800 revenue passenger miles and 15,000 in non-revenue (dead-head) miles.

Ridership Forecasts

The Metropolitan Council estimates that the LRT would serve about 25,600 passenger trips per average weekday. This is over 3 percent of the total person travel in the Hiawatha Avenue influence area (Table 4). Figure 3 shows the one-way ridership at each point along the alignment. The heaviest loading would occur near the downtown stadium. Ridership at that point will be 17,000 passengers per day (total, two directions).

During the morning peak hour, about 2,200 passengers will pass that peak load point. During the afternoon peak hour, about 2,400 passengers will pass that peak load point.

TABLE 2

OPERATING HEADWAYS - HIAWATHA CORRIDOR

Day of Week	Frequency of Services in Minutes			
	5	15	30	60
Week Days	7 AM-9 AM 4 PM-6 PM	5 AM-7 AM 9 AM-4 PM 6 PM-1 AM		
Saturdays			5 AM-1 AM	
Sundays				7 AM-11 PM
Holidays				7 AM-11 PM

TABLE 3

LRT - SCHEDULE, SPEED, TIME AND DISTANCE
HIAWATHA CORRIDOR

Station/Stop	Distance Miles/Feet	Scheduled Speed (MPH)	Running Time (Sec.)	Dwell Time (Sec.)	Cumulative Distance (Miles/Feet)	Cumulative Time* (Sec/Minutes)
1. 1st Avenue N.				0	0/0	0/0
	0.23/1210	7.6	48			
2. Nicollet				61	0.23/1210	48/0.8
	0.16/840	6.0	34			
3. 2nd Avenue				36	0.39/2050	143/2.4
	0.23/1220	10.4	44			
4. 5th Avenue				20	0.62/3270	223/3.7
	0.49/2595	19.7	70			
5. Stadium				17	1.11/5865	313/52
	0.59/3100	24.0	71			
6. Cedar/Riverside				57	1.70/8965	401/6.7
	0.65/3450	17.4	78			
7. Seward/Phillips				32	2.35/12,415	536/8.9
	0.83/4395	19.7	120			
8. Lake				67	3.18/16,810	688/11.5
	0.67/3535	16.6	78			
9. 35th Street				42	3.85/20,345	833/13.9
	0.42/2215	15.0	59			
10. 38th Street				44	4.27/22,560	934/15.6
	0.56/2950	18.0	68			
11. 42nd St.				35	4.83/25,510	1046/17.4
	0.56/2950	19.5	68			
12. 46th St.				21	5.39/28,460	1149/19.2
	0.66/3505	24.1	78			
13. Minnehaha Park				23	6.05/31,965	1248/20.8
	0.60/3190	23.9	72			
14. V.A. Hospital				35	6.66/35,155	1343/22.4
	0.52/2745	18.7	65			
15. Crosstown				25	7.18/37,900	1443/24.0
	0.37/1960	16.7	55			
16. G.S.A.				0	7.55/39,860	1523/25.4

17.8 mph Average Speed

* From Stop 1 departure to arrival at indicated stop.

TABLE 4

YEAR 2000 TRAVEL BY MODE - LRT ALTERNATIVE

Mode	Daily Person Trips			Percent of Total		
Auto Drivers			477,700			57.7%
Auto Passengers			299,000			36.1%
Transit						
LRT						
Downtown	13,300			1.6%		
Non-Downtown	12,300			1.5%		
Total LRT		25,600			3.1%	
Local Bus						
Downtown	4,000			0.5%		
Non-Downtown	22,000			2.6%		
Total Local Bus		26,000			3.1%	
Total Transit			51,600			6.2%
TOTAL TRIPS			828,300			100.0%

NOTE: The patronage estimate of 25,600 prepared by the Metropolitan Council, is based on 6 minute headways and a 15 mph average travel speed. The operating plan and costs are based on 5 minute headways and a 17.8 mph average travel speed. Thus the patronage is slightly understated.

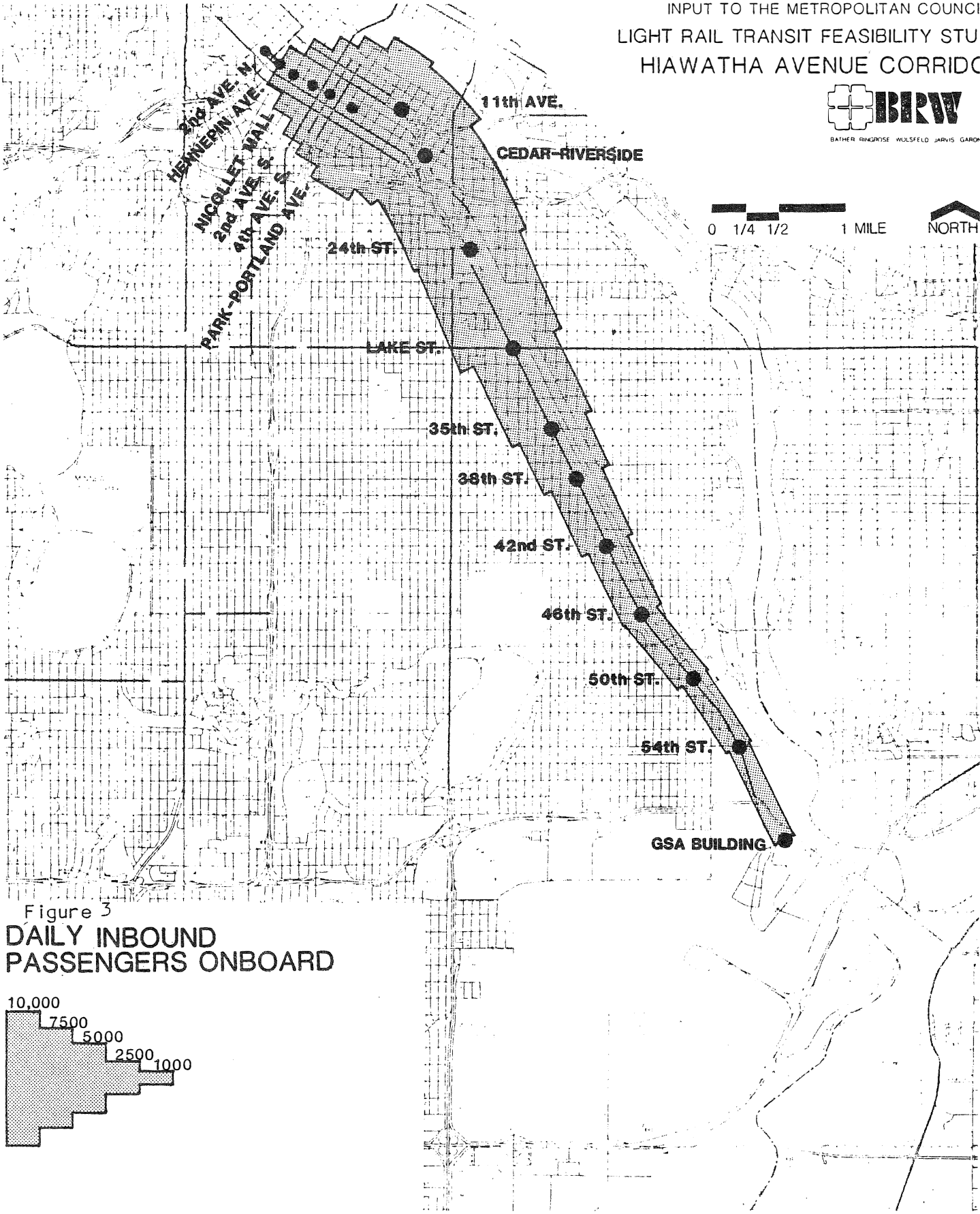

Figure 3

DAILY INBOUND PASSENGERS ONBOARD

Capital Cost and Revenue Characteristics

Capital Cost

The estimated capital cost of the Hiawatha LRT project is $95,149,000 in 1980 dollars or approximately $12.6 million per route mile. This project capital cost includes the LRT system, vehicles, right-of-way and parking. These project capital costs are shown in Table 5. The LRT guidance system construction cost is $79.5 million or about $10.5 million per route mile; this cost includes all costs to build the guidance system and includes 10% for engineering and mobilization and a 15% contingency. Each element of the project cost is discussed below.

- Right-of-Way Acquisition

  Most of the right-of-way needed in the Hiawatha Corridor has been acquired for the construction of a previously planned roadway facility. However, it will be necessary to acquire some property for the CBD terminal stop and for LRT track in the CMStP & P RR corridor. The cost of property acquisition is calculated at $4 per square foot for 181,000 square feet of property or a total cost of $724,000. This estimate includes costs of acquisition as well as the land purchase price.

- Construction (Guidance System)

  Construction costs are estimated at $79,473,000 and includes items shown in Table 6; it excludes costs for construction supervision, insurance, implementing agency staff costs, maintenance of vehicular traffic, force account costs, drainage, communication, maintenance of existing R.R. traffic, rock excavation, dewatering, and the cost of the structure which encloses the LRT in Minnehaha Park.

- Parking Lots

  Parking is important to LRT ridership. Some parking can be provided in surplus space in the Hiawatha Corridor. North of 42nd Street, parking would have little attraction for park/ride commuters unless downtown parking became scarce and expensive. Parking would be provided at the Crosstown stop for LRT patrons. For this estimate, the cost of 1,000 parking spaces is included in the capital cost of the LRT. A construction cost of $1,400 per space has been used; no additional land is required.

- LRT Vehicles

  Fourteen LRT vehicles (12 active and 2 spare) would be required to operate the Hiawatha line during peak periods. At $968,000 per vehicle, the cost is $13.6 million. The vehicle costs are based on the price of a large articulated modern light rail vehicle (the Boeing Standard LRV).

TABLE 5

CAPITAL COST SUMMARY - LRT ALTERNATIVE

HIAWATHA CORRIDOR

Category	Cost in 1980 Dollars
LRT/Feeder Bus System	
Right-of-Way	$ 724,000
Construction (Guidance System)	79,473,000
Parking	1,400,000
LRT Vehicles	13,552,000
Feeder Buses	5,550,000
Feeder Bus Maintenance and Overhaul Facility	2,042,000
LRT/Feeder Bus System Total	$102,741,000
Local Bus System	
Buses	$ 11,550,000
Bus Maintenance and Overhaul Facility	4,250,000
Local Bus Sytem Total	15,800,000
TOTAL	$118,541,000

TABLE 6

LRT CONSTRUCTION COST ESTIMATE - HIAWATHA CORRIDOR (1980 Dollars)

ITEM	QUANTITY	UNIT	UNIT PRICE*	TOTAL
Cross Ties @ 1.6'	48,700	Each	$ 47	$ 2,288,900
Stone Ballast 3581/mi	27,040	L.Y.	35	946,400
115# Rail	81,110	Track L.F. (2 rails)	75	6,083,250
Excavation 25,600/mi	193,200	C.Y.	23	4,443,600
Grade Crossings	12	Each	275,000	3,300,000
Crossovers	10	Each	70,000	700,000
Stops	22	Each	14,133	310,900
Stations	4	Each	760,000	3,040,000
Lake Street/RR Grade Separation	1	Each	9,425,000	9,425,000
Bridges/Special Structures	2	Each	1,000,000	2,000,000
Stream Crossing	1	Each	243,000	243,000
Substation 1/mi	7	Each	405,000	2,835,000
Maintenance and Storage Building	1	Each	975,000	975,000
Catenary	7.7	Miles	798,000	6,144,600
Signals	7.7	Miles	784,000	6,036,800
Asphalt	1,600	Ton	75	120,000
Pavement Removal	288,000	S.F.	1.5	432,000
Utility Relocation	27	CBD Block	500,000	13,500,000
			Sub-Total	$ 62,824,450
			Engineering & Mobilization (10%)	6,282,445
			Sub-Total	$ 69,106,895
			Contingency (15%)	10,366,034
			Total	$ 79,472,929
			SAY	$ 79,473,000

* Unit prices are from Sanders and Thomas' cost estimate. Their use here does not represent endorsement by the Hiawatha Corridor consultant team.

- Feeder Bus System

  A feeder bus system will be implemented along with the LRT to serve LRT passengers who live beyond walking distance of stations. It is estimated that the equivalent of 37 buses (@ $150,00/bus) will be needed to provide this service. Bus maintenance and overhaul facilities (@ $55,200/bus) will also be needed to service these buses. Capital costs associated with the bus feeder service are shown in Table 5.

- Local Bus System

  A local bus system will serve the Hiawatha corridor under this alternative which provides transit service for these trips which cannot use the LRT system. Provision of this service will require 77 buses and a maintenance and overhaul facility to service them.

Revenue

Revenue was calculated for the LRT system using an average fare of $0.50. The number of passengers is estimated by assuming 50% of the weekday passengers on Saturday and 25% of the weekday passengers on Sundays and holidays. This results in a forecast of 7,539,200 passengers/year. Therefore, the LRT systems revenue would be $3,769,600 per year in 1980 dollars. The local bus system, serving 7,657,000 passengers per year, would generate $3,828,500 in revenue.

Operating and Maintenance Cost

- LRT System

  The operating and maintenance costs are based on the annual vehicle miles traveled which are, in turn, related to the labor and materials necessary to keep the system operating satisfactorily. The total annual operating and maintenance costs in 1980 dollars is estimated at $1,319,000 or about $2.81 per mile traveled (see Table 7).

  The annual revenue ridership is calculated at 7,539,200. The passenger miles traveled annually is calculated at 17,316,600. The O & M costs for the Hiawatha line is calculated as $0.076 per passenger mile. This is about one-third the average MTC bus cost per passenger mile.

- Feeder Bus System

  The MTC estimates that the feeder buses transporting LRT patrons to and from the LRT stations in the corridor will travel 641,400 miles per year and over 54,500 bus-hours, including mileage and time required to travel between the bus garage and the corridor. The costs associated with provision of this service are shown in Table 8.

- Local Bus System

  The local bus system, carrying transit patrons who do not ride LRT as part of their trip, will generate 1,362,700 bus miles per year and 115,800 bus hours per year.

Table 9 compares the revenue and operating and maintenance cost of the LRT and feeder bus system. The estimate is that in 1980 dollars, using year 2000 characteristics, a surplus of $666,600 would result. The local bus system, under the same conditions, operates at an annual surplus of $205,700.

TABLE 7

ANNUAL LRT OPERATING AND MAINTENANCE COST

HIAWATHA CORRIDOR

(INFLATED TO YEAR 1980)

ITEM (Unit Cost)	AMOUNT
Track Maintenance ($0.34/VMT*)	$ 159,400
Shelter Maintenance ($500/shelter)	15,000
Yards & Support Maintenance ($1000/peak hour vehicle**)	12,000
Communications & Control ($2,500/track mile)	38,400
Vehicle Maintenance (.24/VMT)	112,500
Vehicle Energy Consumption (.14/VMT)	65,600
Maintenance Facility Energy Consumption ($50/peak hour vehicle)	600
MTC Operators Salary & Benefits ($16,687 x 1.5 x peak hour unit)	300,400
Other Transportation ($0.17/VMT)	79,700
Subtotal	$ 783,600
General and Administrative @ 15%	$ 117,500
1976 Total Cost	$ 901,100
Inflated 10%/Year to 1980	$1,319,300
Round to	1,319,000

* VMT - Vehicle Miles Traveled Calculated as 468,800 annually

** Peak Hour Vehicle Requirements = 12 Vehicles

TABLE 8

BUS FEEDER AND LOCAL BUS SYSTEM
ANNUAL OPERATING AND MAINTENANCE COST

(1980 Dollars)

Feeder Bus System		
Annual Bus Miles	641,400 @ $ 1.10/mile	$ 705,500
Annual Bus Hours	54,500 @ $18.34/hour	$ 999,500
	Subtotal Feeder Bus System	$1,705,000
Local Bus System		
Annual Bus Miles	1,362,700 @ $1.10/mile	$1,499,000
Annual Bus Hours	115,800 @ $18.34/mile	$2,123,800
	Subtotal Local Bus System	$3,622,800
	TOTAL	$5,327,800

TABLE 9

ANNUAL LRT ALTERNATIVE OPERATING COST AND REVENUE (1980 Dollars)

HIAWATHA CORRIDOR

LRT System		
REVENUE		
7,539,200 passengers/year x $0.50 fare		$ 3,769,600
COST (O & M)		
LRT Operating and Maintenance Cost	$ 1,319,000	
Feeder Bus System Operating and Maintenance Cost	1,705,000	
Total Annual Operating and Maintenance Cost		$ 3,024,000
ANNUAL LRT SYSTEM OPERATING SURPLUS (DEFICIT)		$ 745,600
Local Bus System		
REVENUE		
Local Bus System (7,657,000 passengers/year x $0.50 fare)		$ 3,828,500
COST		
Local Bus System Operating and Maintenance Cost		$ 3,622,800
ANNUAL LOCAL BUS SYSTEM OPERATING SURPLUS (DEFICIT)		$ 205,700
ANNUAL LRT ALTERNATIVE OPERATING SURPLUS (DEFICIT)		$ 951,300

Annualized Capital Costs

Annualized capital costs assume the Hiawatha LRT line would be funded locally. Each major item of expense was amortized using the appropriate life expectancy of the item. The annualized costs exclude any cost of borrowing or right-of-way. These annualized costs are shown in Table 10.

Annualized LRT Revenue and Cost

Table 11 illustrates the revenue and operating and maintenance cost for the LRT alternative based on 1980 dollars and year 2000 characteristics. Also shown is the annualized capital cost.

Annualized costs and revenues presented in Table 11 represent only 1980. Comparison costs and revenues for years after 1980 should take into account changes in costs relative to each other caused by differential inflation rates. Consideration of inflation generally has the effect of making capital intensive actions look more advantageous over the long run.

TABLE 10

ANNUALIZED CAPITAL COST - LRT ALTERNATIVE

HIAWATHA CORRIDOR

Item	Cost	Life (Years)	Capital Recovery Factor (9.1% Interest)	Annualized Cost
Right-of-Way	$ 724,000	40	0.09388	$ 68,000
Cross Ties	2,288,900	40		
Stone Ballast	946,400	40		
115# Rail	6,083,250	40		
Excavation	4,443,600	40		
Grade Crossings	3,300,000	40		
Crossovers	700,000	40		
Stops	310,900	40		
Stations	3,040,000	40		
Lake Street/RR Grade Separation	9,425,000	40		
Bridges/Special Structures	2,000,000	40		
Stream Crossing	243,000	40		
Substation	2,835,000	40		
Catenary	6,144,600	40		
Signals	6,036,800	40		
Asphalt	120,000	40		
Pavement Removal	432,000	40		
Utility Relocation	13,500,000	40		
Subtotal	61,849,450			
E & M (10%)	6,184,945			
Subtotal	68,034,395			
Contingency (15%)	10,205,159			
TOTAL	78,239,600		0.09388	$7,345,100
Maintenance and Storage Building	975,000	20		
E & M (10%)	97,500			
Subtotal	1,072,500			
Contingency (15%)	160,875			
TOTAL	1,233,400		0.11033	136,100
Parking Lots	1,400,000	40	0.09388	131,400
LRT Vehicles	13,552,000	30	0.09820	1,330,800
Buses	5,550,000	12	0.14035	778,900
Bus Maintenance and Overhaul Facility	2,042,000	20	0.11033	225,300
		TOTAL LRT SYSTEM ANNUALIZED COST		$10,015,600
Local Bus System				
Buses	11,550,000	12	0.14035	$ 1,621,000
Bus Maintenance and Overhaul Facility	4,250,000	20	0.11033	468,900
		TOTAL LOCAL BUS SYSTEM ANNUALIZED COST		$ 2,089,900

TABLE 11

ANNUAL TOTAL LRT ALTERNATIVE REVENUE AND COST (1980 Dollars)

HIAWATHA CORRIDOR

LRT System		
ANNUAL REVENUE		$ 3,769,600
ANNUAL COST		
Operating and Maintenance Cost	$ 3,024,000	
Annualized Capital Cost	10,015,600	
Total		$13,039,600
ANNUAL LRT SYSTEM SURPLUS (DEFICIT)		($ 9,270,000)
Local Bus System		
ANNUAL REVENUE		$ 3,828,500
ANNUAL COST		
Operating and Maintenance Cost	$ 3,622,800	
Annualized Capital Cost	2,089,900	
Total		$ 5,712,700
ANNUAL LOCAL BUS SYSTEM SURPLUS (DEFICIT)		($ 1,884,200)
ANNUAL LRT ALTERNATIVE SURPLUS (DEFICIT)		($11,154,200)

Land Use Impacts

The Hiawatha Corridor is nearly totally developed. Land uses along the route consist of a mix of single-family residential, high-density residential nodes, commercial uses concentrated primarily at Lake Street, and industrial uses in the form of rail switching yards and strip development throughout the Corridor. The area also contains Minnehaha Park, a regional recreational facility, and the Veterans Administration Hospital complex at the southern edge. With few notable exceptions (Target store at Lake Street, Cedar Riverside new town-in town and the Humphrey Stadium) no new development or redevelopment has occurred in recent decades.

However, the potential for redevelopment activity along the Corridor is immense. Many of the industrial uses located immediately along the Corridor are obsolete or vacant and are often imcompatible with surrounding residential neighborhoods. A large rail switching yard is located between Lake Street and East 24th Street. This facility is underutilized. The current financial plight of the railroad opens the possibility of acquiring and redevel-oping an extremely large area in which no land assembly would be required.

The Minnesota Department of Transportation owns a large amount of vacant land along the Corridor which was originally acquired and cleared for construction of a limited access highway. The roadway/transit improvements currently under consideration will not require use of all the available land. Thus, a linear strip of land will become immediately available for development. At certain locations, most notably at Lake Street, land was acquired and cleared for construction of major highway interchanges. This land will be available for development activity in a large and assembled block.

Other opportunities for development activity include infill sites scattered throughout the Corridor, the Industry Square area surrounding the new stadium site, and the Cedar-Riverside neighborhood.

A study was performed to estimate developmental impacts of transit/roadway improvements on the Hiawatha Corridor. A full range of transportation improvement options was analyzed including the "No Build" alternative, "Class 3 Improvements" (roadway improvements and continued reliance of public bus transit), "Class 2 Improvements" (roadway improvements plus High Occupancy Vehicle lanes) and "Class I Improvements" (roadway improvements plus Light-Rail-Transit).

A variety of public sector policy alternatives regarding encouragement of development along the Corridor was also considered in the analysis. The range of policy alternatives considered ranged from no public sector involvement up to and including major participation, short of absolute control over all land development choices. Moderate public participation includes such actions as: zoning changes, tax abatements and streamlining the permit process. More enterprising policies consist of: institution of a "transit corridor development corporation," land condemnation or the outright purchase of land for development purposes.

The following tables indicate the potential year 2000 impacts of Hiawatha Corridor transportation improvements and public policy actions. The combination of maximum public sector participation and Class 1 transportation improvements which includes light rail transit would stimulate the highest levels of growth in Corridor employment and population. The analysis indicated that this combination would result in a 16.7% increase in population (12,000 persons) and a 11.5% increase in employment (6,337 jobs) over the no-build option.

The LRT offers advantages for residential and commercial development, particularly in the vicinity of stations, that would not be available with any other type of transportation improvement currently under consideration. Based upon documented case studies of other "new-start" cities and on the results of empirical growth models, the upper limit of development influence is approximately 25 percent. This figure represents a percentage increase in the Corridor's expected share of regional growth capture rates. The experience of other cities where new LRT service is located in an existing built-up community indicates that the maximum level of development that can be expected cannot exceed this 25 percent level. This has been the case in Cleveland, Boston, San Francisco, and Toronto.

TABLE 12

CORRIDOR AND REGIONAL DEVELOPMENT
ESTIMATES, 1990-2000
(in Acres)

Hiawatha Corridor Acreage		1990	2000	Change 1990-2000
Residential		7,958	9,145	+1,187
Commercial		768	952	+ 184
Industrial		5,254	569	+ 438
	Total	13,980	15,789	+1,809
Metro Area Acreage				
Residential		174,532	196,005	+21,473
Commercial		15,841	20,174	+ 4,333
Industrial		53,527	63,368	+ 9,841
	Total	243,900	279,547	+35,647

Source: Socio-Economic and Land Use File, Metropolitan Council.

TABLE 13

YEAR 2000 POPULATION ESTIMATES
HIGHWAY 55 ONE-MILE WIDE CORRIDOR

	NO BUILD	CLASS 3 IMPROVEMENTS (Minor)	CLASS 2 IMPROVEMENTS (Moderate)	CLASS 1 IMPROVEMENTS (Major)
No Public Sector Involvement	71,991	72,991	72,991	77,491
% Change Over No Build		1.4%	1.4%	7.6%
Limited Public Sector Imvolvement	71,991	72,991	73,891	78,491
% Change Over No Build		1.4%	2.6%	9.0%
Substantial Public Sector Involvement	71,991	72,991	76,891	83,991
% Change Over No Build		1.4%	6.8%	16.7%

YEAR 2000 EMPLOYMENT ESTIMATES
HIGHWAY 55 ONE-MILE WIDE CORRIDOR

	NO BUILD	CLASS 3 IMPROVEMENTS (Minor)	CLASS 2 IMPROVEMENTS (Moderate)	CLASS 1 IMPROVEMENTS (Major)
No Public Sector Involvement	55,097	55,434	55,434	57,434
% Change Over No Build		0.6%	0.6%	4.2%
Limited Public Sector Involvement	55,097	55,434	55,434	58,434
% Change Over No Build		0.6%	0.6%	6.1%
Substantial Public Sector Involvement	55,097	55,434	57,434	61,434
% Change Over No Build		0.6%	4.2%	11.5%

Source: Metropolitan Council Socio-Economic and Land Use File for 1970 and 1990, revised estimates prepared by Robert J. Harmon & Associates, Inc. and James B. McComb & Associates.

In addition to the previously presented "market share" based analysis, a capacity analysis was performed for the Hiawatha Corridor. In this study an analysis was performed to estimate the maximum development/redevelopment potential of lands within the Corridor. The study was based on the assumption that an LRT would be built along with roadway improvements. It also assumed maximum public sector involvement to encourage development. Significant actions would include the acquisition and redevelopment of both the railway yard and a substantial amount of the existing, often incompatible (with the surrounding neighborhood) industrial uses found in a linear strip between Lake Street and Minnehaha Park.

The capacity analysis is based upon a theoretical, corridor-wide land use plan. This plan was developed on the basis of the following:

1. Existing development patterns
2. Established City and neighborhood plans
3. Input from the Hiawatha Avenue Task Force
4. Input by concerned government officials
5. Accepted planning practices

The following assumptions were utilized to develop Table 14.

1. An average residential density of 20 units per acre was used to convert "market share" projected households to acres. An average of 2.2 people per household was also assumed.

2. The employment projected for the Corridor will be in a mix of office, commercial and industrial jobs. The acreage was computed as follows:

% of Jobs		Ratio of Employment to Area
Commercial	5%	15 workers per acre
Industrial	60%	40 workers per acre
Office	35%	75 workers per acre

3. For the Capacity Analysis the following assumptions were used. Acreage is taken directly from the proposed land use plan. The total area of 435+ acres includes vacant areas and large tracts of land believed to have high potential for redevelopment. The worker/area ratio stated above in #2 is used. Table 14 provides the additional assumptions used in formulating the Capacity Analysis.

Table 14 shows that sufficient capacity exists in the Hiawatha Corridor to accommodate the growth potential indicated by the Market Share Analysis.

The Regional LRT Study conducted for the Metropolitan Council utilized acreage calculations rather than absolute numbers for analysis of Land Use Impacts. For the sake of commonality the data presented in Tables 13 and 13A has been converted to acreage and is shown in Table 14.

TABLE 13A

DEVELOPMENT CAPACITY - HIAWATHA CORRIDOR

Land Use		Density	Available Acres	Population/ Employment
Residential	20 units/acre	3.0 people/unit	50.5 acres	3030 persons
Residential	30 units/acre	2.4 people/unit	100.9 acres	7265 persons
Residential	45 units/acre	1.5 people/unit	83.3 acres	5623 persons
Residential	65 units/acre	1.3 people/unit	49.4 acres	4174 persons
Office		75 workers/acre	45.0 acres	3375 jobs
Commercial		15 workers/acre	22.5 acres	340 jobs
Industrial		40 workers/acre	83.5 acres	3340 jobs

Totals 435± acres
20,100 persons
7,055 jobs

TABLE 14

PROJECTED LRT/MAXIMUM PUBLIC SECTOR INVOLVEMENT
LAND USE IMPACTS, NEW CONSTRUCTION, YEAR 2000

Land Use	Market Share Analysis	Land Use Capacity Analysis
Residential	12,000 persons/272.0 acres	20,100 persons/284 acres
Commercial	320 jobs/23.4 acres	340 jobs/22.5 acres
Industrial	3800 jobs/95.0 acres	3340 jobs/83.5 acres
Office	2220 jobs/29.6 acres	3375 jobs/45.0 acres
Totals	12,000 persons 6,340 jobs 420 acres	20,100 persons 7,055 jobs 435 acres

From the above table one can draw the conclusion that sufficient capacity exists in the Hiawatha Corridor to easily accommodate the growth potential indicated by the Market Share Analysis.

Energy

The energy use of the LRT Alternative in the Hiawatha corridor is shown in Table 15. It is estimated that the transit system (LRT, Feeder Bus and Local Bus) will consume about 126 billion BTU's per year. Coal based electrical energy will be used in powering the LRT vehicles. The remaining energy is consumed in the form of diesel fuel for buses.

TABLE 15

ANNUAL ENERGY USE - LRT ALTERNATIVE
HIAWATHA CORRIDOR
(Millions of BTU's)

	Coal	Oil	Total
LRT Line	46,665	0	46,665
Feeder Bus System	0	25,368	25,368
Subtotal	46,665	25,368	72,033
Local Bus System	0	53,895	53,895
Total	46,665	79,263	125,928

Noise

The operation of an LRT system in the Hiawatha corridor will not increase disturbance from noise and in some areas can result in an improvement. For analyzing the difference in the magnitude of sound a transportation system will make, the A-weighted decibel level is used. A light rail vehicle, in the configuration planned along the Hiawatha alignment, traveling at 40 miles per hour, is expected to produce an exterior single event noise level of 55 dBA at a distance of 50 feet. Traveling at 20 miles per hour, the single event noise level would drop to 49 dBA at a distance of 50 feet. For a comparison, the following guidelines can be used.

- For comfortable conversation, noise levels should not exceed 65 to 75 dBA.
- Ambient noise levels for quiet to normal residential neighborhoods is 50 to 60 dBA.
- Autombiles create noise levels of 60 to 70 dBA at 25 to 35 miles per hour, and 75 to 80 dBA at 55 to 65 miles per hour. Combined autombile and truck freeway noise levels are 80 to 90 dBA (all figures are measured at 50 feet).
- Noise levels for buses on city streets are 80 to 88 dBA and at highway speeds 80 to 85 dBA.

TABLE 16

ESTIMATED POLLUTANT LOADS - LRT ALTERNATIVE
HIAWATHA CORRIDOR
(In Pounds)

	LRT Alternative			
	LRT Line	Feeder Buses	Local Buses	Total
Air Pollution				
Particulate	11,789*	1,843	3,915	17,547
Carbon Monoxide (CO)	2,456	34,218	72,699	109,373
Hydrocarbons (HC)	737	7,654	16,262	24,653
Nitrogen Oxides (NO_x)	44,208	13,367	28,399	85,974
Sulphur Oxides (SO_x)	139,992	3,970	8,432	152,394
Water Pollution				
Suspended Solids (SS)	0			
Chemical Oxygen Demand (COD)	0			
Biochemical Oxygen Demand (BOD)	0			
Other	0			

* Assumes emission controls eliminate 97% of particulate from power generating plant stacks.

NON-LRT ALTERNATIVE

The alternative to implementation of an LRT system which is analyzed in this study is an all bus system. Existing bus routes would be upgraded, expanded and supplemented to serve the expected demand for transit service.

Operating Characteristics

The bus system would be operated essentially as it is now operated, with additional service to serve expected demand.

Transit Patronage

Under this alternative, transit use is expected to increase through the year 2000. Transit patronage in that year is projected to be 44,100 trips per average weekday (Table 17).

Cost and Revenue Characteristics

Capital Cost

To serve the transit patronage forecasted to occur in the year 2000 will require 145 buses and maintenance facilities to serve those buses (Table 18).

Operating and Maintenance Cost

The cost of operating and maintaining this bus system is based on MTC estimates of annual bus miles (3,044,800) and bus hours (223,400). The calculation of these costs is shown in Table 19.

Revenue

Based on the patronage estimates described above, annual patronage has been estimated at 12,987,450. At a fare of $0.50, revenue would equal $6,493,700 per year.

Annual operating costs and revenues are compared in Table 20.

Annualized Cost

The annualized costs for this alternative are calculated and given in Table 21.

Annual Revenue and Cost Comparison

The comparison in Table 22 shows that when the annualized capital cost is considered, the all-bus system will incur an annual deficit of $4,888,800.

TABLE 17

YEAR 2000 TRAVEL BY MODE - NON-LRT ALTERNATIVE

HIAWATHA CORRIDOR

	Daily Person Trips	Percent of Total
Auto Drivers	482,200	58.2%
Auto Passengers	302,000	36.5%
Transit		
Downtown	14,900	1.8%
Non-Downtown	29,200	3.5%
Total Transit	44,100	5.3%
Total Trips	828,300	100.0%

TABLE 18

CAPITAL COST - NON-LRT ALTERNATIVE
HIAWATHA CORRIDOR

Buses (145 buses at $150,000/bus)		$ 21,750,000
Bus Maintenance Facility (at $43,560/bus)		$ 6,316,200
Bus Overhaul Facility (at $11,660/bus)		$ 1,690,700
	TOTAL	$ 29,756,900

TABLE 19

ANNUAL NON-LRT ALTERNATIVE OPERATING AND MAINTENANCE COST
HIAWATHA CORRIDOR

Item		Unit Cost		Cost
Annual Bus Miles	3,044,800	$1.10/mile		$ 3,349,300
Annual Bus Hours	223,400	$18.34/hour		$ 4,097,200
			Total	$ 7,446,500

TABLE 20

ANNUAL NON-LRT ALTERNATIVE - OPERATING COST AND REVENUE

(1980 DOLLARS) - HIAWATHA

REVENUE	
12,987,450 passengers/year x $0.50 fare	$ 6,493,700
COST	
Operating and Maintenance Cost	$ 7,446,500
NON-LRT ALTERNATIVE ANNUAL OPERATING SURPLUS (DEFICIT)	$ (952,800)

TABLE 21

NON-LRT ALTERNATIVE ANNUALIZED COST

Item	Cost	Life (Years)	Capital Recovery Factor	Annualized Cost
Buses	2,750,000	12	0.14035	$3,052,600
Bus Maintenance Facility	6,316,200	20	0.11033	696,900
Bus Overhaul Facility	1,690,700	20	0.11033	186,500
		Total Annualized Cost		$3,936,000

TABLE 22

ANNUAL TOTAL NON-LRT ALTERNATIVE REVENUE AND COST
HIAWATHA CORRIDOR

ANNUAL REVENUE		$ 6,493,700
ANNUAL COST		
Operating and Maintenance Cost	$7,446,500	
Annualized Capital Cost	$3,936,000	
TOTAL		$ 11,382,500
ANNUAL NON-LRT ALTERNATIVE SURPLUS (DEFICIT)		$ (4,888,800)

Impact Analysis

Land Use Impact

The all-bus alternative itself would have essentially no impact on land use. Analysis has indicated that the lower levels of service, lack of significant stations or inter-modal points and lack of significant public sector involvement associated with the all-bus alternative will contribute to this situation. However, the all-bus alternative and roadway improvements will leave vacant a portion of the right-of-way acquired and cleared when a grade separated, limited access highway was being considered. Most of this area is located in a strip of land approximately 300-500 feet wide found between Lake Street and Minnehaha Park. At Lake Street a larger area was acquired for an interchange. A total of approximately 80 acres is included in this category.

While the Metro Council apparently has not taken this area into consideration, it is reasonable to assume that some sort of infill development will occur on this vacant property. This infill would occur whether or not bus system improvements are made. The infill development is merely a response to the availability of the land. The majority of the areas is suitable only for infill of low to moderate density housing. The Lake Street node is the only exception to this rule. Based on the assumption that full use will be made of the Lake Street node (mixed use development including high denisty residential, commercial and office space) and infill housing occurs along the corridor, the land use impacts described below would occur.

- Residential

50 acres at 20 units/acre	1000 housing units
20 acres at 45 units/acre	900 housing units

- Office

6 acres at 75 workers/acre	450 jobs

- Commercial

4 acres at 15 workers/acre	60 jobs

- Totals 80 acres
  1900 housing units (approximately 4200 persons)
  510 jobs

Energy Impact

Annual energy use is estimated at 144,181 million BTU's per year (Table 23).

Pollutant Loads

Estimated annual pollutant loads are shown in Figure 24.

TABLE 23

ANNUAL ENERGY USE - NON-LRT ALTERNATIVE

HIAWATHA CORRIDOR

Bus System		120,422 Million BTU's
Additional Auto Travel		23,759 Million BTU's
	Total	144,181 Million BTU's

TABLE 24

ESTIMATED POLLUTANT LOADS - NON-LRT ALTERNATIVE
HIAWATHA CORRIDOR
(In Pounds)

	Bus System	Additional Auto Travel	Total
Air Pollution			
Particulate	8,748	0	8,748
Carbon Monoxide (CO)	117,219	438,802	556,021
Hydrocarbons (HC)	29,204	29,669	58,873
Nitrogen Oxides (NO_x)	54,572	23,681	78,253
Sulphur Oxides (SO_x)	18,841	0	18,841
Water Pollution			
Suspended Solids (SS)			
Chemical Oxygen Demand (COD)			
Biochemical Oxygen Demand (BOD)			
Other			

LRT AND NON-LRT ALTERNATIVE COMPARISON

The following tables summarize data for a direct comparison of the LRT Alternative and the Non-LRT Alternative.

TABLE 25

SUMMARY COMPARISON - LRT VERSUS NON-LRT ALTERNATIVE
HIAWATHA CORRIDOR

		Alternative	
		LRT	Non-LRT
TRANSIT RIDERSHIP (Average Week Day)	LRT/Feeder Bus	25,600	0
	Local Bus	26,000	44,100
	Total	51,600	44,100
COST			
Capital Cost		$118,541,000	$ 29,756,900
Annual Revenue		7,598,100	6,493,700
Annual Operating and Maintenance Cost		6,646,800	7,446,500
Operating Surplus (Deficit)		951,300	(952,800)
Annualized Capital Cost		12,105,500	3,936,000
Annual Surplus (Deficit)		$(11,154,200)	($4,888,800)
PERFORMANCE MEASURES			
LRT/Feeder Bus System			
Operating Surplus (Deficit) per Passenger		$ 0.099	
Surplus (Deficit) per Passenger		$ (1.230)	
Local Bus System			
Operating Surplus (Deficit) per Passenger		$ 0.027	$ (0.073)
Surplus (Deficit) per Passenger		$ (0.241)	$ (0.376)
Composite			
Operating Surplus (Deficit) per Passenger		$ 0.063	$ (0.073)
Surplus (Deficit) per Passenger		$ (0.734)	$ (0.376)

TABLE 26

COMPARATIVE LAND USE IMPACTS

LRT VERSUS NON-LRT - HIAWATHA

Non-LRT	LRT Market Share Analysis	Capacity Analysis
Residential 70.0 acres/4200 persons	272 acres/12,000 persons	284 acres/20,100 persons
Commercial 4.0 acres/60 jobs	23.4 acres/370 jobs	22.5 acres/340 jobs
Industrial N/A	95.0 acres/3800 jobs	83.5 acres/3340 jobs
Office 6.0 acres/450 jobs	29.6 acres/2220 jobs	45.0 acres/3375 jobs
TOTALS	420 acres 12,000 persons 6,340 jobs	435 acres 20,100 persons 7,055 jobs
80 acres 4200 persons 510 jobs		

TABLE 27

COMPARATIVE ANNUAL ENERGY IMPACTS -
LRT VS NON-LRT - HIAWATHA

LRT Alternative Energy Consumption		
LRT Line		46,665 MM BTU's*
Feeder Bus System		25,368 MM BTU's
Local Bus System		53,895 MM BTU's
	Total	125,928 MM BTU's
Non-LRT Alternative Energy Consumption		
Buses		120,422 MM BTU's
Additional Auto Travel		23,759 MM BTU's
	Total	144,181 MM BTU's

* Millions of BTU's

TABLE 28

COMPARATIVE ANNUAL ENVIRONMENTAL IMPACTS
LRT VS NON-LRT - HIAWATHA

Pollutants	LRT Alternative (pounds)	Non-LRT Alternative (pounds)
Air Pollution		
Particulate	17,547	8,748
Carbon Monoxide (CO)	109,373	555,721
Hydrocarbons (HC)	24,653	58,873
Nitrogen Oxides (NO_x)	85,974	78,253
Sulfur Oxides (SO_x)	152,394	18,841
Water Pollution		
Suspended Solids (SS)		
Chemical Oxygen Demand (COD)		
Biochemical Oxygen Demand (BOD)		
Other		