LRT

Metropolitan Council of the Twin Cities Area

Consultant Report

Light Rail Transit Feasibility Study

April 1981

Pursuant to 1980 Laws, ch 607, Art 13, section 3
(one of 5 pubns)

SANDERS & THOMAS.
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March 19, 1981

The Metropolitan Council of the Twin Cities
300 Metro Square Building
St. Paul, Minnesota 55101

Attention: Mr. Ghaleb Abdul-Rahman, Project Manager

Reference: Light Rail Transit Feasibility Study

Subject: Submittal of Final Report

Our Job No.: 10-4674

Gentlemen:

This letter transmits our final report to you on the feasibility of light rail transit in the Twin Cities.

The report contains our analysis of light rail in comparison to a non-light rail option in each of four transportation corridors.

It has been a pleasure to work with you on this important assignment.

Sincerely,

SANDERS & THOMAS, INC.

Stewart F. Taylor

Stewart F. Taylor
Vice President

SFT:jee

LIGHT RAIL TRANSIT

FEASIBILITY STUDY

FINAL REPORT

March 1981

Prepared For:

The Metropolitan Council of the Twin Cities Area
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St. Paul, Minnesota 55101

By

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The LRT Feasibility Study has never been intended to be used to compare different alignments among themselves or to identify one single "best" alignment. When reading the final report, one must keep in mind that certain aspects of the various corridors analyzed are definitely not comparable. This cautionary note is particularly applicable to the definition of the feeder bus system required to supplement an LRT line or its non-LRT alternative. In the West/Southwest Corridor, an upgraded bus system reoriented to feed into the LRT line or its alternative has been fully costed out. Therefore, it is possible to have a complete picture of the total operating and maintenance costs for the two alignments considered within the corridor. Because of the complexities of fully costing out a feeder bus system and in view of the limitations of the contract, a simpler approach has been taken for the other three corridors.

The feeder bus system has been completely disregarded from the University alignment analysis because it has been assumed to be essentially in place. In the Northeast and Northwest corridors, only bus additions required to support the LRT line have been considered in the analysis. Most of the existing routes, which could serve as feeder bus routes, have not been costed out.

In summary, the operating and maintenance costs obtained for the University, Northeast and Nothwest corridors include none or very little of the feeder bus service.

LIGHT RAIL TRANSIT FEASIBILITY STUDY

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CHAPTER I

INTRODUCTION

THE PURPOSE OF THE STUDY

The purpose of this study is to provide the information necessary to permit the Metropolitan Council to determine the feasibility of light rail transit (LRT) in the Twin Cities Metropolitan Area as mandated by the Minnesota Legislature and to provide input to the review of the Transportation Policy Plan.

A Need for Policy Change

As part of its responsibilities for coordinating metropolitan planning and development, the Metropolitan Council is required by Minnesota statute (Section 473.146, Subd. 2) to carry out a comprehensive review of the Transportation Policy Plan at least once every four years.

One element of the Policy Plan, as adopted in 1976, states that, "No fixed guideway for the exclusive use of transit (buses and automated and semi-automated technologies) is to be provided for regional and subregional service" through the year 1990. In the intervening 4 years significant changes in the price and availability of petroleum as well as patterns of development and public attitudes towards transportation warrant a reexamination of this statement.

Since 1976 transit ridership in the Twin Cities has increased from 62 million to 75 million. During the same period transit operating costs have increased from $42 million to over $80 million. A prime attribute of fixed guideway transit modes is their potential to carry higher passenger volumes more productively than is possible with highway-oriented modes such as the bus. With the sharp runup in patronage and costs, this attribute justifies consideration of fixed guideway transit as a plausible candidate for future development.

Minnesota Legislative Mandate

Several types of fixed guideway modes have been subjects of earlier studies. One that was not is light rail transit (LRT). However, because of its unique characteristics and growing popularity in North America and Europe, the time appeared appropriate to investigate the potential of LRT for the Twin Cities. Therefore, in early 1980, legislation was enacted which requested the Council to "conduct a feasibility study of the use of light rail transit in the Metropolitan Area." (Chapter 607, Minnesota Laws, 1980) The study is to become a significant input in the updating of the applicable policies, priorities and implementation guidelines.

DEFINITION OF LIGHT RAIL TRANSIT

LRT uses electrically propelled rail vehicles which operate singly or in trains on predominantly reserved, but not necessarily grade-separated, rights-of-way. It provides a wide range of passenger capacities and performance characteristics at moderate costs.

Rights-Of-Way

The feature that distinguishes LRT most sharply from other urban transit modes is the variety of options for the location and design of the guideway. For maximum benefit, LRT should operate primarily on private or reserved rights-of-way separated from traffic. However, even when this is not always possible, the overall system functions at a higher level of performance and reliability than is possible with a totally highway-oriented mode.

The virtue of LRT is that a system can perform effectively even when it consists of a mix of alignment locations: streets, pedestrian malls, highway medians, separate rights-of-way with or without grade crossings, railroad or utility rights-of-way, elevated structures or subways. Segments can then be upgraded on an incremental basis as funds become available. For example, a particularly congested and hazardous intersection can be eliminated by a short overpass or section of tunnel. Some LRT systems have been labeled "premetro," with the long range objective of total conversion to full-scale, heavy rail transit.

Vehicles

LRT vehicles range from single-unit, four-axle cars to five-unit, 12-axle cars. The vehicles can be designed to load from ground level or from high, train floor level platforms. The new cars manufactured by the Boeing Company for San Francisco have convertible steps for high loading in the subway portion and low loading on the surface portion of the system.

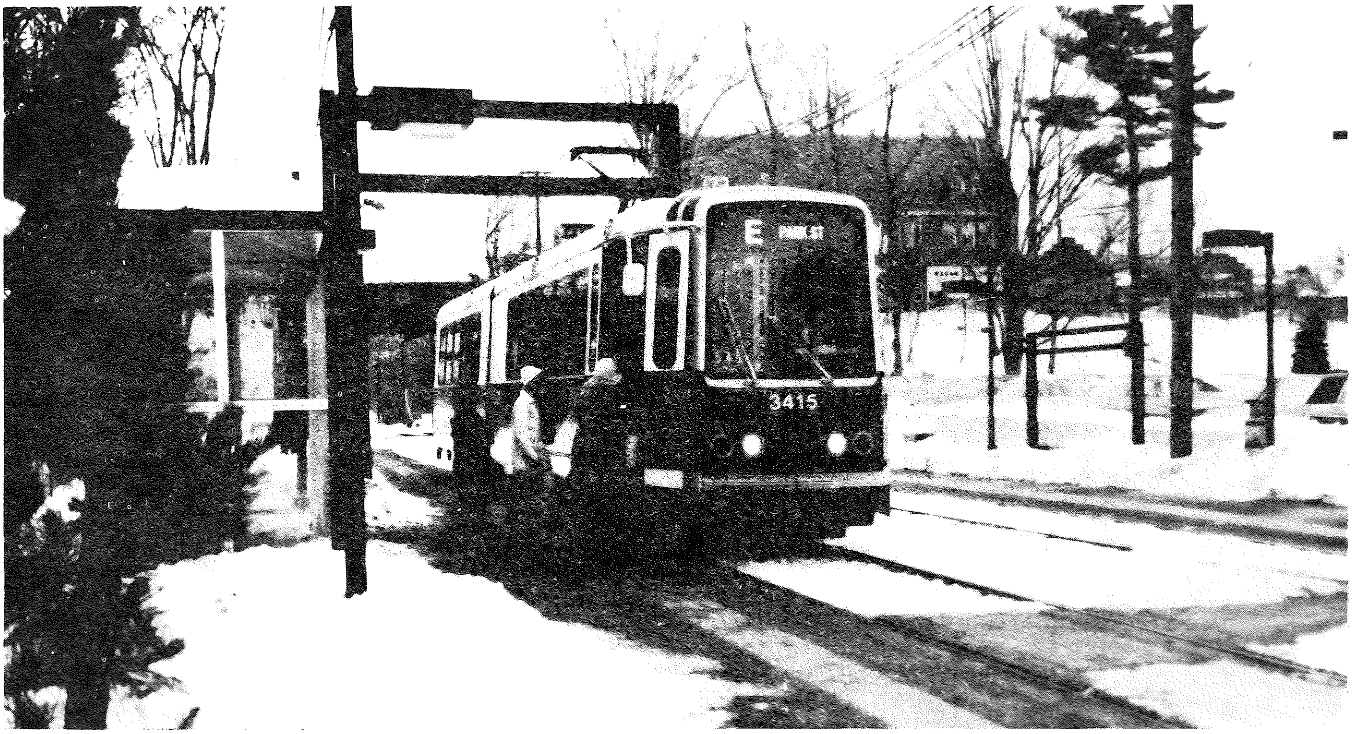
Passenger capacity of LRT vehicles bears a close relationship to car length, although the number of seats will affect total capacity. The new, single unit Canadian light rail vehicle has 46 seats and room for 85 standees for a total of 131 passengers. The West German designed U-2 vehicle, which has been delivered to Edmonton, Calgary and San Diego, has 64 seats plus 97 standees for a total capacity of 161 passengers. The 71 foot, two-unit Boeing light rail vehicle, which has been used as a basis for all calculations in this study, has 68 seats and a planning capacity of 140 passengers. Most light rail vehicles have couplers to permit multiple car operations. A two-car train of Boeing vehicles, operated by one crewman, would provide a total planning capacity of 280 passengers.

Relatively close station spacing requires high performance in order for LRT to provide competitive travel time. State-of-the-art vehicle technology demonstrates this performance is achieved. In addition, operating noise generated by typical, modern LRT vehicles is less than that of buses. With regard to providing full access for the elderly and handicapped, light rail vehicles can be equipped with chair lifts in conjunction with low level platforms.

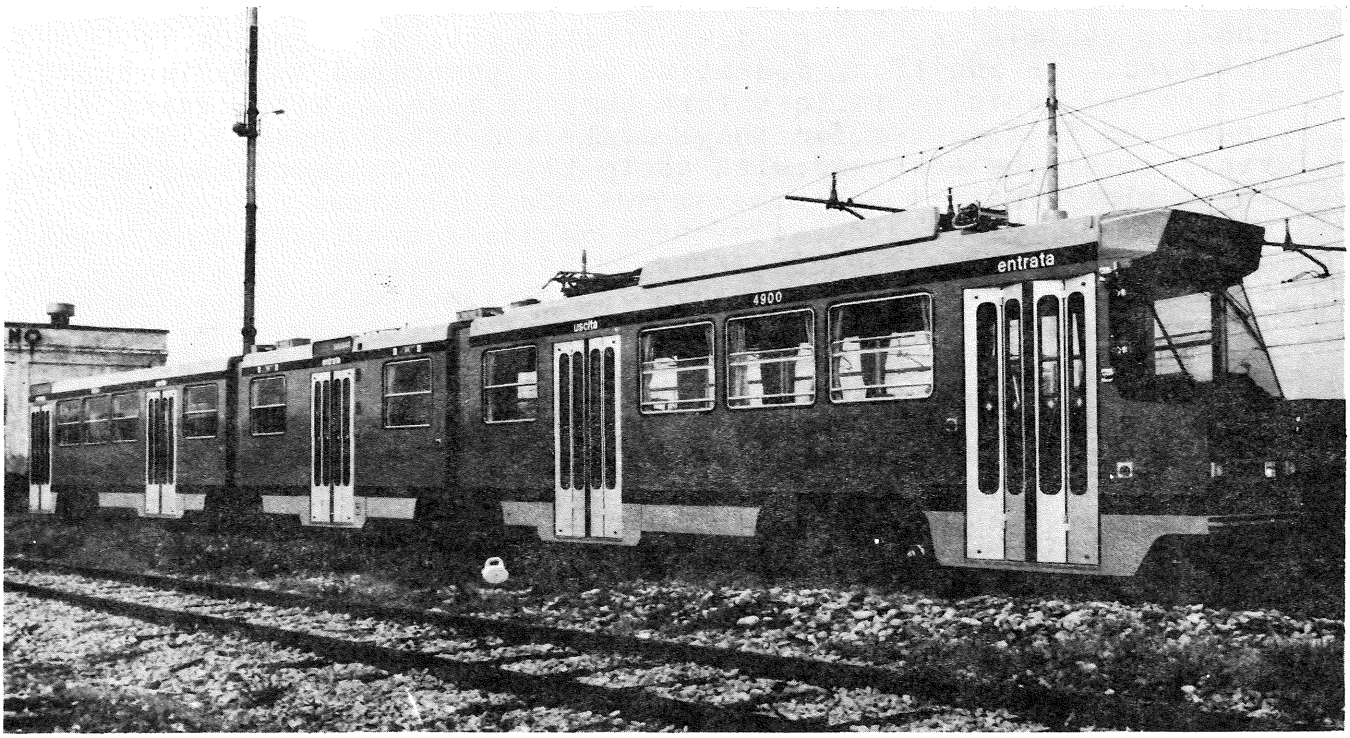
Stations

Stations for LRT need not be elaborate and do not require cashiers. In the United States, fares are usually collected on board by the operator, while in Europe there is a widespread practice of self-service fare collection whereby the operator is relieved of all responsibilities for the function. In this study, it is assumed that some form of self-service fare collection will be employed. This affects operating costs and speed assumptions.

Platforms are usually 75 to 250 feet in length. They can be as simple as a loading area that is delineated by pavement markings in a city street to a full, high-level platform of the type that is found in heavy rail transit systems. Designs can be

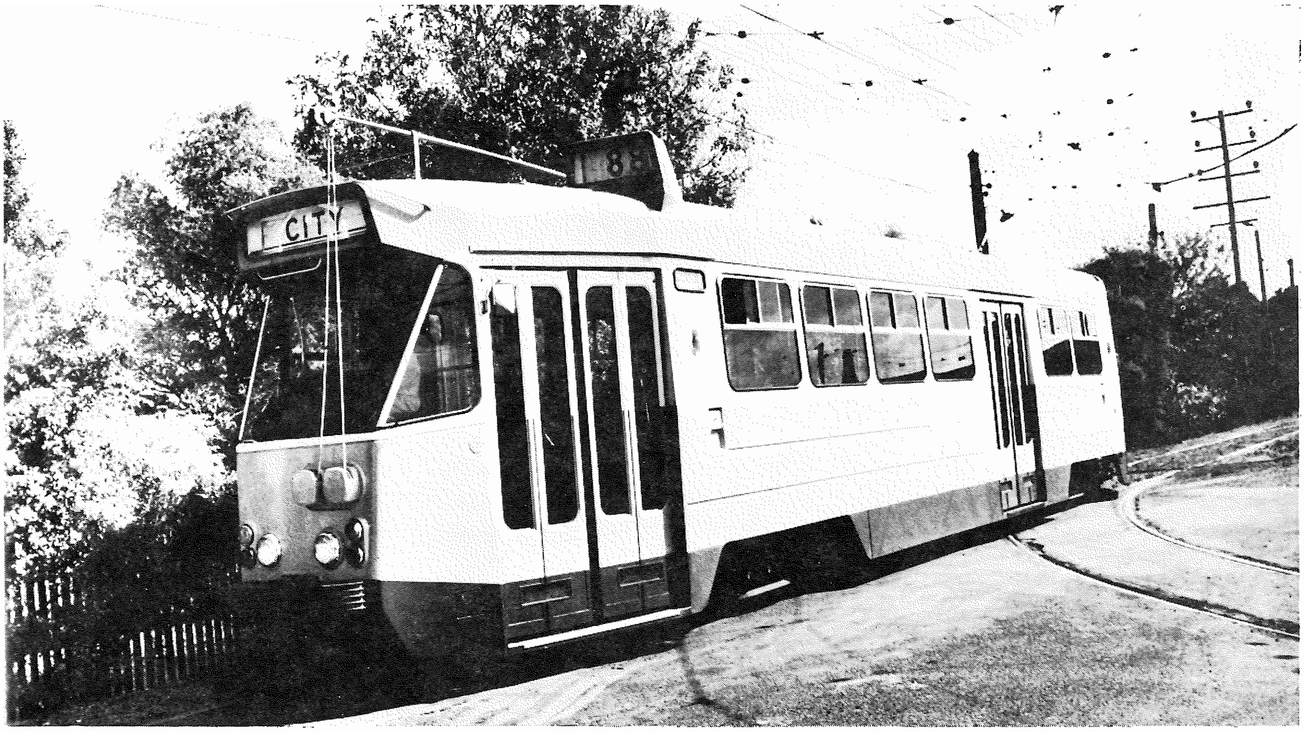


The United States Standard Light Rail Vehicle, manufactured by the Boeing Company, has been acquired by the transit systems in San Francisco and Boston, where it is seen here on the upgraded Riverside Line.



One of the longest (95 ft) urban light rail vehicles, this eight-axle car operates in Milan, Italy. It has 80 seats and a standee capacity of 210.

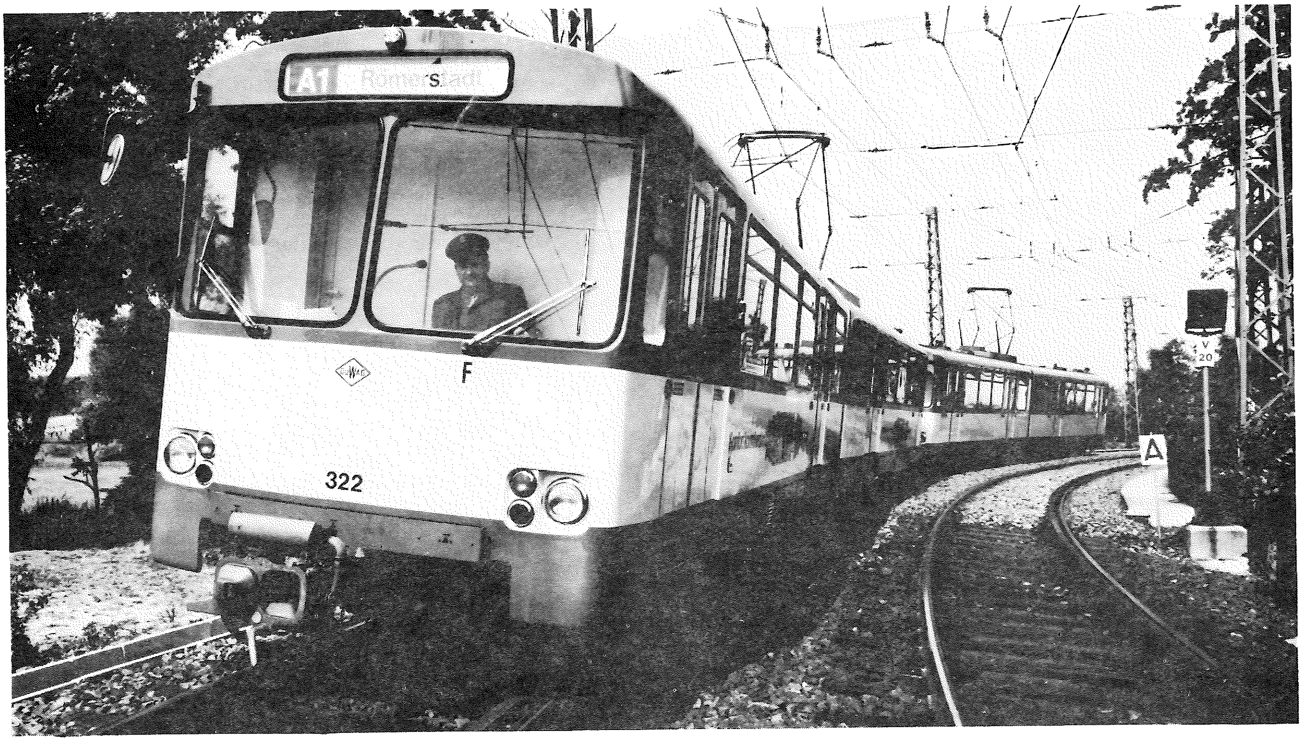
FIGURE I-1. VEHICLES.



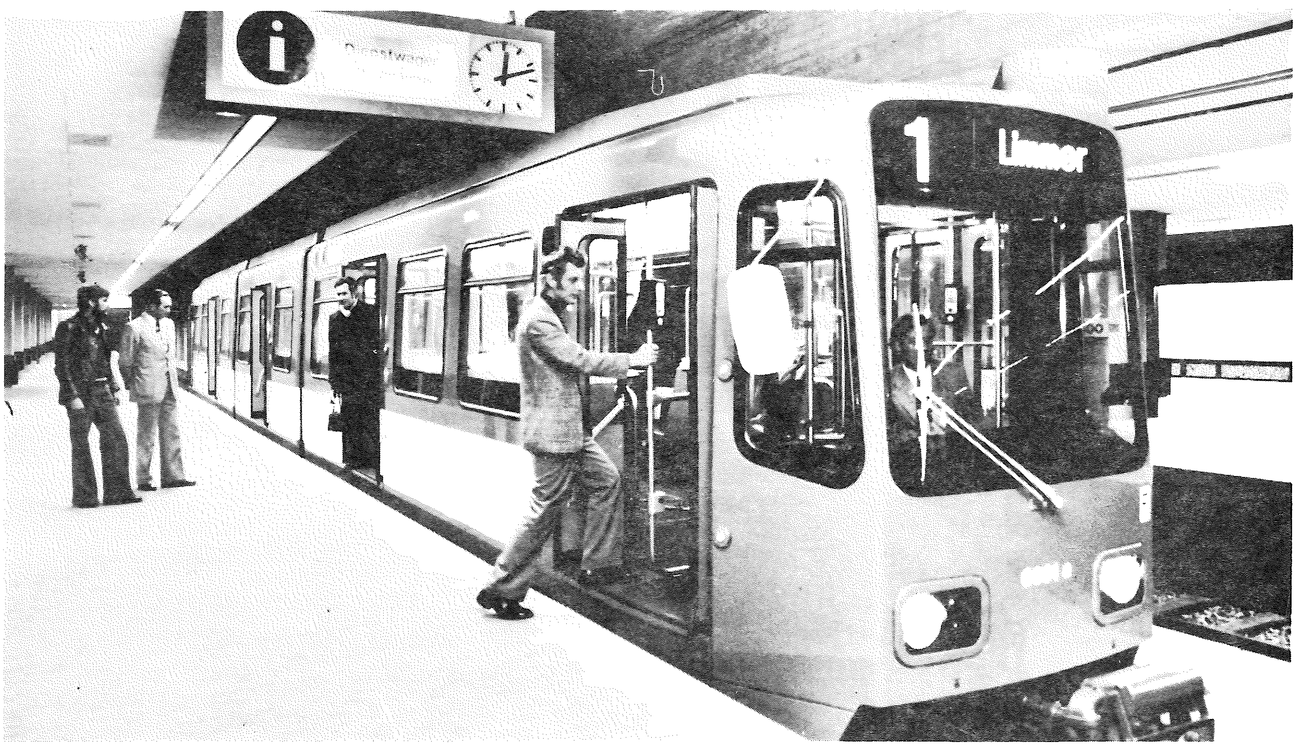
This single-unit vehicle is one of an original fleet of 115 placed in service by the Melbourne, Australia transit system in 1975. A second order for 100 of these double-ended cars is now being delivered.

These three-unit vehicles were manufactured in Belgium for the expanding Brussels "premetro" light rail transit system. All trucks are powered.

FIGURE I-2. VEHICLES.

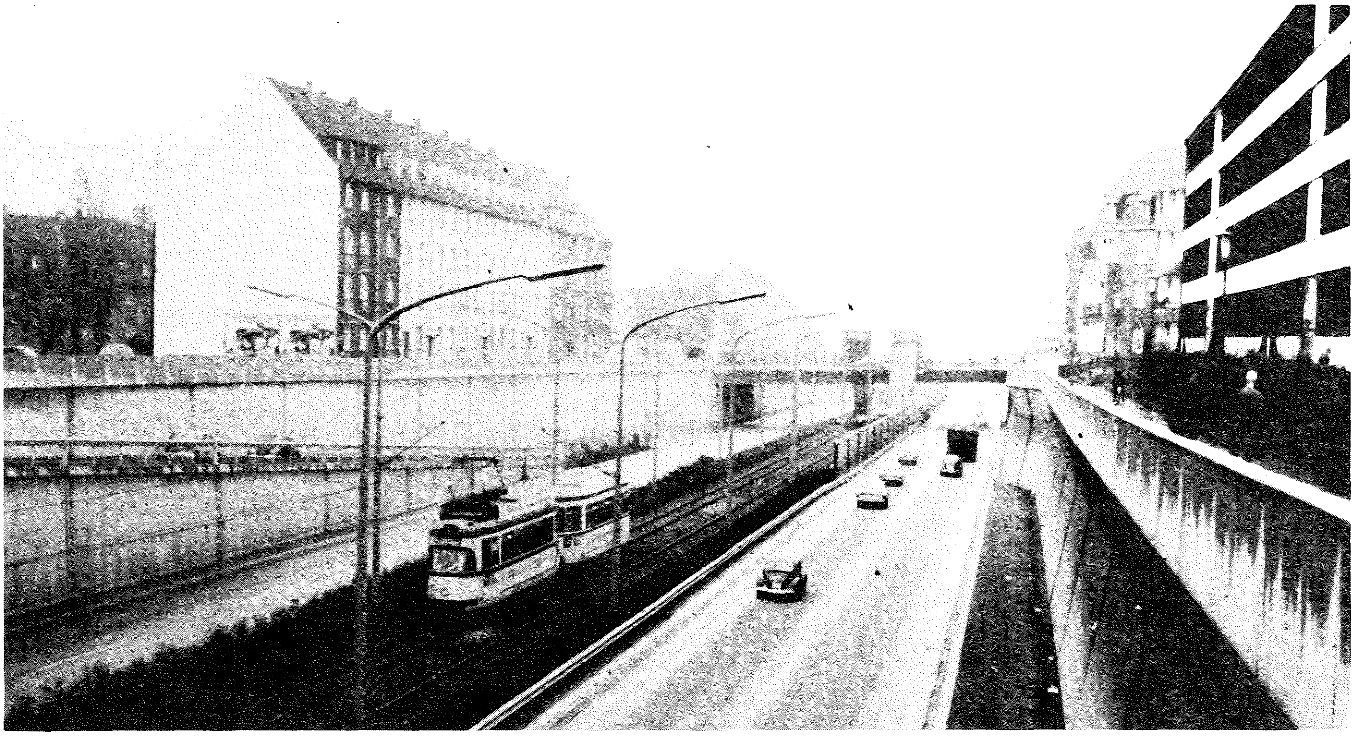


Light rail transit reaches the highest level of performance when located on its own right-of-way as demonstrated by this Frankfort, West Germany suburban line. The U-2 type vehicle has also been delivered to Edmonton, Calgary and San Diego.



More than a score of cities have modernized their street railway systems by placing certain segments in subway. The upgrading process can occur on an incremental basis as financial resources become available.

FIGURE I-3. RIGHTS-OF-WAY.



Expressway medians are ideal locations for high speed LRT operations as seen in this view of West Germany's Autobahn through the Ruhr metropolis of Essen.

Downtown alignments in street medians or pedestrian malls provide the highest degree of passenger access at minimal cost. Operations can be speeded by LRT preemption of traffic signals.

FIGURE I-4. RIGHTS-OF-WAY.

tailored to the site and can incorporate simplicity and low-cost characteristics. In the study, a uniform station design has been adopted for all locations: a 150 foot, low-level platform with two off-the-shelf bus shelters.

Operations and Control

The separation of LRT lines from general traffic permits higher running speeds and more reliable schedules. However, more positive control of vehicle movement is required. On the street the operation may be under total control of the driver, while on separated rights-of-way where higher speeds are practical some form of automatic train control is advisable. The study provides for manual, line-of-sight operation on the downtown, street-running segments. For the private rights-of-way, which comprise more than 90 percent of the total alignments, a conventional electric block signal system has been incorporated into the hypothetical lines. The system includes an automatic stop to bring the train to a halt if the driver does not respond to the red indication.

CHAPTER II

METHODOLOGY

METROPOLITAN DEVELOPMENT GUIDE POLICIES

The feasibility of any proposed public facility or function must be measured against a set of policies or goals that have been established by the community to be served. For this study of the feasibility of LRT the Project Management Team extracted from the Transportation Development Guide/Policy Plan a set of five regional policies which must be met if the proposed transit mode is to be a logical candidate for future implementation.

Policy #1

Provide metropolitan residents with good accessibility to subregional and regional opportunities.

Discussion. This policy emphasizes the need for good accessibility for downtown oriented travel where generally regional opportunities are located and for trips that remain within subregions or localized market areas with basic necessities for daily living (employment, shopping, health care, education, recreation and government centers).

For the purpose of this study, accessibility should be determined in terms of travel time between home and the desired activity or opportunity (home-to-work, home-to-shop, etc.). Greater priority should be given to providing good accessibility to the Metro Centers of Minneapolis and St. Paul because all of the selected corridors are primarily downtown oriented. Accessibility to subregional opportunities, however, should also be taken into consideration according to the specific characteristics of each corridor.

Policy #2

Provide residents of the Urban Service Area, as defined in the Development Framework, with efficient, convenient and attractive alternative choices of transportation to both subregional and regional opportunities.

Discussion. This policy indicates that the region must strive for a well balanced and integrated transportation system including both highway and transit facilities and services that provide alternative choices of transportation to the residents of the Urban Service Area. For the purpose of this study, the ability of an LRT line to be an efficient, attractive and convenient alternative to the automobile and to interface with other transportation needs should be assessed. Although greater priority should be given to downtown oriented travel, attention should be paid, whenever justified, to the potential of an LRT line to satisfy subregional travel demand.

Policy #3

Utilize transportation to strengthen the two Metro Centers as the major employment, financial, institutional, retail, cultural, entertainment, medical and service centers for the Metropolitan Area, the State of Minnesota and the Upper Midwest area of the United States.

Discussion. This policy implicitly recognizes the close relationship between transportation and land use and the ability of the transportation system to foster development at specific locations such as major transit stations. It also expresses a regional commitment to the development of two strong downtowns in Minneapolis and St. Paul as key activities centers at the metropolitan, state and supra-state levels, and encourage the utilization of the transportation system as a vehicle to achieve it.

Policy #4

Coordinate metropolitan transportation service and investments with the other metropolitan services and investments; determine priorities on the basis of overall metropolitan needs and the ability of the Metropolitan Area to support the needed services and investments over time.

Discussion. Policy #4 indicates that investments for construction and operation of the transportation system should be viewed within the overall context of the metropolitan investments and that priorities should be established accordingly. It also stresses that transportation investments should be justified on the basis of need and the financial ability of the area to respond to these needs. Capital, maintenance and operating costs are to be considered in determining the ability of the area to support these investments.

Policy #5

Provide transportation facilities and services that produce positive impacts upon the social, economic and physical environment and will conserve the supply of metropolitan energy resources.

Discussion. This policy recognizes the social, economic and environmental impacts of the transportation system and the need to implement those facilities and services that can produce positive impacts. The conservation of energy resources is also identified as an important metropolitan strategy to be strongly considered in the design, implementation and operation of transportation facilities and services.

DEFINITION OF FEASIBILITY

Feasibility, for purposes of this study, is defined as the capability of LRT to attain the regional transportation goals in comparison with other transit alternatives.

The definition includes the reasonableness of implementing an LRT line from a technical, economic, institutional, operational and financial standpoint.

STUDY ASSUMPTIONS

A number of assumptions were made as to general conditions and LRT operating practices in the period 1990 to 2000. They are as follows:

1. There will be no catastrophic cut-off of external petroleum supplies, of long duration.

2. There will be no widespread breakthrough in alternative automobile power technology.

3. There will be no major changes in the highway network or Metro Center parking capacity other than what is currently under construction.

4. Self-service fare collection will be employed on the LRT line.

CORRIDOR SELECTION PROCESS

At the start of the study the Project Management Team examined 15 corridors demonstrating major travel demand and selected four in which the feasibility of LRT was to be assessed (The corridors are shown on Figure II-1.):

1. Minneapolis West/Southwest

2. St. Paul-Minneapolis

3. St. Paul Northeast

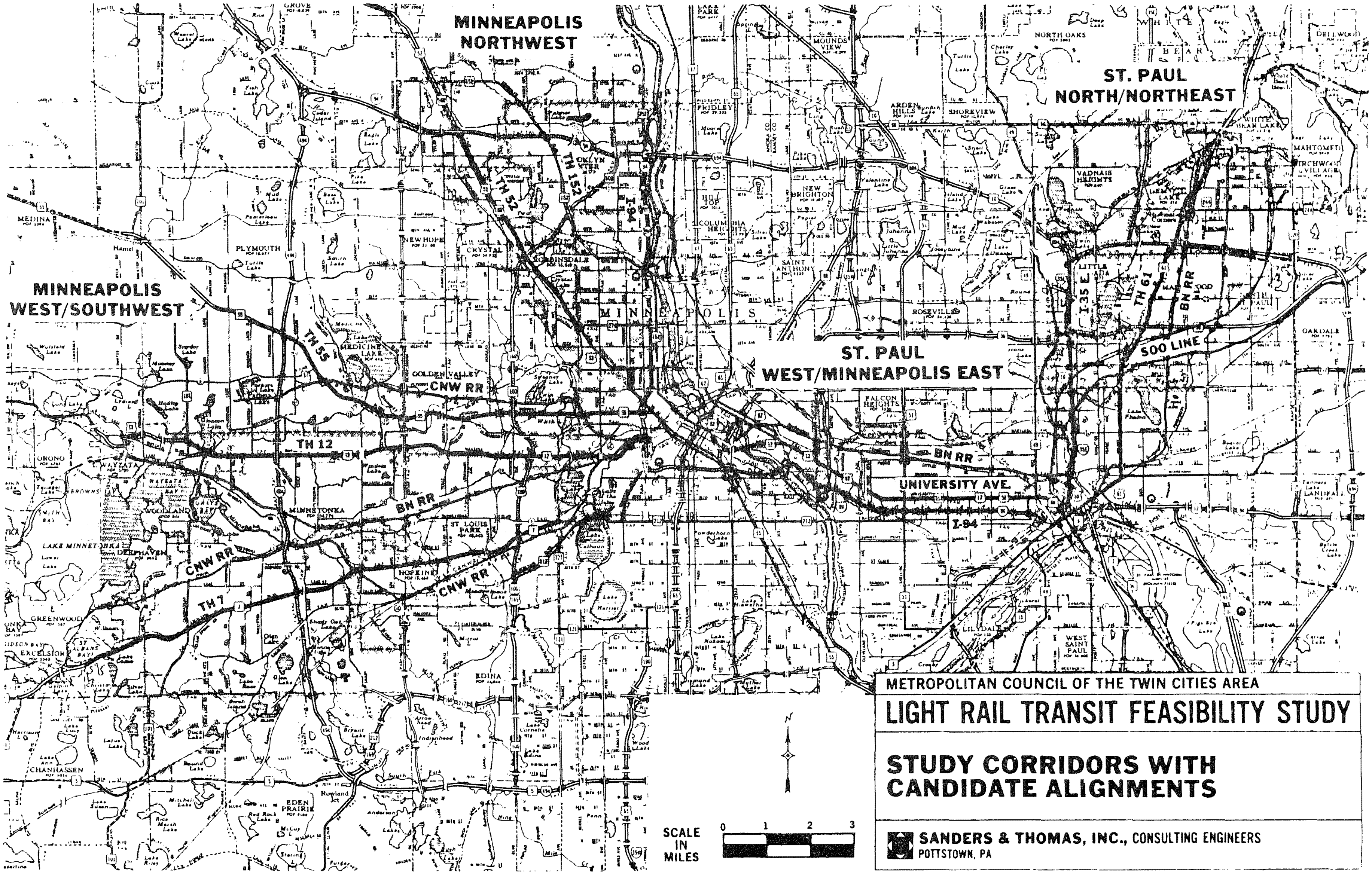
4. Minneapolis Northwest

The selection procedure was carried out in *three stages*. However, there were four basic criteria which applied throughout the investigation.

1. The selected corridors should have high potential for light rail (travel market, right-of-way availability, urban development potential, etc.).

2. The selected corridors, when analyzed, should provide a maximum of information which can be applied to similar corridors.

3. The selected corridors, when analyzed, should illustrate the viability of light rail under different service characteristics and travel demand (person and transit trips).



MINNEAPOLIS NORTHWEST
ST. PAUL NORTH/NORTHEAST
MINNEAPOLIS WEST/SOUTHWEST
ST. PAUL WEST/MINNEAPOLIS EAST
TH 152
TH 52
I-94
TH 55
CNW RR
TH 12
BN RR
UNIVERSITY AVE.
I-94
CNW RR
TH 7
CNW RR
I 35 E
TH 61
BN RR
SOO LINE
MINNEAPOLIS
MEDINA
PLYMOUTH
NEW HOPE
CRYSTAL
ROBBINSDALE
FRIDLEY
COLUMBIA HEIGHTS
SAINT ANTHONY
NEW BRIGHTON
ARDEN HILLS
SHOREVIEW
MOUNDS VIEW
NORTH OAKS
VADNAIS HEIGHTS
ROSEVILLE
FALCON HEIGHTS
GOLDEN VALLEY
MEDICINE LAKE
WAYZATA
ORONO
WOODLAND
DEEPHAVEN
MINNETONKA
ST LOUIS PARK
HOPKINS
EDINA
GREENWOOD
EXCELSIOR
CHANHASSEN
EDEN PRAIRIE
LILYDALE
WEST SAINT PAUL
OAKDALE
MAHTOMEDI
DELLWOOD
LAKE MINNETONKA
SCALE IN MILES
0 1 2 3
METROPOLITAN COUNCIL OF THE TWIN CITIES AREA
LIGHT RAIL TRANSIT FEASIBILITY STUDY
STUDY CORRIDORS WITH CANDIDATE ALIGNMENTS
SANDERS & THOMAS, INC., CONSULTING ENGINEERS
POTTSTOWN, PA

FIGURE II-1

4. The selected corridors analysis should establish refined feasibility criteria which can be used to identify and plan for specific line proposals in the study and other corridors in the Metropolitan Area.

First Stage

The first stage of the process defined the corridor as reflected by *travel sheds* and in the context of existing regional transportation policies. The following criteria were used:

1. The corridor must serve both the Metro Centers or one Metro Center and a suburban subregion.
2. The travel shed of a corridor is the area of trip attraction to a route using minimum time paths to the CBD. The area is adjusted to reflect probable transit operations.
3. The travel shed of a corridor may also be defined along a major travel desire line to the CBD.
4. The corridor may not extend beyond the Metropolitan Urban Service Area (MUSA) and the line will terminate at least 3 miles inside the MUSA boundary.

Second Stage

In the second stage numerical values were applied. The criteria for the second "cut" were:

1. Market by Travel Shed
   a. Forecasted Year 2000 person trip demand through the corridor of CBD bound travel
   b. Forecasted Year 2000 work trip demand through the corridor of CBD bound travel.
   c. Forecasted Year 2000 work trip transit usage through the corridor of CBD bound travel
   d. Present transit usage through the corridor

2. Market by Subregion

   a. Forecasted Year 2000 person trip demand-subregion to CBD

   b. Forecasted Year 2000 person trip transit demand-subregion to CBD

   c. Forecasted Year 2000 work trip demand-subregion to CBD

   d. Forecasted Year 2000 transit trip demand-subregion to CBD

3. Congestion forecast in the corridor on the Metro Highway System

Third <u>Stage</u>

Nine candidate corridors emerged from the second stage evaluation. These were then subjected to a third set of criteria which led to the final selection of the four corridors enumerated above. There were *five criteria* used in the third stage evaluation:

1. Available rights-of-way

2. Available background studies

3. Potential for development (or redevelopment)

4. Representatives of different collection and/or distribution needs

5. Unresolved capacity deficiencies in the corridor

ALIGNMENT SELECTION PROCESS

Each of the four corridors identified for further study has a number of alignments which, from a strictly physical standpoint, could be suitable for an LRT right-of-way. However, it was necessary to consider two other critical aspects: 1) potential patronage and 2) land use impacts.

Potential Patronage

The determination of the best alignment from a patronage standpoint was carried out by a sketch planning process.

Sketch planning is a tool for rapid and inexpensive testing of several alternatives to ascertain differences among them and to provide insight into the preferred alternative. It is performed by the utilization of a computer model. This study used the sketch planning model previously developed for the Twin Cities. The model is based on the regional planning models, particularly the modal split model, and is designed to test express transit and/or high occupancy vehicle lanes.

The sketch planning model was used to aid in determining which alignments in the four specified corridors best attracted patronage to an LRT line. The model does not test networks of lines but only individual lines superimposed on the existing transit and highway system. All possible alignments in each corridor were tested and only those parameters necessary for realistic comparison were altered. All other parameters were kept constant to permit comparisons.

The Working of the Model. The Twin Cities Sketch Planning Model generates an express line--as specified by the parameters --which originates at the zone centroid of a specified zone and proceeds at a specified angle, distance and speed. This line is incorporated into the network through centroid connectors to all "corridor" and "CBD" zones perpendicular to the line. It is compared in the modal split process to ubiquitous local radial and non-radial service, operating at a uniform speed with zone specific headways.

The output of the model is a summation of travel by local and express transit between the defined corridor, the CBD and other zones, a total entering and exiting trips by half-mile increments along the lines and a listing of trips generated within each zone for the express lines, local transit and autos. These data can be used to plot volumes along the line and analyze trip origins.

Since little information is used to define the line, the alignment is at best, an approximation of the actual alignment under consideration. Alignments with major changes in the direction of the line can only be simulated using segmentation techniques and are less precise than simulations of fairly straight lines. However, reasonable volumes can be calculated by combining model runs.

Alignments Tested. All alternative alignments were tested in each corridor including those considered marginal based on superficial examination. Some alignments require the use of railroad rights-of-way on main lines with frequent train service. Some alignments require removal of two traffic lanes from freeways or arterials. However, these limitations were not considered sufficient basis for determining that a potential alignment was not feasible and should not be considered. Rather, it was decided to test all alternatives and use that information in comparing alignments to determine the best alignment for detailed analysis. Analysis results are shown in the Technical Supplement.

Assumptions. For testing alignments (but not determining patronage on the selected alignment), a number of the parameters in the sketch planning model were kept constant to permit comparability. Many parameters can be varied to test the impact of different relationships and operating assumptions within a corridor. These constant assumptions include:

- o Express line headway of 3.0 minutes
- o Constant fare assumptions
- o Walking distances up to 0.5 mile
- o Circuity factors of 1.35 for local transit and 1.10 for express transit
- o Constant auto operating costs
- o Local transit speed of 12 mph
- o Express transit speed of 25 mph for exclusive right-of-way (medians or railroad rights-of-way) and 15 mph for on-street operations (raised median, but with an at-grade crossing every block). Note that speeds were determined more accurately for the chosen alignments. Constant speeds were used to enhance comparability.

For each alignment, zones with walk and bus accessibility were defined, based on assumed bus realignment to feed the LRT line. Radial local headways were increased to between 20 and 50 minutes on the assumption that most local radial bus service would be replaced by the LRT line. Additional zones with likely auto access to the LRT line were also designated. The line was defined using the closest approximation to the actual alignment possible with a straight line. Where railroad rights-of-way and highways were parallel or nearly parallel, only one test was run to determine the potential for both alignments, since the model is not sensitive to such fine distinctions.

Land Use Impact

The second aspect to be analyzed in selecting the best alignment in each corridor was land use impact. The consultant's approach to determining probable land use impacts associated with LRT development in the Twin Cities require research in the following four major categories:

1. Review of Literature on Land Use Impacts Associated with LRT Development.

2. Delineation of Municipal Land Use Perspectives and Control Policies.

3. Vacant and Underutilized Land Analysis.

4. Establishment of Key Development Indices.

Literature Review. A substantial number of books and reports by land use consultants and governmental agencies were acquired addressing the actual or projected land use impacts resulting from LRT or other rail projects in various North American cities.

The general consensus among those who have studied the impacts of light rail transit on land use development is that while LRT will not create development, it will help shape and probably speed up development that would have taken place in any event. The existence or absence of an LRT system is but one factor on which a development decision is based.

Other equally important factors include general economic trends, local land use policies, and the general desirability of the land parcel including location, size, topography, visual appeal and legal encumbrances. An additional factor that appears to be gaining increasing importance in shaping development decisions is the attitudes and perspectives of the communities and neighborhoods in which specific parcels of land are located. All of these factors need to be taken into account when assessing the land use impacts associated with LRT implementation.

Municipal Land Use Perspectives and Control Policies. Every municipality in the region has a different perspective on what constitutes acceptable development. These perspectives are reflected, to some degree, in the land use policies instituted by these communities. Beyond these institutionalized policies, it is important to understand the tendencies toward development that are shown in the actions and perspectives of key municipal officials and planners.

Key planners and officials in all 17 municipalities located within the four study corridors were interviewed. The purpose of these meetings was to obtain all relevant land use information pertinent to the study and to review with these individuals the availability and viability of vacant parcels of land for development. A copy of the questionnaire used in these meetings is shown in the Technical Supplement. The detailed information received from these individuals was compiled, combined with data obtained from individual comprehensive plans, and refined into summary profiles. Copies of these profiles are included in the Technical Supplement.

Vacant and Underutilized Land Analysis. Municipal officials and planners possess a wealth of up-to-date information on the availability and suitability of vacant land or underutilized developable land in their communities. These individuals can also speak directly to any pending discussion regarding disposition of these parcels and the kinds of uses considered most appropriate by city councils and affected neighborhoods.

A preliminary review of developable vacant land was made as part of the interview process with municipal planners. Key parcels of vacant land were outlined on each municipality's land use map and were numbered for identification. Questions were then addressed to the planner relative to each of the numbered parcels. An example of the information obtained for a parcel of vacant land in Brooklyn Park is shown in the Technical Supplement.

Establishment of Key Development Indices. Any effort to assess land use impacts from development of an LRT line in the Twin Cities must take into account the time delays required in planning, financing and constructing such a line. This study assumes a 1990 target date for LRT. The need, therefore, is to provide some objective basis for projecting current development patterns ahead to 1990. Obviously, many developable land parcels that exist today will not be available for development a decade from now.

Field Examinations

In a final step of the alignment selection process the consultant made a series of field trips to look at candidate alignments in each corridor. Over the 4 days required for this task the consultant team was accompanied by representatives from the Metropolitan Council, Metropolitan Transit Commission and Minnesota Department of Transportation. Every alignment was visually inspected as to surrounding land use. Each was compared to the others in the corridor by consideration of such factors as right-of-way availability, travel conflicts (highway and railroad), type and level of immediately adjacent activity, and the potential for future land development.

ALIGNMENT SELECTION FACTORS

Throughout the selection process the consultant and Project Management Team were guided by a series of alignment selection factors which served as a distillation of all aspects which were required to be considered. Those factors included:

1. The Metro Centers should be served.
2. Activity centers outside the Metro Centers should be served.
3. There should be adequate alignments which do not require heavy capital expenditures.
4. Maximum use should be made of existing rights-of-way established by railroads and highways.
5. The streetcar mode should be minimized.
6. There should be relatively favorable ridership projections.

7. Concentrations of existing population should be served.

8. Concentrations of employment should be served.

9. Areas of potential development or redevelopment should be served.

10. There should be coordination with other modes of transportation.

FEATURES EVALUATED

Once the specific alignments were selected, a new phase in the study was initiated. Station (stop) sites were selected on the basis of the road network, potential walk-on traffic, development potential and land availability for parking lots. The investigation of land use impact could then focus more accurately on target sites. New calculations of ridership were made. Methodology for the latter is described below.

Quantities for all materials required for the right-of-way and rolling stock were developed. These served as inputs to cost calculations. Train operating schedules were developed in order to determine total vehicle, manpower and electric power requirements.

All capital and operating costs were calculated. A constant transit fare assumption of $0.50 was used throughout. Revenues were, in turn, compared with costs.

PATRONAGE FORECASTING

For the final step in determining ridership on each of the five alignments in the year 2000 the following procedures were used: 1) The sketch planning model was employed to determine daily and peak hour boardings and loadings; 2) Model runs were made for each segment on the five lines; 3) On each line the average speed from downtown for each segment was used as a speed; 4) Circuity factors were calculated on the basis of the actual alignment.

The output of the sketch planning model Production and Attractions Home-Based Work Summary Trip Tables was plotted on Traffic Analysis Zone Maps as the base volumes to be assigned to the line. Appropriate segment runs were used for each zone. With the use of the base trip tables from the regional models, factors were developed to factor home-based work trips to total trips (peak hour and ADT). Revised bus routings were developed in each corridor to feed the LRT and replace direct service downtown, where appropriate. Further detailing of the patronage forecasting methodology is included in the Technical Supplement.

COST ANALYSIS

Capital expenditures and operating costs were estimated for each recommended alignment. Capital cost estimates are based upon the most recent light rail construction cost data available, adjusted for local conditions. Cost information was obtained from the new San Diego and Calgary light rail systems as well as form current preliminary engineering and feasibility studies now underway in the various United States cities. Vehicle costs are based upon the most recently submitted bids on the Boeing Standard Light Rail Vehicle, inflated to 1980.

Operating costs are based upon 1976 unit cost relationships established in *Light Rail Transit, A State of the Art Review*, United States Department of Transportation, 1976, inflated to 1980.

ENERGY AND ENVIRONMENTAL IMPACTS

The objective in analyzing the impact on the environment was to determine whether overall environmental impacts of LRT based service will be better or worse than those of the alternative service.

The purpose of the analysis was not to develop an environmental impact statement, but a description of impacts. Greater precision will be more appropriate at a later time if an LRT system is to be built.

The Midwest Research Institute's Resource, Energy and Environmental Profile Analysis (REEPA) methodology was applied to produce energy and pollutant impact data. The analysis of the two systems compared operations only. The objective was to compare two alternative systems. Calculating the energy and environmental impact during construction of systems is beyond the scope of this study.

Since REEPA is not designed to produce determination of noise and visual pollution, these were dealt with separately. First, there was a review of literature identifying noise levels associated with modern LRT, buses and high density auto traffic. This was then applied to the vehicular mix, neighborhoods in each alignment and vehicle operations speed to derive conclusions. Finally, a literature review was conducted to determine if LRT has been perceived to be a visual pollutant problem elsewhere.

To analyze the overall impact on the environment by the two alternative systems, several assumptions were made:

1. Coal will be used to produce 100 percent of the electricity used in operating LRT. Nuclear is projected to be some factor through the year 2000, but it is currently impossible to predict the environmental impact. The only new plants projected are coal generating, and in any case, coal will be the source for the majority of electricity produced.

2. Most automobiles on the road will be powered by gasoline, with diesel, gasohol and electric powered cars as a minor factor.

3. Automobile fleets will have a 10 year lifespan.

4. Automobile fleet efficiencies will continue to improve past the end of current guidelines in 1985.

5. Bus fleet efficiencies will not show measurable improvement during the period being studied.

LAND USE IMPACTS

Introduction

A light rail transit (LRT) line in the Twin Cities will offer the potential of improved individual access to major residential, commercial and industrial centers along or at either end of the transit alignment. It is this improved accessibility--both real and perceived--that, in turn, can influence the value and desirability of land located along the line.

At the same time, it is important to recognize that while LRT can influence development patterns, it cannot dictate them. Along any of the LRT study alignments some amount of development is likely to occur. The extent of that development will depend on a variety of factors, of which LRT deployment is but one. These other key factors include:

1. The availability of relatively large and unencumbered parcels of land
2. The desirability of the land and the character of surrounding development
3. The prevailing economic conditions, community support and public land use policies impacting on development or redevelopment along the alignment

Land use impacts are determined by economic forces and local public policies. To the extent that an LRT reinforces these factors, it can help focus and concentrate the development that occurs. The key to assessing the land use impacts associated with LRT development is to sort out the residential, commercial and industrial growth linked to the introduction of the LRT from growth that would have occurred in any event along the alignment.

LRT Impact in Other Cities

The study of transit induced land use impacts is by no means an exacting science. Most of the research in this country is recent--the last 5 or 6 years--and has focused principally on heavy rail impacts (e.g., the BART system in San Francisco and the METRO in Washington, D.C.). These systems include major station structures with large numbers of people using them. LRT stops are more closely related to bus stops than major structures. Until the opening of the Edmonton, Alberta, system in 1978, there was no developing LRT system that could be studied for land use impacts. Even the Edmonton case is considered less than optimum because of the size and configuration of the city and the unusual, for this country, land use controls available to support high density growth in that Canadian city. As other new or expanded

LRT systems are completed in such American cities as Portland, San Diego, Buffalo and Pittsburgh, more will be learned about the impacts LRT can have on land use development.

From the transit impact studies that have been published to date, there is evidence of a number of impact patterns that are very relevant to this LRT impact study. These are:

- o Transit construction will not create development. From a regional perspective, transit will have the effect of shaping and speeding up development that would have occurred in the region in any event. For this reason, direct land use impacts from transit development are subregional and local, impacting on individual neighborhoods and communities.

- o Transportation induced development at an established site will rarely mean a significant change in land use at that site. Given supportive land use policies and local support, the impact of the transit development will be in higher densities, particularly where the site is within a radius of no more than a half mile of a transit stop.

- o The major transportation induced impacts are likely to occur around transit stops where there are large parcels of relatively unencumbered land enhanced by favorable community support and land use policies. The primary factor, however, behind development at that site will be the existence of strong and effective market demand.

- o A number of cities (e.g., Washington, D.C. and Edmonton, Alberta) have underestimated parking space requirements at transit stops.

- o Transit development influences land use by increasing accessibility to a particular site. Unlike the 1950's and 1960's, when transportation system expansion opened up major new tracts of developable land, most current transit development overlays an existing transportation system, resulting in much less real improvement in accessibility.

- o Land use expectations play a major role in amplifying both positive and negative impacts.

- The timing of land use impacts seems largely dependent on general economic conditions. Where no demand or development capital exists, little, if any, land use impacts will take place along the transit system. Five years seems to be a minimum wait for substantial impact in most cases. In other cases, it can be much longer or never.

- Land use policy has been found to be one of the most important factors in the generation or prevention of impact. Zoning near LRT stops, in particular, must usually allow intensification of use if any significant impact is to occur.

- Major transit improvements often act as catalysts in the process of land use change, coalescing support for previously contested policy changes. The results can be negative if fear is the motivation such as with a transit stop located within an established neighborhood.

- "The overall development impact of a new transit system may prove somewhat disappointing. The monopoly on rapid movement in urban areas held by mass transit in the early years of this century has long since disappeared. High accessibility is no longer a quality restricted to areas around transit stops, but is enjoyed by innumerable areas within any region. Mass transit today represents only an incremental improvement in the accessibility of selected sites, rather than a wholesale change affecting an entire region."[1]

Study Approach and Methodology

The study approach employed in determining LRT induced land use impacts, along each of the five LRT study alignments, was based on accepted research practices. As a study of LRT feasibility in the Twin Cities, and not an extensive work-up for LRT construction along any particular alignment, the focus of this impact component has been on projecting direct LRT induced land use impacts. The results are land use changes and construction associated with LRT induced development. The study does not include land value impacts, fiscal impacts or other indirect or spill-over impacts. An in-depth assessment at this broader scale would be more appropriately undertaken at a later stage in the LRT planning process.

[1] Administration and Management Research Associates of New York City, Inc. *Transit Station Area Joint Development Strategies for Implementation*, February, 1976.

The basic approach has been to assign specific impacts at the key development points along the alignments--that is, within a half-mile radius of proposed transit stops and the outbound terminus points. The LRT lines as described in this study are not assumed to have a measureable impact on the already fast developing downtown Minneapolis and St. Paul CBD's. Projections of total alignment impacts take into consideration regional and subregional growth projections through the year 2000.

In assessing land use impacts, major emphasis has been given to realistic impact projections, based on specific available and developable land parcels and the experience and judgments of community land use planners and project staff. Specific tasks accomplished are shown in the Technical Supplement.

Underlying Assumptions

The following assumptions underlie the land use impact study:

- o An LRT line would be built and operating January 1, 1990, with no speculative LRT-induced development preceding that date.
- o Only one LRT line would be constructed, that one being the particular alignment being studied at the time.
- o LRT-induced land use impacts would occur during the decade 1990 to 2000.
- o No measurable LRT-induced land use impacts would occur within either the Minneapolis or St. Paul CBD.
- o Prevailing subregional land development patterns would continue through the end of the century.
- o The Metropolitan Council's development framework and individual community comprehensive plans would not be dramatically revised before the year 2000.
- o Local zoning codes, density allowances and land use control policies would not be changed drastically before the year 2000.

- o The only land use impacts considered would be direct consequences of LRT development. (The study does not consider indirect and fiscal impacts.)
- o The Metropolitan Council data base accurately projects development growth in the subregion.
- o The analysis of land along the West alignment (TH12) assumes adoption of the proposed I-394 route alignment changes.

Since the development of an LRT line in the Twin Cities Area is only at the speculation stage at this point, the study of LRT impacts must be based on a number of "givens." In all cases, these assumptions can be considered realistic and intended to yield conservative and justifiable results. Since a total of five independent alignments are considered over the course of the study, a consistent set of base assumptions will also enable useful comparisons to be made between alternative alignments. This, in turn, will be useful in the final development of revised Metropolitan Council transportation goals.

PRESENTATION OF THE ANALYSIS

Each of the four study corridors were described separately. In each corridor one alignment was studied except in the Minneapolis West/Southwest where two alignments were studied. In each alignment LRT will be compared to a Non-LRT alternative. The four study corridors and the potential alignments within them are shown in Figure II-1.

Each of the five study alignments is examined in a separate chapter. In these chapters the corridors will be referred to as:

CORRIDOR	DESCRIPTION
Minneapolis West/Southwest	West/Southwest
St. Paul West and Minneapolis East	University
St. Paul North/Northeast	Northeast
Minneapolis Northwest	Northwest

It should be reemphasized that each recommended alignment constitutes an individual LRT line. The discussion of multiple corridors does *not* imply a system.

CONSTANTS

Throughout the five alignment analysis certain aspects will remain constant. Therefore, in order that these not be repeated with each corridor they will be stated here:

Ridership Forecasts

The sketch planning model developed by the Metropolitan Council was used to forecast LRT ridership for work trips. Total daily patronage was generated from these work trip figures based upon factors obtained from the regional model. The sketch planning model also forecasts numbers of passengers using the local bus system that serves the corridor. Additional information on forecasting methodology may be found in the Technical Supplement.

Operating Plan

Operating Plans are based on estimated LRT schedule speeds between stops. Schedule speed includes waiting time at each stop (dwell time) and is estimated based on established relationships of distance between stops, acceleration/deceleration rates, and maximum speed capability. Important assumptions made in preparing speed estimates were:

1. 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/her favor. Some signal preemption equipment is already in place along University Avenue. This study assumes LRT will be able to use this equipment.

2. 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.

Days and Hours of Operation

LRT will operate 7 days a week including holidays. Weekday and Saturday operations will being at 5:00 A.M. and continue until 1:00 A.M. On Sundays and holidays service will begin at 7:00 A.M. and continue until 11:0● P.M.

Annual Vehicle Miles

Annual vehicle miles are an indication of equipment utilization efficiency and are used in this study as one basis of energy impact analysis. Vehicle miles are calculated on the basis of the anticipated number of round trips occurring on weekdays, Saturdays, Sundays and holidays. To this, an additional percentage must be added to account for non-revenue car miles. Non-revenue mileage is primarily for deadheading (trips without passengers to reach maintenance shops, yards, or to the starting point of a revenue run). This percentage cannot be accurately predicted. The actual percentage will depend upon the location of the maintenance shops and storage yards and actual scheduling of revenue runs. It can be assumed that scheduling will be efficient but this study does not explore maintenance and storage yard locations. New systems may initially have high non-revenue mileage due to startup difficulties but, if efficiently planned, non-revenue mileage should be less than 5 percent of revenue miles. For purposes of this study a 3 percent figure has been used for non-revenue vehicle miles, except in the University corridor, where no non-revenue miles were assumed.

Modal Interface

Planning for mode interchange at LRT stops will require close interagency cooperation and coordination. Changes may be required for improved automobile access. These may include establishing one-way streets or revising traffic signals. Bus routes will need to be revised to feed LRT stops. Pedestrian links to the surrounding neighborhood will need to be strengthened.

Automobile Access and Parking. Steps should be taken to assure that commuters who will drive to and park at the LRT stop and those who will be driven to and dropped off at the LRT stop can do so with relative ease. If auto access and parking become problems, patrons will be discouraged from using LRT.

Pedestrian Requirements. If LRT stops are to be successfully integrated into their respective neighborhoods, safe accessibility for neighborhood residents is essential. Sidewalks leading to the LRT stop should be rehabilitated. "Walk" phases may need to be integrated into traffic signal cycles. Lighted walkways should be provided throughout the immediate area surrounding the LRT stop.

Feeder Bus Service. Existing bus service along the study corridors will need to be realigned to create new bus routes to connect neighborhoods to LRT stops and to eliminate parallel service.

Capital Costs

For each alignment there are four aspects of capital costs. These are: 1) right-of-way acquisition; 2) construction; 3) vehicles; and 4) parking lots.

Right-of-Way Acquisition. Each LRT alignment requires approximately a 36 foot right-of-way for operations plus additional width for LRT stops and yards. Rights-of-way acquisition costs are estimated at $4.00 per square foot except where LRT operates on city streets, in which case no right-of-way costs are included.

Construction. LRT line and infrastructure costs are based upon recent LRT unit costs experienced in such cities as San Diego and Calgary.

Vehicles. Vehicle costs are based upon a 1978 unit cost of $800,000 per Boeing vehicle escalated at 10 percent per annum to 1980 or $968,150 each including $300 per vehicle for on-board traffic signal preemption equipment. The basis for the number of vehicles required is the maximum passenger load point, the number of passengers anticipated during peak hour operations, and a capacity per vehicle of 140 passengers. Vehicle capacity was established to be consistent with Metropolitan Transit Commission (MTC) bus loading philosophy.

Parking Lots. Parking costs are determined by using an average land cost of $4.00 per square foot or $1,600 per space. A construction cost per space of $1,400 is used. This figure is consistent with recent park-n-ride lot costs in the Metropolitan Area.

Operating and Maintenance Costs

Costs are estimated by using established 1976 unit costs escalated at 10 percent per annum to 1980. The number of LRT operators required is estimated based upon established relationships between the number of operators and peak period vehicles. Operating and Maintenance Costs are also estimated for the bus collection and distribution system.

Annualized capital costs are arrived at by determining the useful life expectancy of each major cpaital component and amortizing its cost over this useful life. Annualized bus costs are based upon an MTC maintenance facility cost of $43,560 per bus, an overhaul facility cost of $11,660 per bus, a capital cost of $150,000 per bus, and a useful life of 12 years.

Impact Analysis

Land Use. LRT development will not produce a major shift in land use patterns. As shown in the previous section, the prevailing market demands and land use policies have much more to say about land use changes than will the development of an LRT line. What is likely to occur, however, is an increase in density in complementary uses at or around the individual stop sites.

The projection of land use impacts at each site was based on an analysis of key factors relating to the availability and clear ownership of the land; the physical desirability of the parcel and surrounding development; and the prevailing economic conditions, community support, and public land use policies impacting on development of each site. From this analysis of individual characteristics and development potential, a judgment was made concerning the degree to which each development would have occurred as a direct consequence of LRT development.

In each study alignment, the analysis has assumed current zoning and land use policies.

Energy. Calculation of the energy consumed by an LRT or alternative system consists of vehicle operation of an LRT or an alternative system on an annual basis. It is assumed that the infrastructure for the Non-LRT system will be built in either case. Actual calculation of energy consumption was accomplished by means of a computer model.

Energy impacts are based on the level of operations in the year 2000 and give emphasis to analysis of comparable LRT and Non-LRT systems.

Environment. Analyzing the potential environmental impact of an LRT involves studying both objective data and subjective human reactions. Studies in other cities have not always found objective analyses consistent with the perception of residents.[1] Pollutant loads, noise and visual problems of LRT are described based on calculable data and the expected perception of people affected by the system.

Pollution from the operation of a transportation system will affect the air, water and land. 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.

The pollutant impacts of LRT and Non-LRT alternatives reflect the pollution associated with not only the combustion of fuel but also obtaining it at the well or minehead, transporting, refining, etc.

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[1] *Environmental Impacts of BART*, U.S. Department of Transportation, April 1979.

CHAPTER III

WEST/SOUTHWEST CORRIDOR
WEST ALIGNMENT

INTRODUCTION

The West/Southwest Corridor best represents that corridor with longer trips and which would permit higher LRT operating speeds to attract patrons. Major communities in the corridor include: St. Louis Park, Hopkins, Minnetonka, Wayzata, and Golden Valley. Major transportation facilities include several multilane highways (TH12, TH55, TH7), and three rail lines (Chicago and Northwestern, Burlington Northern, and the Chicago, Milwaukee, St. Paul and Pacific).

ALIGNMENT SELECTION

The alternative alignments tested in the West/Southwest are shown in Figure II-1. They are, from north to south:

- C&NW Railroad North of TH55
- TH55
- TH12
- BN Railroad between TH12 and TH7
- TH7
- C&NW/CMTP&P Railroad parallel to TH7

The sketch planning analysis revealed that there was little difference between the alignments in terms of patronage. Therefore, alignment selection was based on factors other than patronage. On the basis of criteria described in Chapter II, and input from the various committees overseeing the project, TH12 and the C&NW Railroad parallel to TH7 emerged as the preferred alignments in the West and Southwest, respectively.

Trunk Highway 12, the selected West alignment, has been the subject of considerable study since its reconstruction as Interstate 394 has been proposed. At its present design stage, LRT or an alternative mode could be incorporated relatively easily into I-394 design. TH12 serves numerous communities and activity nodes along its length, is intersected by several limited access highways, is a prime commuter route, and is generally overutilized by automotive traffic.

LRT ALTERNATIVE

LRT Stop Locations

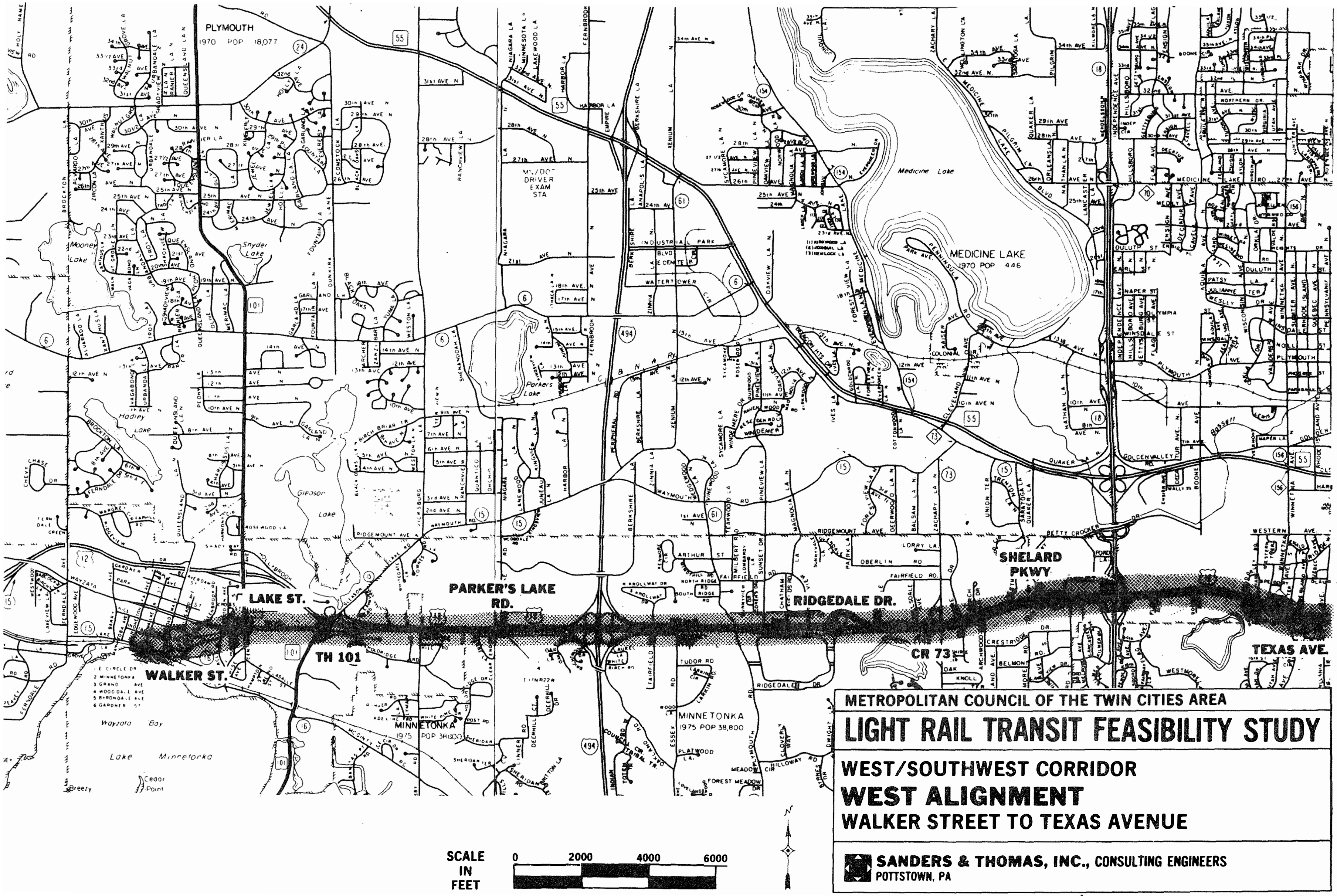
Alignment details and LRT stop locations are shown in Figures III-1 and III-2. Beyond the Minneapolis Central Business District LRT stops are spaced, on the average, just under one mile apart. Within the CBD, stops are spaced, on the average, two-tenths of a mile apart. Stops have been located to maximize patronage potential while not compromising LRT operational capabilities. Table III-1 notes each proposed LRT stop.

TABLE III-1

PROPOSED LRT STOPS-WEST

Walker & Lake Street	Vernon Avenue & TH12
Lake Street & TH101	Tyrol Hills & TH12
TH101 & TH12	Penn Ave. & TH12
Parkers Lake Rd. & TH12	Wayzata Boulevard & Linden Ave.
Ridgedale Drive & TH12	6th St. & 2nd Ave.
CR73 & TH12	Hennepin Ave. & 6th St., South
Shelard Parkway	Nicollet Mall & 6th St., South
Texas Ave. & TH12	2nd Ave.,South & 6th St.,South
Louisiana Ave. & TH12	4th Ave.,South & 6th St.,South
Colorado Ave. & TH12	Chicago Ave. & 6th St., South

FIGURE III-1



METROPOLITAN COUNCIL OF THE TWIN CITIES AREA

LIGHT RAIL TRANSIT FEASIBILITY STUDY

WEST/SOUTHWEST CORRIDOR

WEST ALIGNMENT

WALKER STREET TO TEXAS AVENUE

SANDERS & THOMAS, INC., CONSULTING ENGINEERS
POTTSTOWN, PA

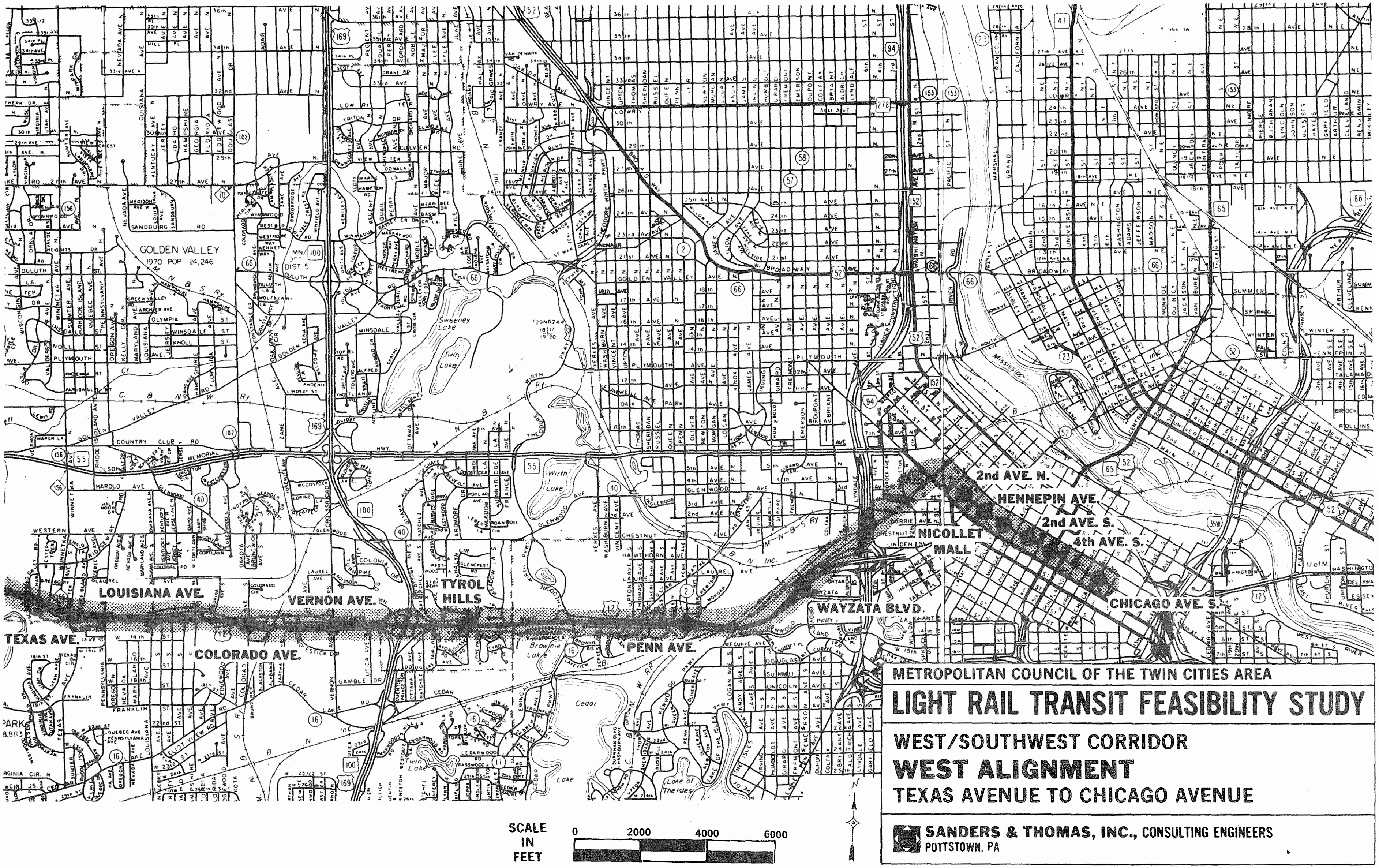


FIGURE III-2

III-4

Ridership Forecasts

Total daily LRT ridership is estimated at 27,800 or 2.6 percent of total travel in the corridor. The number of passengers passing the maximum load point during the peak hour is 2,800.

Table III-2 compares forecasted LRT travel to total corridor travel and corridor travel by other modes. Daily inbound ridership is shown on Figures III-3 and III-4.

TABLE III-2

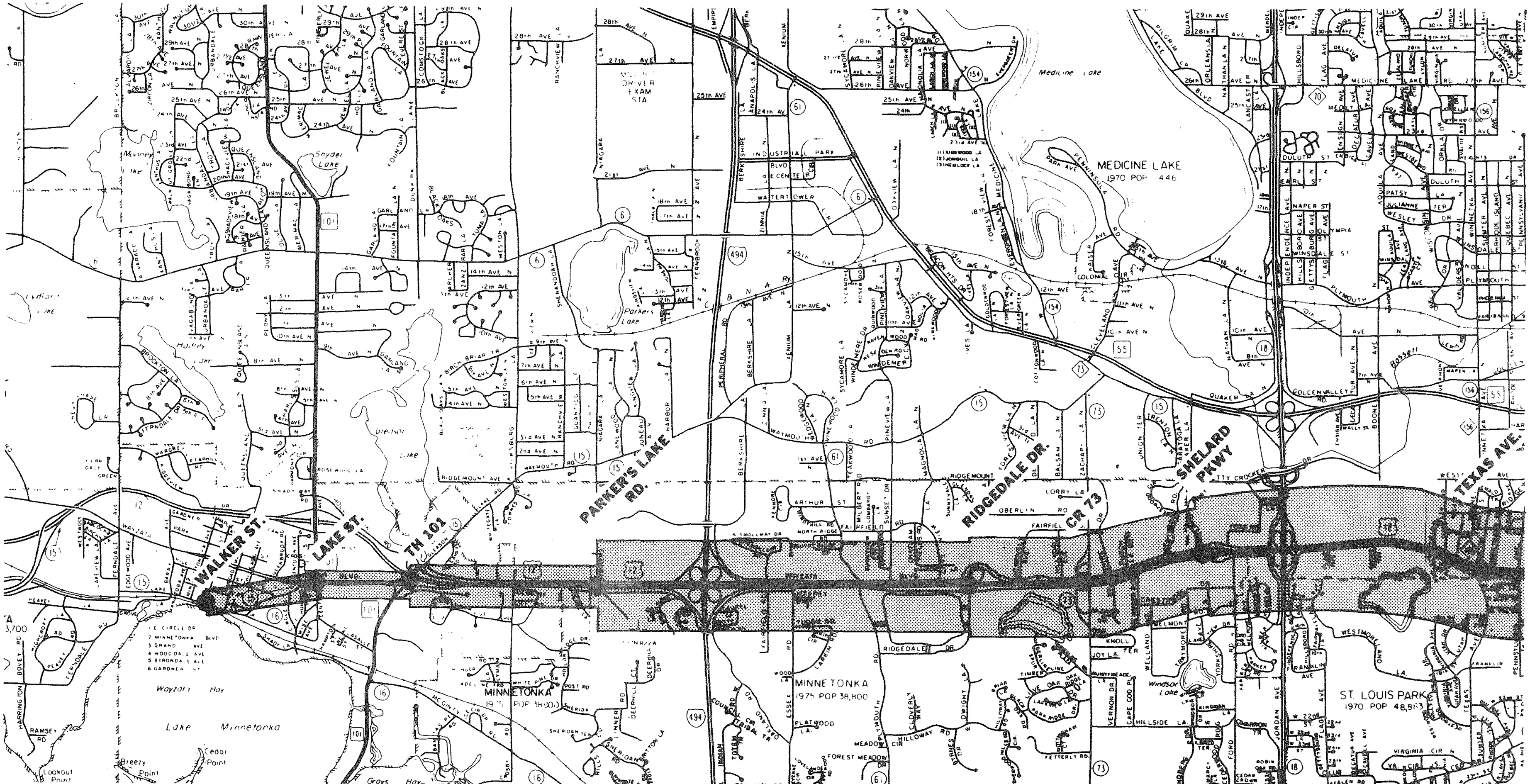
FORECAST TRAVEL BY MODE-WEST LRT

MODE	24 Hours (000's)	Percent	Peak Hour Passing Maximum Load Point	Percent
Auto Driver	607.9	58.3	5,860	59.6
Auto Passenger	389.2	37.4	1,175	11.9
Local Bus Passenger	15.1	1.5	--	--
LRT Passengers:				
Mpls. Downtown	10.6	1.0	--	--
Non-Downtown	17.2	1.6	--	--
Total LRT	27.8	2.6	2,800	28.5
TOTAL	1040.0	100.0	9,835	100.0

Operating Plan

Table III-3 shows the operating plan in the West in terms of headways by hour and day.

FIGURE III-3



STOP	PASSENGERS ON BOARD
WALKER ST	600
LAKE ST.	1,050
TH 101	1,800
PARKER'S LAKE RD	3,750
RIDGEDALE DR	3,900
CR 73	4,050
SHELARD PKWY	5,000
TEXAS AVE	5,000

N

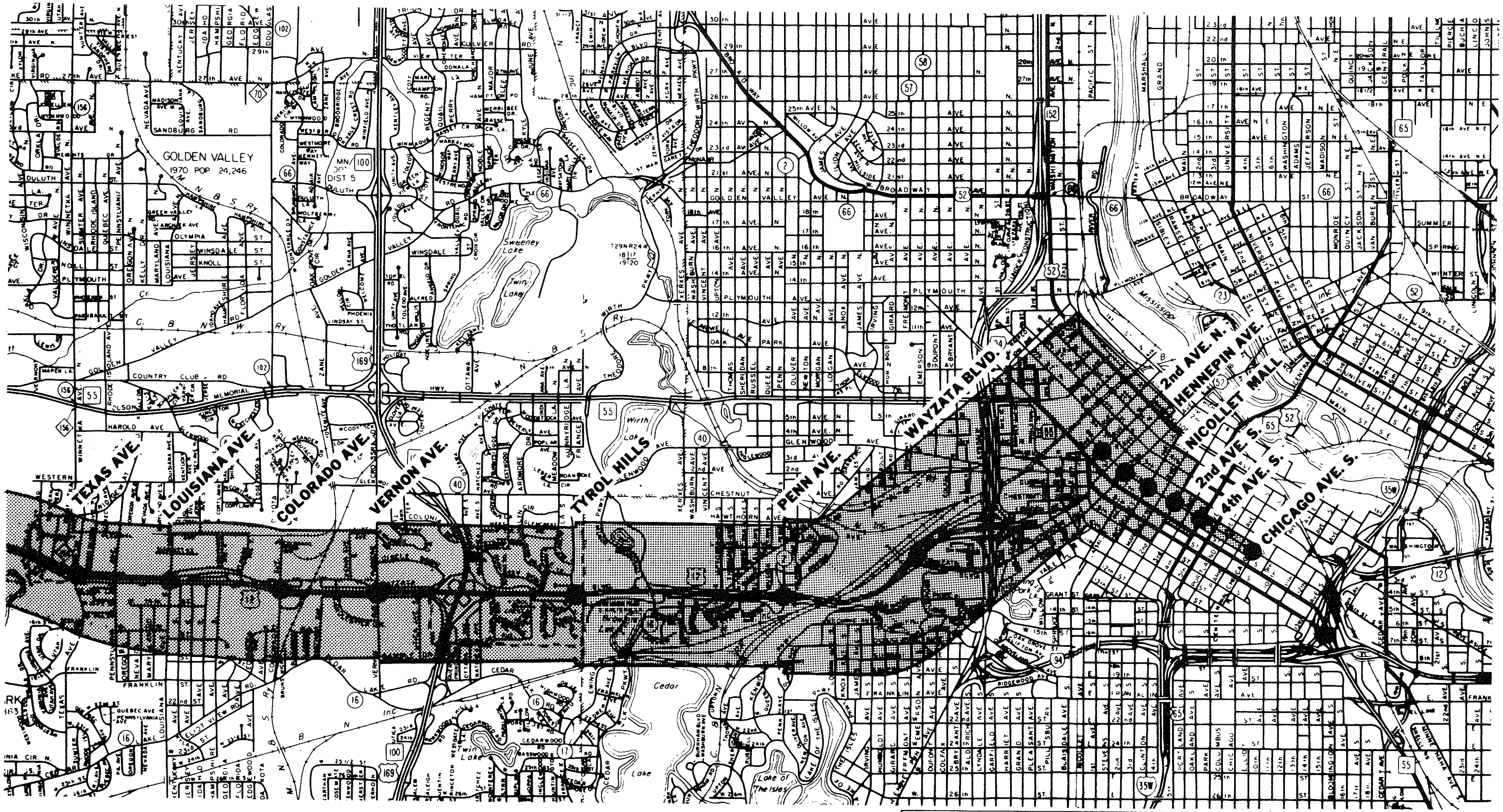
SCALE IN FEET 0 2000 4000 6000

METROPOLITAN COUNCIL OF THE TWIN CITIES AREA

LIGHT RAIL TRANSIT FEASIBILITY STUDY

WEST ALIGNMENT
DAILY INBOUND PASSENGERS ON-BOARD
WALKER STREET TO TEXAS AVENUE

SANDERS & THOMAS, INC., CONSULTING ENGINEERS
POTTSTOWN, PA



STOP	PASSENGERS ON BOARD	STOP	PASSENGERS ON BOARD
TEXAS AVE	5,000	2ND AVE N.	6,700
LOUISIANA AVE	5,400	HENNEPIN AVE	5,450
COLORADO AVE	5,300	NICOLLET MALL	3,800
VERNON AVE	6,350	2ND AVE S.	1,650
TYROL HILLS	6,700	4TH AVE S.	300
PENN AVE	7,000	CHICAGO AVE S.	0
WAYZATA BLVD	7,050		

SCALE IN FEET 0 2000 4000 6000

METROPOLITAN COUNCIL OF THE TWIN CITIES AREA

LIGHT RAIL TRANSIT FEASIBILITY STUDY

WEST ALIGNMENT
DAILY INBOUND PASSENGERS ON-BOARD
TEXAS AVENUE TO CHICAGO AVENUE

SANDERS & THOMAS, INC., CONSULTING ENGINEERS
POTTSTOWN, PA

FIGURE III-4

TABLE III-3

OPERATING HEADWAYS
(Minutes)

	5 A.M.- 7 A.M.	7 A.M.- 9 A.M.	9 A.M.- 4 P.M.	4 P.M.- 6 P.M.	6 P.M.- 11 P.M.	11 P.M.- 1 A.M.
Weekdays	15	5	15	5	15	15
Saturdays	30	30	30	30	30	30
Sundays & Holidays		60	60	60	60	

Table III-4 shows scheduled speeds and times between LRT stops as well as the cumulative time and distance from the terminal point. Average schedule speed along the 12.5 mile long line is approximately 21 miles per hour. Approximately 33.5 minutes are required to make the trip from Chicago Avenue and 6th Street South to Wayzata.

Feeder Bus Operations

To complement the West LRT line, a bus system providing feeder service to the LRT line will be required. The bus service would operate in a predominantly north-south direction, using existing arterials, and would provide crosstown service as well as feeder service. Based upon the projected volumes of feeder bus riders and operating characteristics in the West corridor, a fleet of 53 feeder buses would be required, including six spares, according to MTC staff.

Annual Vehicle Miles

Total annual vehicle miles are calculated at 887,880 in the West. Vehicle mile calculations are shown in the Technical Supplement.

TABLE III-4

SCHEDULED SPEEDS, TIME, AND DISTANCE - WEST

Chicago & 6th St. S (Hospital)	Distance (Miles)	Scheduled Speed (MPH)	Scheduled Time (Seconds)	Cumulative Time From Terminal (Minutes)	Cumulative Distance From Terminal (Miles)
4th Ave. S. & 6th St. S.	0.30	12	1.50	1.50	0.30
2nd Ave. S. & 6th St. S.	0.20	12	1.00	2.50	0.50
Nicollet Ave. & 6th St. S.	0.20	12	1.00	3.50	0.70
Hennepin Ave. & 6th St. S.	0.10	12	.50	4.00	0.80
6th St. & Second Ave. N.	0.10	12	.50	4.50	0.90
Wayzata & Linden Ave. (Parade)	1.10	25	2.65	7.15	2.00
Penn Ave. & TH 12	0.75	25	1.75	8.95	2.75
Tyrol Hills & TH 12	1.20	25	2.70	11.85	3.95
Vernon Ave. & TH 12	0.75	25	1.75	13.65	4.70
Colorado Ave. & TH 12	0.40	25	1.00	14.60	5.10
Louisiana Ave. & TH 12	0.50	25	1.12	15.80	5.60
Texas Ave. & TH 12	0.40	25	1.00	16.75	6.00
Shelard Parkway & TH 12	1.50	25	3.36	20.35	7.50
CR 73 & TH 12	0.50	25	1.12	21.55	8.00
Ridgedale Dr. & TH 12	0.50	25	1.12	22.75	8.50
Parkers Lake Rd. & TH 12	1.75	25	4.12	26.95	10.25
TH 101 & TH 12	1.25	25	3.00	29.95	11.50
Lake St. & TH 101	0.50	20	1.50	31.45	12.00
Walker St. & Lake St. (Wayzata)	0.50	15	2.00	33.45	12.50

TABLE III-5

CONSTRUCTION COST ESTIMATE - WEST

Item	Quantity	Unit	Unit Price $	Amount
Cross Ties	69,960	Each	47	$ 3,288,120
Stone Ballast	46,640	Linear Yards	35	1,632,400
115# Rail	139,920	Linear Feet	75	10,494,000
Excavation	127,111	Cubic Yards	23	2,923,553
Electric Grade Crossings	-	Each	275,000	-
Crossovers (Includes 2 turnouts)	12	Each	70,000	840,000
Stops	39	Each	14,133	551,187
Utility Relocation in CBD	26	Blocks	500,000	13,000,000
36' Grade Separation Extensions	4 major	Each	144,000	576,000
	17 minor	Each	72,000	1,224,000
36' Share of Base Grading	10.6	Miles	500,000	5,300,000
Bus Bays and Pedestrian Ramp @ Selected Stops	8	Each	360,000	2,880,000
Pedestrian Bridge and Ramp @ Colorado Avenue	1	Each	325,000	325,000
Pedestrian Ramp @ Tyrol Hills	1	Each	75,000	75,000
Substation	10	Each	405,000	4,050,000
Roadway: 6" Concrete	14,667	Square Yards	30.35	446,000
Car Shop	1	Each	975,000	975,000
Simple Catenary System	13.5	Route Miles	798,000	10,773,000
Signal Comm + Wayside Controls	10.3	Route Miles	784,550	8,080,865
Pavement Removal	132,000	Square Feet	4.92	649,440
Traffic Signal Preemption Equip.	27	Intersection	8,000	216,000
	1980 PRICES:	SUBTOTAL		$68,299,565
		+ 15% Contingency		10,244,934
		+ 10% Engineering & Mobilization		6,829,956
		TOTAL		$85,374,455
		USE		$85,374,000

Construction Requirements and Costs

Total construction costs are estimated at $85.3 million in 1980 dollars. It should be noted that construction costs in the West would be higher if LRT were not planned in conjunction with I-394 construction. Construction costs are shown in Table III-5.

Right-of-Way Acquisition. Costs are estimated at $8.1 million for the 10.6 miles of the 12.5 mile line not located on city streets.

Parking Lots. Approximately 2,500 parking spaces will be required. Most of these will be located west of CR18 where lower land costs (approximately $4.00 per square foot) will make parking economically feasible.

Vehicles. There will be 28 vehicles required for revenue service. This includes three spares. Total vehicle costs are estimated at $27.1 million. Calculation of vehicle requirements is shown in the Technical Supplement.

Feeder Buses. Including seven spares, 53 buses, at $150,000 each plus $55,200 per bus for maintenance and overhaul facilities, would cost a total of $10.9 million.

Capital costs are summarized in the following table:

TABLE III-6

CAPITAL COST SUMMARY-WEST

CATEGORY	COST IN MILLIONS OF DOLLARS
Right-of-Way Acquisition	$ 8.1
Construction	85.3
Vehicles	27.1
Parking Lots	7.5
Subtotal	$128.0
Feeder Bus System	10.9
TOTAL	$138.9

TABLE III-7

ANNUAL LRT OPERATING AND MAINTENANCE COSTS INFLATED TO YEAR 1980

Based on 1976 Unit Cost Relationships
(West)

Item (With 1976 Unit Cost)	
Track Maintenance (.34/Vehicle Mile Traveled)	$ 301,879
Shelter Maintenance ($500/Shelter)	19,000
Yards & Support Maintenance ($1,000/Peak Hour Vehicle)	20,000
Electrical Maintenance (.04/Vehicle Mile Traveled)	35,515
Communications & Control Maintenance ($2,500/Track Mile)	51,500
Vehicle Maintenance (.24/Vehicle Mile Traveled)	213,091
Vehicle Energy Consumption (.14/Vehicle Mile Traveled)	124,303
Maintenance Facility Energy Consumption ($50/Peak Hour Vehicle)	1,000
Vehicle Storage Energy Consumption ($400/Peak Hour Vehicle)	8,000
MTC Operators Salary plus Benefit ($16,867)	506,010
Other Transportation (.17/Vehicle Mile Traveled)	150,940
SUBTOTAL	$1,437,238
General & Administrative (15% of Subtotal)	5,586
1976 TOTAL COST	$1,652,824
Inflated at 10%/Annum to 1980	$2,419,899
TOTAL	$2,419,899
USE	$2,420,000

Unit Cost Source: Light Rail Transit, A State of the Art, U.S. Department of Transportation, 1976.

Operator's Cost Source: Metropolitan Transit Commission.

Total capital costs, exclusive of feeder bus requirements, are estimated at $128 million in 1980 dollars, or about $11.1 million per double tracked mile.

Operating and Maintenance Costs

Table III-7 shows estimated annual LRT operating costs totaling $2.4 million. Feeder bus costs for the 53-bus addition to the MTC fleet are estimated at $3.9 million. Costs are based upon the need for approximately 2.02 million bus miles at $1.10 per mile and 92,000 bus hours at $18.34 per hour (See Table III-8.).

TABLE III-8

LOCAL BUS SERVICE ANNUAL
OPERATING AND MAINTENANCE COSTS - WEST
(1980 Dollars)

ITEM	UNIT COST		COST
Annual Bus Miles: 2,019,000	$1.10/mile		$2,220,900
Annual Bus Hours: 92,000	$18.34/hour		1,687,280
		TOTAL	$3,908,180
		USE	$3,908,000

Total annual operating and maintenance costs exclusive of annualized capital costs, are estimated at $6.3 million. On a cost per passenger basis, this works out to about $0.78.

Annualized Capital and Operating Costs

Annualized capital costs assume that total project costs would be locally financed. Each category of capital expense (for example, buildings, vehicles, tracks, etc.) has been amortized over a useful life expectancy ranging from 2 to 40 years depending on the category. Table III-9 shows total annual operating and maintenance costs including annualized capital costs for LRT in the West. Annualized capital costs are calculated in the Technical Supplement.

TABLE III-9

TOTAL ANNUAL LRT OPERATING AND MAINTENANCE COSTS INCLUDING ANNUALIZED CAPITAL COSTS - WEST

Operating and Maintenance Costs	$ 6,328,000
Annualized Capital Costs	13,600,000
TOTAL	$19,928,000

Annualized capital costs are in 1980 dollars. The relationship between annualized capital costs and annual operating and maintenance costs is only accurate for the first year of a capital investment.

Operating Costs Versus Revenues

Table III-10 compares operating costs to the revenues anticipated. A fare of $0.50.

TABLE III-10

ESTIMATED LRT OPERATING COST VERSUS REVENUES
IN 1980 DOLLARS - WEST

Total Annual LRT Passengers		8,187,000
Annual LRT Operating & Maintenance Costs*		$2,420,000
Annual Feeder Bus Operating and Maintenance Costs		$3,908,000
Annual LRT & Feeder Bus Operating and Maintenance Costs		$6,328,000
LRT Revenue Generated at $0.50 Fare		$4,093,550
Surplus/(Deficit)		($2,234,450)
	USE	($2,234,000)

*Not including annualized capital costs

Impact Analysis

Land Use. LRT development along the West alignment would not lead to any major shift in patterns of land use; the prevailing market demands and land use policies are much more critical to land use change in this corridor than would be the development of an LRT line. What is likely to occur with LRT is an increase in density of development at or around the individual LRT stops.[1]

[1]The methodology and assumptions underlying the land use impact analysis were described previously in Chapter II of this report. The analysis is based on a detailed parcel-by-parcel assessment of vacant and underutilized land supplemented by input from planners and city engineers in each of the affected communities. This section presents a summary of the detailed research findings. Pertinent charts and maps reflecting the analysis at each LRT stop are found in the Technical Supplement to this report.

The Metropolitan Council's social and economic profile data base (built into the Transportation Analysis Zone Model) has projected continued strong residential, commercial and industrial growth in the general West corridor area to the year 2000. As shown in Table III-11, an estimated 1,900 acres of land is expected to be developed in this corridor between 1990 and 2000. This amounts to about 5 percent of the development activity expected for the entire Twin Cities Metropolitan Area over the same 10 year period.

TABLE III-11

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

WEST CORRIDOR ACREAGE**	1990	2000	CHANGE 1990-2000
Residential	17,331	18,425	1,094
Commercial	1,678	2,001	323
Industrial	3,974	4,461	487
TOTAL	22,983	24,887	1,904
METRO AREA ACREAGE			
Residential	174,532	196,005	21,473
Commercial	15,841	20,174	4,333
Industrial	53,528	63,368	9,840
TOTAL	243,901	279,547	35,646

*Since these figures are based on utilized acreage, the estimates do not reflect redevelopment activity where the land use remains unchanged.

**Includes an area 1 to 3 miles on either side of the West corridor alignment. These estimates also include the Minneapolis CBD.

Source: Socio-Economic and Land Use File, Metropolitan Council, 1980.

The primary land use impacts associated with development of an LRT line along TH12/I-394 alignment can be expected to occur within 0.5 mile of the individual LRT stops. Beyond a 0.5 mile radius, developments could not conveniently serve passengers boarding or disembarking at the LRT stops. Because most of the stops along this alignment already are well developed intersections, are economically stable, and are controlled by relatively conservative land use policies, the actual development impacts from construction of an LRT will be small--only a fraction of 1,900 acres of development projected for the full corridor over the decade.

Projected land use development in the vicinity of the West alignment LRT stops for the decade 1990 to 2000 is shown in Table III-12. In total, an estimated 256 acres of land can be expected to develop or be redeveloped within a half-mile radius of individual LRT stops. Of this total, about half or 136 acres of land can be expected to develop as a direct consequence of the LRT line. About one-third of this amount would be new development, while about two-thirds of the acreage would be in redevelopment. Based upon an analysis of the development potential of individual land parcels, it is estimated that establishment of an LRT line along the West alignment would result in development of 81 acres of residential property, 46 acres of commercial property, and 9 acres of redeveloped industrial property.

TABLE III-12

PROJECTED LAND DEVELOPMENT WITHIN 0.5 MILE OF THE WEST ALIGNMENT LRT STOPS, 1990-2000
(In Acres)

	NEW DEVELOPMENT	REDEVELOPMENT	TOTAL
Acreage Projected to Develop Around LRT Stops, 1990-2000	78.0	178.4	256.4
Acreage of Development LRT Induced:			
Residential	38.5	42.5	81.0
Commercial	6.0	40.4	46.4
Industrial	0	9.0	9.0
TOTAL	44.5	91.9	136.4

Source: Midwest Research Institute

The direct impacts of LRT developments along the West alignment, based on current municipal land use controls and density allowances, would be the construction (or redevelopment) of about 1,175 high and medium density multi-family housing units, more than 570,000 square feet of retail and office commercial space, and nearly 200,000 square feet of industrial space. As indicated in Table III-13, the construction impacts in 1980 dollars of this LRT-induced residential, commercial and industrial development would be on the order of $71 million.

While $71 million in construction impacts is a substantial figure, it is important to understand that this is not new regional development but, in all likelihood, is development shifted from other locations within the West corridor. It also represents only 136 acres out of an estimated 1900 acres of land, in the West corridor, projected to develop during the decade 1990 to 2000.

These land use impacts are based on prevailing land use density allowances and control policies. By giving greater emphasis to available control policies and development strategies, it is likely that higher densities and larger scale development efforts could be achieved along the West LRT alignment. Three potential strategies for generating larger scale, more concentrated development around the LRT stops are identified in Table III-14.

Energy. The projected energy impacts of an LRT line and supporting feeder bus system in the West corridor are shown in Table III-15. As indicated, a total annual consumption of about 171,150 million (M)BTU's of energy is projected for an LRT system operating along that alignment in the year 2000. Of this total, slightly more than half would be coal-based electrical energy used in powering the LRT vehicles. The other half would be oil-based energy used in operating the feeder bus system.

Environment. The environmental impacts associated with the operation of an LRT line in the West corridor will involve air, water, and land pollution; noise; and visual impacts. The pollutant impacts are based on the electrical energy consumed in powering the LRT vehicle and the diesel fuel required in operating the feeder bus system. As shown in Table III-16, more than 3.2 million pounds of pollution can be associated with operation of the LRT system in the West corridor over a 1 year period. Of this total, about 87 percent, or 2.8 million pounds of pollution, is tied to coal-based electrical generation, with

TABLE III-13

PROJECTED LRT-INDUCED LAND USE CHANGES AND CONSTRUCTION IMPACTS, WEST ALIGNMENT - 1990-2000

	New Development	Redevelopment	Total
Projected LRT-Induced Land Use Changes			
. Residential Multi-Family Units			
High Density	175	518	693
Medium Density	280	200	480
Low Density	0	0	0
Total	455	719	1,173
. Commercial Square Footage			
Retail	0	76,000	76,000
Office	104,500	392,290	496,790
Total	104,500	468,290	572,790
. Industrial Square Footage	0	196,000	196,000
Projected LRT-Induced Building Construction (in 1980 Construction $'s)*			
. Residential	$18.4 million	$27.9 million	$46.3 million
. Commercial	4.3 million	17.3 million	21.9 million
. Industrial	0.0	3.5 million	3.5 million
Total Construction Impact	$22.7 million	$48.7 million	$71.7 million

*Does not include costs of demolition, relocation, parking, landscaping, or other site preparation costs.

Source: Midwest Research Institute

TABLE III-14

POTENTIAL STRATEGIES FOR GENERATING MORE CONCENTRATED DEVELOPMENT AROUND LIGHT RAIL TRANSIT STOPS

1. Establish a single agency or transit development corporation with the authority for applying development considerations in locating LRT stops, making route alignment decisions, and supporting the use of innovating land use control techniques.

2. Develop or expand the use of incentive techniques for application in cases where weak market demand is holding back development. Some of the techniques that have been shown to be effective in other cities include:

   - Tax exemption and abatement
   - Special capital improvements
   - Tax increment financing
   - Equity participation
   - Loans and guarantees
   - Direct public development

3. Institute land use techniques to oversome multiple ownership constraints. Some techniques that have been given high marks in this application include:

   - Zoning (in particular, special districts, incentive zoning, floating zones, planned unit developments and conditional zoning)

   - Property tax program linked to a program of rapid and accurate assessment

Source: Transit Station Area Joint Development: Strategies for Implementation--Executive Summary, 1976, by Administration and Management Research Association of New York City, Inc.

TABLE III-15

PROJECTED ENERGY CONSUMPTION WITH
LRT OPERATION, WEST ALIGNMENT, YEAR 2000

	LRT Line	Feeder Buses
Annual Vehicle Miles	992,400	2,019,000 miles[1]
Projected Fuel Efficiency	8 KWH/ vehicle mile[2]	4 miles/ gallon (diesel)[3]
Annual Energy Consumption	7,939,200 KWH	504,750 gallons
BTU's of Energy Consumed[4]	91,300 MBTU's	79,850 MBTU's

TOTAL ANNUAL ENERGY CONSUMPTION - 171,150 MBTU's

[1] Based on Metropolitan Transit Commission (MTC) estimate of total bus miles required in the year 200 to service an LRT line along TH12.

[2] LRT vehicle fuel efficiency based on estimate of the Boeing Company, the proposed LRV manufacturer.

[3] Based on projections by the Metropolitan Transit Commission.

[4] Energy consumption figures assume not only the burning of coal to produce electricity and the burning of the diesel fuel, but the total energy required to obtain the source fuels from the well head and coal mine, to refine them, to transport them, and ultimately to consume them.

TABLE III-16

PROJECTED POLLUTANT LOADS[1] - WEST ALIGNMENT LRT SYSTEM, YEAR 2000

(In Pounds)

	LRT Operations[2]	Feeder Buses	Total
Air Pollution			
Particulate	283,000	7,600	290,600
Carbon Monoxide (CO)	-	160,300	160,300
Hydrocarbons (HC)	7,100	55,900	63,000
Nitrogen Oxides (NO_x)	65,400	118,700	184,100
Sulfur Oxides (SO_x)	642,700	26,700	669,400
Water Pollution			
Suspended Solids (SS)	-	200	200
Chemical Oxygen Demand (COD)	-	1,200	1,200
Biochemical Oxygen Demand (BOD)	-	300	300
Other	-	26,200	26,200
Solid Waste			
Mining/Drilling Wastes	1,583,900	7,200	1,591,100
Other Solid Wastes	258,400	8,700	267,100
Total Pollutant Loads	2,840,500	413,00	3,253,500

[1] MRI's REEPA analysis projects a "cradle to grave" estimate of pollution, i.e. pollutant loads at the well head and mine through to combustion of the coal and petroleum fuels.

[2] Assumes that electricity for LRT operations would be coal generated. To the extent that this electricity is available from existing capacity or from other electrical sources - e.g. hydroelectric power - this estimate may overstate actual pollution impacts. The emphasis on coal is judged reasonable given current NSP source projections and prevailing trends.

most of this in the form of mining related wastes and power utility related air pollution. The primary on-site pollutants are associated with operation of the feeder bus system.

Evaluating the impact of sound from operation of an LRT is a complex problem. While measurements of sound intensity are important, they can only be used to analyze the magnitude of the sound and not the human reaction to it. Noise has a psychological impact and individuals respond to sounds differently. Further, measurements and human perceptions are of integrated sound intensities. Sounds in combination cannot be analyzed strictly in an additive or subtractive manner.

In general, the operation of an LRT along the West alignment should not significantly raise the perceived noise levels in the area. There is evidence in fact to suggest that LRT vehicle operation may be quieter than buses and in some areas may be below automobile noise levels. At a speed of 40 miles per hour and a distance of 50 feet, a light rail vehicle will have an exterior noise level of 80 decibels (dBA's). By comparison, noise levels for buses on city streets and highways are between 80 and 88 dBA, and automobiles at highway speeds approache 75 to 80 dBA.

Assessing the visual impact of an LRT is a subjective process, where clearly defined parameters are lacking and differences between individuals judging the visual impact can be great.

A modern LRT design that is sensitive to the characteristics of the neighborhood through which it passes can at worst have no significant visual impact and at best may even be considered a benefit. As is amply demonstrated in many European cities, a carefully designed and landscaped LRT line can blend into the surrounding environment better than most other modes of transit.

The greatest visual problem is likely to be the LRT overhead traction support system. In the past, low-cost wood and labor dictated closely-spaced, unsightly pole supports. However, modern designs in Europe and Japan have demonstrated that overhead wire systems can be sensitive to appearance while still being economical.

Another potential problem is parking around LRT stops. When space has been inadequate, commuters have been forced to park in the surrounding neighborhoods. This is often a major visual and noise complaint among neighborhood residents.

NON-LRT ALTERNATIVE

The non-LRT alternative chosen for evaluation in the West corridor is the provision of High Occupancy Vehicle (HOV) lanes within the freeway.

Characteristics

The HOV lanes follow the proposed I-394 route between downtown Minneapolis and the intersection with I-494. Two reversible lanes located in the median of the freeway with access to the 3rd Avenue distributor and the Lowry Hill Tunnel would provide preferential access and an exclusive right-of-way for carpools, vanpools, and buses. The main characteristics of the HOV lanes are summarized in Table III-17.

TABLE III-17

HOV LANE CHARACTERISTICS - WEST

Length	9.5 miles
Right-of-Way Width	44 feet
Number of Entrances to HOV Lanes	5
Number of Intermediate Bus Stops	4
Average Carpool/Vanpool Speed	50 mph
Average Bus Speed	45 mph
Peak-Period Headway for Buses	5 minutes
Time of Operations	Peak period
Carpool Definition	2 + persons/car

Express buses would enter the HOV lane at five points along its length. At each entrance point, buses would operate at 5 minute headways during the peak or 12 buses per hour. Therefore 60 buses per hour would be passing the maximum load point, just east of Penn Avenue in Minneapolis.

Ridership Forecasts

The Metropolitan Council and the Minnesota Department of Transportation prepared HOV lane ridership forecasts. The sketch planning model developed by the Metropolitan Council was used to forecast HOV lane use for downtown oriented trips. These forecasts have been documented by the Minnesota Department of Transportation in their report, *Transportation Analysis Report, M-253*. The model output provides 24 hour home-based work trips for auto drivers, carpool drivers, carpool passengers and transit passengers.

All transit passengers from the corridor west of TH100 destined for downtown Minneapolis were assumed to use the HOV lanes. Non-downtown Minneapolis oriented transit trips were estimated from the regional model. The transit passenger forecast for work trips was expanded to total daily transit ridership of the HOV lanes or express ridership was segregated from the ridership on the local bus system that serves the corridor. Two orientations for both the express and the local patronage figures have been considered. The results are summarized in Table III-18 and Table III-19.

TABLE III-18

HOV LANE DAILY TRANSIT RIDERSHIP - WEST

Express Service	
Minneapolis Downtown Oriented Trips	10,802
Non-Downtown Oriented Trips	14,397
TOTAL DAILY RIDERSHIP	25,199
Local System	
Minneapolis Downtown Oriented Trips	722
Non-Downtown Oriented Trips	12,949
TOTAL DAILY RIDERSHIP	13,671

TABLE III-19

FORECASTED TRAVEL BY MODE WITH HOV LANE

	24 Hours		Peak Hour Passing Peak Load Point	
	# of People	%	# of People	%
Auto Driver	610,400	58.6	4,565	46.4
Carpool Driver	--	--	1,070	10.9
Auto Passenger	390,700	37.7	1,260	12.8
Local Bus Passenger	13,700	1.3	--	--
HOV Bus Passenger	25,200	2.4	--	--
TOTAL	1,040,000	100.0	9,835	100.0

Capital Costs

HOV lane construction costs are itemized in Table III-20. HOV lane capital costs totaling approximately $77.2 million are shown in Table III-21. Cost estimates for right-of-way acquisition and construction were prepared by the Minnesota Department of Transportation in the development of the 1981 Interstate Cost Estimate. Parking lot costs assume identical parking facilities to those required for LRT. The number of vehicles required was calculated by the MTC as were maintenance and overhual facility costs. It should be noted that HOV lane construction costs would be higher if the HOV lane was not planned in conjunction with I-394 construction.

TABLE III-20

CONSTRUCTION COST ESTIMATE - WEST HOV

Item	Cost
Grading (Including drainage, erosion control, clear and grub, etc.)	$ 3,400,000
Surfacing (Including subbase and base)	4,000,000
Bridging for HOV including Entrys/Exits	18,000,000
Bus Stops and Passenger Access/Facilities	1,500,000
44 Ft. Grade Separation Extention	
4 Major	704,000
14 Minor	1,232,000
Traffic Control	5,500,000
SUBTOTAL	$34,336,000
+30% Mobilization, Engineering, Construction, Supervision, Contingencies, etc.	10,300,800
TOTAL	$44,636,800
USE	$44,637,000

Source: Minnesota Department of Transportation.

TABLE III-21

HOV LANE CAPITAL COSTS - WEST (1980 Dollars)	
Right-of-Way Acquisition	$ 5,000,000
Construction	44,637,000
Vehicles (45 express buses)	6,750,000
Feeder Buses (53)	7,950,000
Park/Ride Lots	7,500,000
Maintenance Facility ($43,560/bus)	4,268,880
Overhaul Facility ($11,660/bus)	1,142,680
TOTAL	$77,248,560
USE	$77,200,000

Operating Plan

HOV operations would consist of line-haul express bus operations to downtown Minneapolis on TH12/I-394 complemented by local feeder bus service at key stops.

Operating and Maintenance Costs. Based on the ridership forecasts, the following requirements found in Table III-22 will result.

TABLE III-22

ANNUAL HOV LANE OPERATING AND MAINTENANCE COST - WEST			
Annual Vehicle Miles =	1,778,000	$1.10/mile	$1,955,800
Annual Vehicle Hours =	56,000	$18.34/hour	1,027,040
TOTAL			$2,982,840
USE			$2,983,000

Total annual operating and maintenance costs exclusive of annualized capital costs are estimated at $6.9 million. This works out to about $0.93 per passenger.

Feeder Bus Requirements. For analysis purposes the same feeder bus system used for the LRT line was used for the HOV lane because the two services were essentially the same. Costs would therefore be the same--$3.9 million.

Annualized Capital Costs. Annualized capital costs for the HOV lane are estimated at $8.0 million. Calculations appear in the Technical Supplement. Table III-23 combines annual operating and maintenance costs with annualized capital costs for HOV lanes.

TABLE III-23

TOTAL ANNUAL OPERATING AND MAINTENANCE COSTS INCLUDING ANNUALIZED CAPITAL COSTS HOV LANE - WEST

Operating and Maintenance Costs	$ 6,891,000
Annualized Capital Costs	8,000,000
TOTAL	$14,891,000

Annualized capital costs are in 1980 dollars. The relationship between annualized capital costs and annual operating and maintenance costs is only accurate for the first year of a capital investment.

Operating Costs Versus Revenues

Table III-24 compares HOV lane operating costs to the anticipated revenues. Based on a $.50 fare, annual HOV lane revenues would exceed operating and maintenance costs by approximately $727,700. When feeder bus operating and maintenance costs are included, the annual deficit is approximately $3.18 million.

TABLE III-24

HOV LANE ESTIMATED OPERATING COSTS VERSUS REVENUES	
Total Annual HOV Passengers	7,421,400
Total Express Bus Operating and Maintenance Costs	$2,983,000
HOV Revenue Generated - @ $.50 fare	$3,710,700
Bus Collection/Distribution Costs	$3,908,000
Total HOV and Bus Costs	$6,891,000
Surplus/(Deficit)	($3,180,300)

COMPARISON OF LRT AND NON-LRT - WEST

Table III-25 shows that though LRT will carry more total passengers than HOV, HOV will carry more peak hour passengers. Capital costs for LRT are approximately twice that of HOV but annual operating and maintenance costs for HOV are approximately 17 percent higher than LRT. HOV lane operating costs per passenger mile are 43 percent higher than for LRT.

Impact Analysis

Energy. The projected energy impacts associated with the non-LRT alternative system are indicated in Table III-26. As shown, an HOV system including feeder buses would consume on an annual basis about 150,200 MBTU's of energy. To permit a balanced comparison with the LRT model, the analysis also includes the estimated 3.6 million automobile miles driven by individuals that would ride the LRT but would not ride the HOV buses. By incorporating these auto miles into the non-LRT alternative model, the annual energy impact reaches 166,200 MBTU's.

In terms of overall energy consumption, the LRT and non-LRT alternative come out essentially even, with the LRT model

TABLE III-25

SUMMARY COMPARISON - WEST: LRT VERSUS NON-LRT

	LRT	Non-LRT
24 Hour Ridership	27,800	25,000
Peak Hour Ridership	2,800	2,940
Capital Cost	$138.9 million	$77.2 million
Annual Operating & Maintenance Cost	$ 6.5 million	$ 6.9 million
Operating & Maintenance Cost/Passenger	$0.80	$0.93
Annualized Capital Cost	$ 13.6 million	$ 8.0 million
Surplus/(Deficit)*	($ 2.2 million)	($ 3.2 million)
Surplus/(Deficit)**	($ 15.8 million)	($11.2 million)

*Excluding annualized capital costs.

**Including annualized capital costs.

only about 3 percent higher than the non-LRT alternative (171,150 MBTU's to 166,200 MBTU's for the non-LRT alternative).

An important issue in the consideration of an LRT system in the Twin Cities is the potential for petroleum fuel conservation. As shown in Table III-27, the LRT model in the West corridor is projected to save 555,700 gallons of petroleum fuel during the year 2000. Eighty percent of this total would be attributable to reduced bus service needs in the corridor. In addition, an estimated 111,200 gallons of gasoline would also be saved because of the ability of the LRT to entice more

TABLE III-26

PROJECTED ENERGY CONSUMPTION FOR THE NON-LRT ALTERNATIVE, WEST ALIGNMENT, YEAR 2000

	HOV Buses and Feeder Buses	LRT Riders Shifting to Automobiles
Annual Vehicle Miles	3,797,000 miles[1]	3,601,500 miles[2]
Projected Fuel Efficiency[3]	4 miles/gallon (diesel)	32.4 miles/gallon (gasoline)
Annual Fuel Consumption	949,250 gallons	111,200 gallons
BTU's of Energy Consumed[4]	150,200 MBTU's	16,000 MBTU's

TOTAL ANNUAL ENERGY CONSUMED - 166,200 MBTU's

[1]Based on MTC estimates for the year 2000.

[2]Determined on the basis of the difference between the number of projected auto driver trips with LRT and the number of trips with the non-LRT alternative.

[3]Based on projecttions by the Minnesota Energy Agency and the Metropolitan Transit Commission.

[4]Energy consumption estimates include all energy required to obtain the petroleum at the well head, to refine and transport it, as well as to consume it.

automobile drivers to public transit than would the HOV alternative. This gasoline saving, however, accounts for just four-tenths of 1 percent of the 27 million gallons of gasoline that will still be required to fuel the automobile fleet operating in the West corridor.

TABLE III-27

PROJECTED PETROLEUM SAVINGS WITH OPERATION OF AN LRT LINE - WEST CORRIDOR YEAR 2000

Gasoline Savings with Reduced Automobile Use	111,200 gallons
Diesel Fuel Savings with Reduced Bus Service Needs	444,500 gallons
Annual Petroleum Savings	555,700 gallons
Remaining Gasoline Consumption by Automobiles Under the LRT Model	27,029,000 gallons

Environment. The comparative pollution impacts from operation of the LRT and the non-LRT alternative are shown in Table III-28. As indicated, the LRT model shows about three times the overall pollution of the non-LRT alternative. The LRT impacts, however, are almost all off-site, with most of the pollution associated with either mining or electrical generation. The non-LRT alternative with its emphasis on petroleum fuel combustion shows significantly higher levels of carbon monoxide pollution within the confines of the study corridor.

CHAPTER IV

WEST/SOUTHWEST CORRIDOR
SOUTHWEST ALIGNMENT

INTRODUCTION

The Chicago and Northwestern (C&NW) Railroad alignment from TH101 to downtown Minneapolis is the selected Southwest alignment. At least a portion of this railroad alignment will be abandoned by the C&NW and will therefore be available for other rail purposes.

LRT ALTERNATIVE

LRT Stop Locations

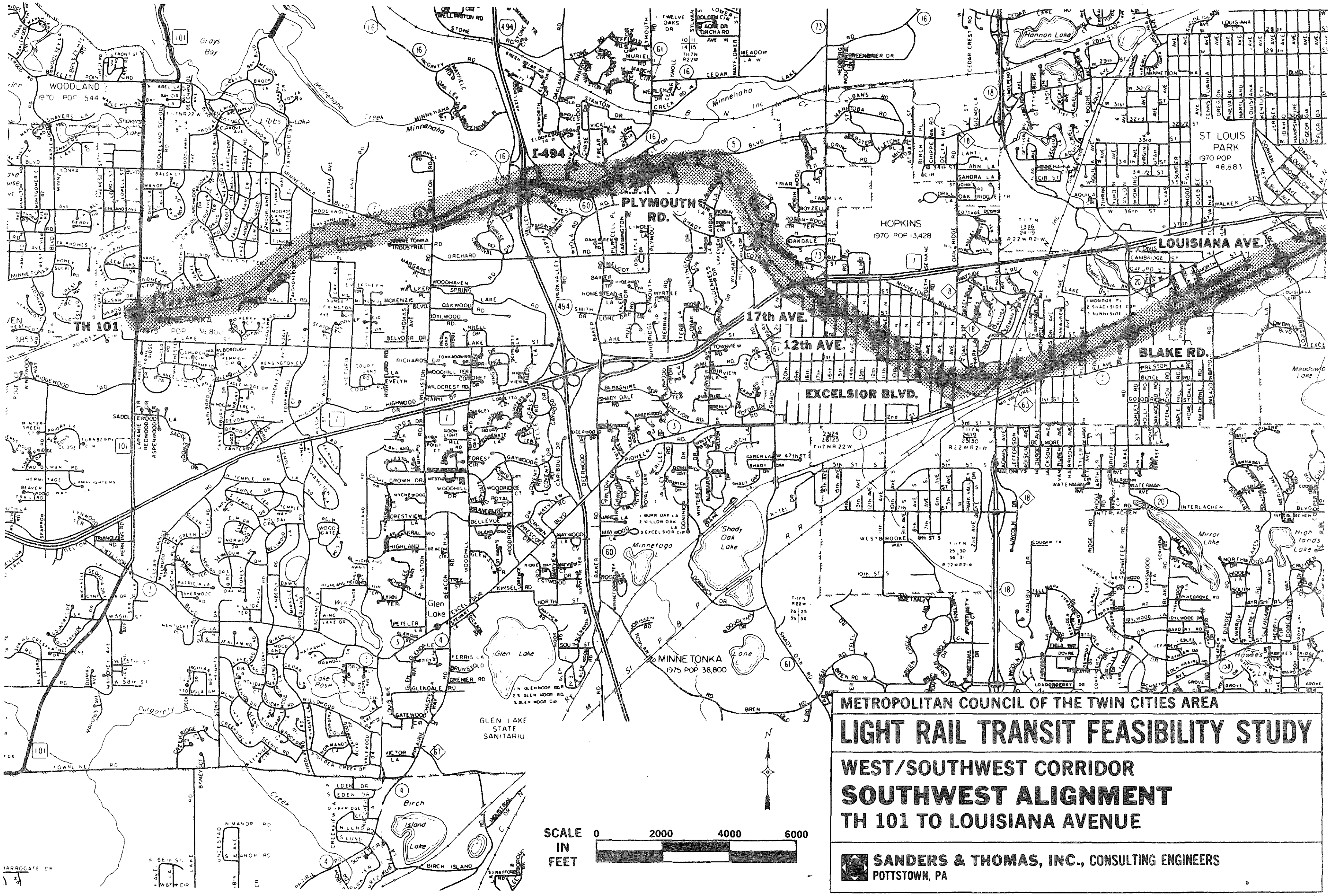
Alignment details and LRT stop locations are show on Figures IV-1, and IV-2.

Table IV-1 shows each proposed LRT stop. Within downtown Minneapolis stops are identical to those proposed for the West alignment. Beyond downtown Minneapolis, stops are spaced, on average, just under 1 mile apart.

Ridership Forecasts

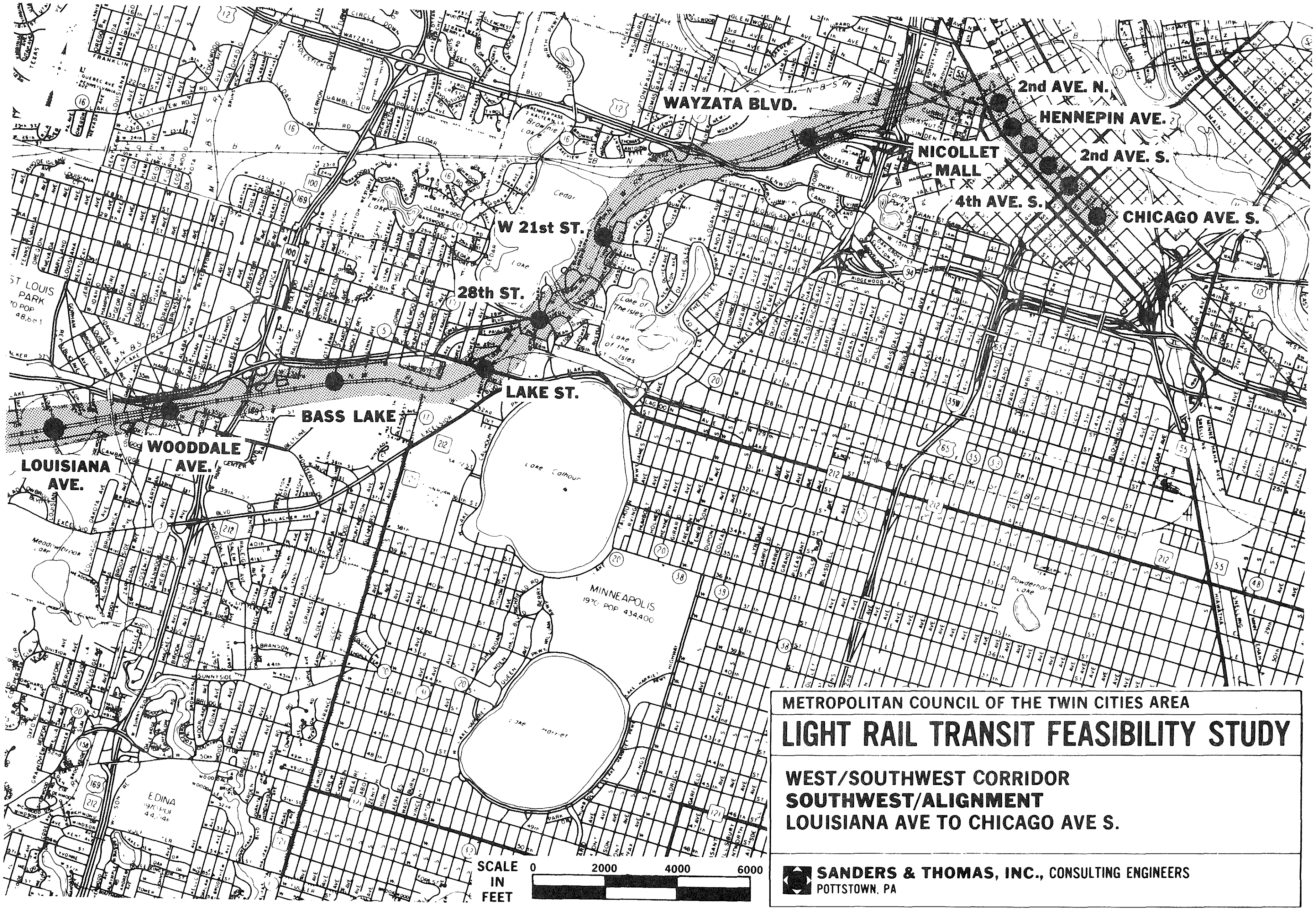
LRT ridership was developed by using the same Metropolitan Council sketch planning model used for the West alignment. Methodology is described in the Technical Supplement.

Table IV-2 shows the forecasted LRT ridership as it relates to total corridor travel and to corridor travel by other modes. Total daily LRT ridership is estimated at 25,400 or 2.3 percent of total travel in the corridor. Daily inbound ridership is shown on Figures IV-3 and IV-4.



METROPOLITAN COUNCIL OF THE TWIN CITIES AREA
LIGHT RAIL TRANSIT FEASIBILITY STUDY
WEST/SOUTHWEST CORRIDOR
SOUTHWEST ALIGNMENT
TH 101 TO LOUISIANA AVENUE
SANDERS & THOMAS, INC., CONSULTING ENGINEERS
POTTSTOWN, PA
SCALE IN FEET
0
2000
4000
6000
N
TH 101
I-494
PLYMOUTH RD.
17th AVE.
12th AVE.
EXCELSIOR BLVD.
LOUISIANA AVE.
BLAKE RD.
HOPKINS
1970 POP 13,428
ST LOUIS PARK
1970 POP 48,883
MINNETONKA
1975 POP 38,800
WOODLAND
1970 POP 544
Glen Lake
GLEN LAKE STATE SANITARIU

FIGURE IV-1



METROPOLITAN COUNCIL OF THE TWIN CITIES AREA

LIGHT RAIL TRANSIT FEASIBILITY STUDY

WEST/SOUTHWEST CORRIDOR
SOUTHWEST/ALIGNMENT
LOUISIANA AVE TO CHICAGO AVE S.

SANDERS & THOMAS, INC., CONSULTING ENGINEERS
POTTSTOWN, PA

FIGURE IV-2

TABLE IV-1

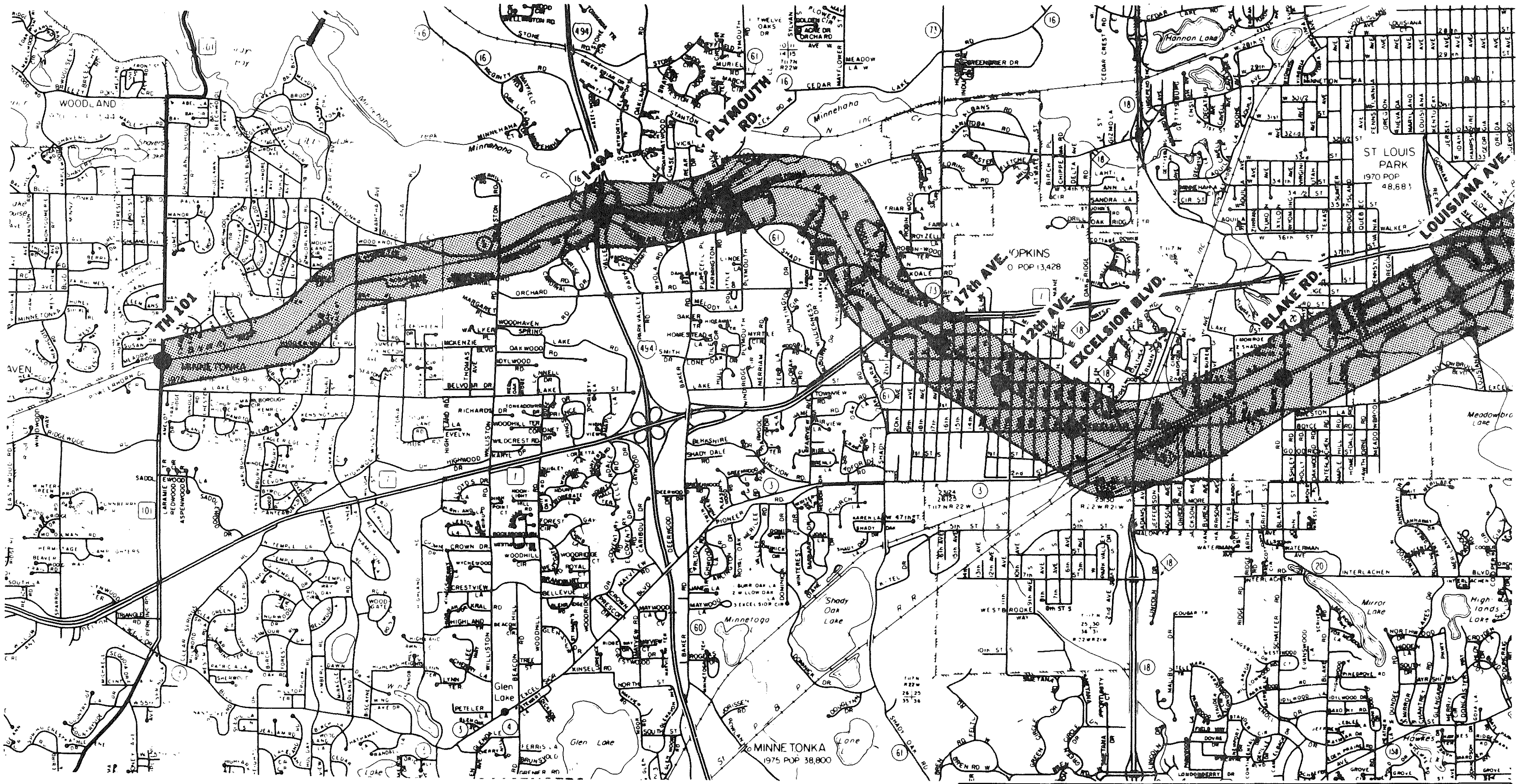
PROPOSED LRT STOPS - SOUTHWEST

TH101	Lake Street
I-494	28th Street
Plymouth Road	21st Street
17th Avenue	Wayzata Boulevard (Parade)
12th Avenue	6th Street & 2nd Avenue
Excelsior Boulevard	Hennepin Ave. & 6th St., S.
Blake Road	Nicollet Mall & 6th St., S.
Louisiana Avenue	2nd Ave., S. & 6th St., S.
Wooddale Avenue	4th Ave., S. & 6th St., S.
Bass Lake	Chicago Ave. & 6th St., S.

TABLE IV-2

FORECAST TRAVEL BY MODE - SOUTHWEST - LRT

	Daily Transit Trips	%	Peak Period	%
Auto Drivers	648,500	59.2	93,400	57.9
Auto Passengers	410,900	37.5	59,200	36.6
LRT				
Downtown	10,400	1.0	2,600	1.6
Non-Downtown	15,000	1.4	3,750	2.3
Total LRT	25,400	2.4	6,350	3.9
Local Feeder Bus	9,800	0.9	2,450	1.6
Total Transit	35,200	3.3	8,800	5.5
TOTAL TRIPS	1,094,600	100.0	161,400	100.0



STOP	PASSENGERS ON BOARD	STOP	PASSENGERS ON BOARD
TH 101	2,300	LAKE ST	5,850
I-494	2,800	28TH ST	6,000
PLYMOUTH RD	2,850	W. 21ST ST	6,450
17TH AVE	3,050	WAYZATA BLVD	6,950
12TH AVE	3,150	2ND AVE N.	6,100
EXCELSIOR BLVD.	3,700	HENNEPIN AVE	4,050
BLAKE RD	3,750	NICOLLET MALL	2,200
LOUISIANA AVE	4,300	2ND AVE S.	800
WOODDALE AVE	5,350	4TH AVE S.	200
BASS LAKE	5,400	CHICAGO AVE S.	0

SCALE IN FEET 0 2000 4000 6000

METROPOLITAN COUNCIL OF THE TWIN CITIES AREA

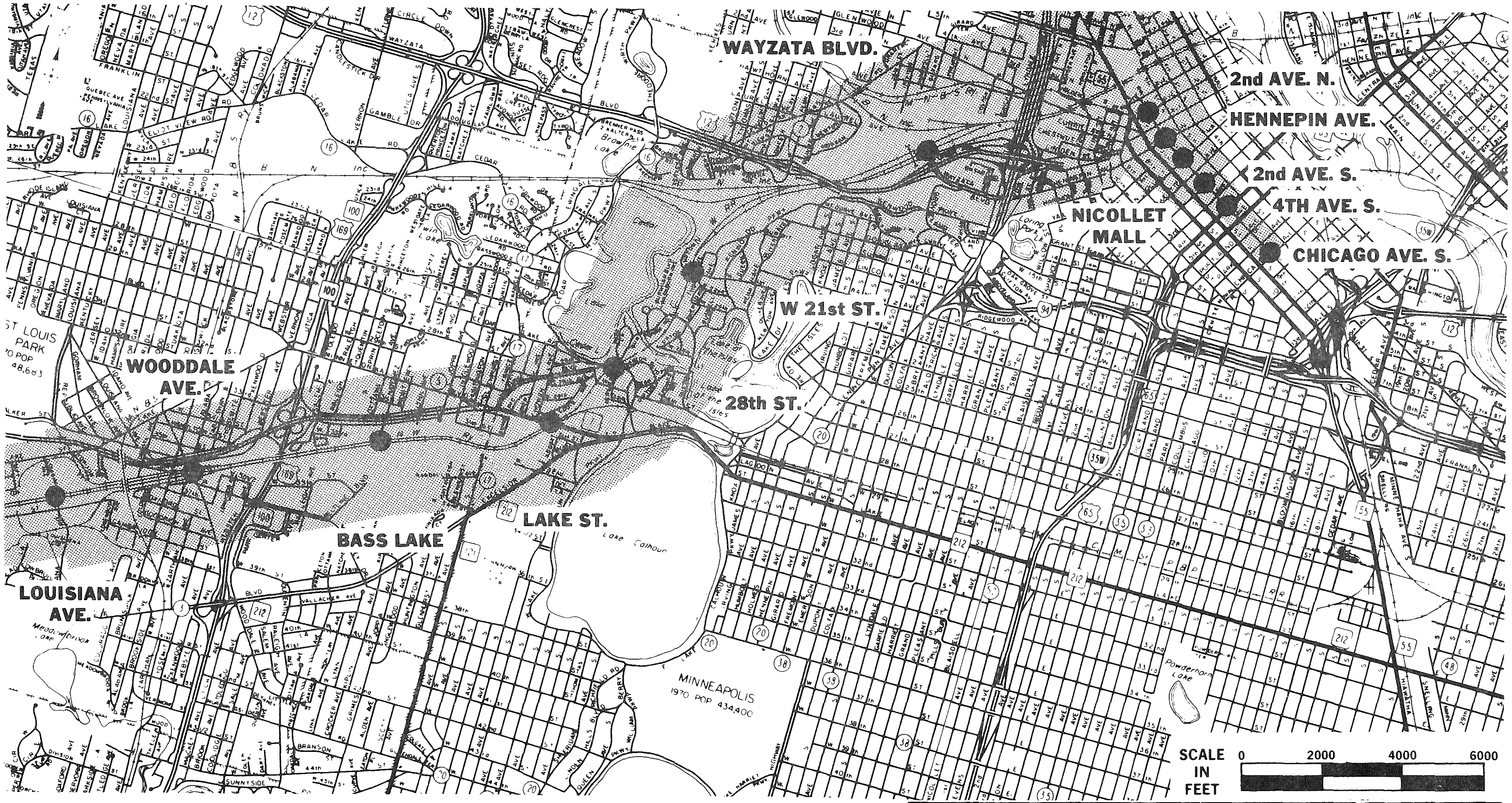
LIGHT RAIL TRANSIT FEASIBILITY STUDY

SOUTHWEST ALIGNMENT
DAILY INBOUND PASSENGERS ON-BOARD
TH 101 TO LOUISIANA AVENUE

SANDERS & THOMAS, INC., CONSULTING ENGINEERS
POTTSTOWN, PA

FIGURE IV-3

FIGURE IV-4



STOP	PASSENGERS ON BOARD	STOP	PASSENGERS ON BOARD
LOUISIANA AVE	4,350	2ND AVE N.	6,100
WOODDALE AVE	5,350	HENNEPIN AVE	4,050
BASS LAKE	5,400	NICOLLET MALL	2,200
LAKE ST	5,850	2ND AVE S.	800
28TH ST	6,000	4TH AVE S.	200
W. 21ST ST	6,450	CHICAGO AVE S.	0
WAYZATA BLVD	6,950		

METROPOLITAN COUNCIL OF THE TWIN CITIES AREA

LIGHT RAIL TRANSIT FEASIBILITY STUDY

SOUTHWEST ALIGNMENT
DAILY INBOUND PASSENGERS ON-BOARD
LOUISIANA AVENUE TO 28TH STREET

SANDERS & THOMAS, INC., CONSULTING ENGINEERS
POTTSTOWN, PA

Operating Plan

Table IV-3 shows the Southwest LRT operating plan in terms of headways by hour and day.

TABLE IV-3

OPERATING HEADWAYS - SOUTHWEST
(Minutes)

	5 A.M.- 7 A.M.	7 A.M.- 9 A.M.	9 A.M.- 4 P.M.	4 P.M.- 6 P.M.	6 P.M.- 11 P.M.	11 P.M.- 1 A.M.
Weekdays	15	5	15	5	15	15
Saturdays	30	30	30	30	30	30
Sundays & Holidays		60	60	60	60	

Table IV-4 shows scheduled speeds and times between LRT stops as well as cumulative time and distance from the terminal point. Average schedule speed along the 14.1 mile long line is approximately 24 miles per hour. Approximately 31.2 minutes are required to make the trip from TH101 to Chicago Avenue and 6th Street South.

Annual Vehicle Miles

Total annual vehicle miles are calculated at 1,014,229 in the Southwest. Vehicle mile calculations are shown in the Technical Supplement.

Capital Requirements and Costs

Capital construction costs are shown in Table IV-5. Total construction costs are estimated at $83.7 million. Since LRT is being constructed on an existing rail right-of-way, costs are lower than would be required for LRT on a new alignment.

TABLE IV-4

SCHEDULED SPEEDS, TIME, AND DISTANCE - SOUTHWEST

Chicago & 6th St. S. (Stadium)	Distance (Miles)	Scheduled Speed (MPH)	Scheduled Time (Seconds)	Cumulative Time from Terminal (Minutes)	Cumulative Distance From Terminal (Miles)
4th Ave. S. & 6th St. S.	0.3	12	1.50	1.50	0.3
2nd Ave. S. & 6th St. S.	0.2	12	1.00	2.50	0.5
Nicollet Ave. & 6th St. S.	0.2	12	1.00	3.50	0.7
Hennepin & 6th St. S.	0.1	12	.50	4.00	0.8
2nd Ave. N. & 6th St. S.	0.1	30	.20	4.20	0.9
Wayzata Blvd. & C&NW RR (Parade)	1.1	35	1.88	6.08	2.0
21st & C&NW	1.3	25	3.12	9.20	3.3
28th & C&NW	0.6	25	1.43	10.63	3.9
Lake St. & C&NW	0.5	35	.85	11.48	4.4
Bass Lake & C&NW	1.0	30	2.00	13.48	5.4
Wooddale Ave. & C&NW	0.8	30	1.60	15.08	6.2
Louisiana Ave. & C&NW	0.6	30	1.20	16.28	6.8
Blake Rd. & C&NW	1.0	30	2.00	18.28	7.8
Excelsior Ave. & C&NW	1.2	30	2.40	20.68	9.0
12th Ave. & C&NW	0.5	15	2.00	22.68	9.5
17th Ave. & C&NW	0.3	15	1.20	23.88	9.8
Plymouth Rd. & C&NW (Minnetonka Mills)	1.3	30	2.60	26.48	11.1
I-494 & C&NW	1.0	35	1.72	28.20	12.1
TH 101 & C&NW	2.0	40	3.00	31.20	14.1

TABLE IV-5

CONSTRUCTION COST ESTIMATE - SOUTHWEST

Item	Quantity	Unit	Unit Price $	Amount
Cross Ties	78,408	Each	47	$ 3,685,176
Stone Ballast	52,272	Linear Yards	35	1,829,520
115# Rail	156,816	Linear Feet	75	11,761,200
Excavation*	142,997	Cubic Yards	23	3,288,000
Electric Grade Crossings	8	Each	275,000	2,200,000
Crossovers (Including 2 turnouts)	14	Each	70,000	980,000
Platforms	39	Each	14,133	551,187
Utility Relocation in CBD	26	Blocks	500,000	13,000,000
Substation	11	Each	405,000	4,455,000
Roadway: 6" Concrete	14,493	Square Yards	30.45	410,862
Car Shop	1	Each	975,000	975,000
Simple Catenary System	16.0	Route Miles	798,000	12,768,000
Signal Comm + Wayside Controls	13.1	Route Miles	784,550	10,277,600
Pavement Removal	121,440	Square Feet	4.92	597,485
Traffic Signal Preemption Equip.	27	Intersection	8,000	216,000
	1980 PRICES:	SUBTOTAL		$66,995,961
		+ 15% Contingency		10,049,394
		+ 10% Engineering & Mobilization		6,699,596
		TOTAL		$83,774,951
		USE		$83,700,000

Right-of-Way Acquisition. Costs are estimated at $10.0 million for the 13.2 miles of the 14.1 miles line not located on city streets.

Parking Lots. Approximately 3,600 parking spaces will be required. Most of these will be in the western portion of the line where land costs of $4 per square foot will make parking lot construction economically feasible. At $3,000 per space, including land, costs will total $10.8 million.

Vehicles. Twenty-three vehicles, including three spares, will be required for revenue service. Total vehicle costs are estimated at $22.3 million. Calculations for vehicle requirements are shown in the Technical Supplement.

Feeder Buses. Thirty-four buses, including 5 spares, at $150,000 each, plus $55,200 per bus for maintenance and overhaul facilities, would cost a total of $7 million.

Capital costs are summarized as follows:

TABLE IV-6

CAPITAL COST SUMMARY - SOUTHWEST LRT

Category	Cost in Millions of Dollars
Right-of-Way Acquisition	$ 10.0
Construction	83.7
Vehicles	22.3
Parking Lots	10.8
SUBTOTAL	$126.8
Feeder Bus	7.0
TOTAL COSTS	$133.8

Total capital costs, exclusive of feeder bus costs, are estimated at $126.8 million in 1980 dollars, or about $9.0 million per double-tracked mile.

Operating and Maintenance Costs

Table IV-7 shows estimated annual oeprating costs by category of expense. Total annual operating and maintenance costs, including feeder bus, but exclusive of annualized capital costs, are estimated at $5.4 million. On a cost per passenger basis this works out to $0.72.

Feeder bus costs of $2.8 million are based upon the need for approximately 1.233 million bus miles at $1.10 per mile and 80,000 bus hours at $18.34 per hour as shown in Table IV-8.

TABLE IV-8

LOCAL BUS FEEDER SERVICE ANNUAL OPERATING AND MAINTENANCE COSTS (1980 Dollars)

Annual Bus Miles 1,233,000	$1.10/mile	$1,356,300
Annual Bus Hours 80,000	$18.34/hour	$1,467,200

Annualized Capital Costs

Annualized capital costs are estimated at approximately $12.9 million (calculations appear in the Technical Supplement). Table IV-9 shows total annual operating and maintenance costs including annualized capital costs for LRT in the Southwest.

TABLE IV-7

ANNUAL LRT OPERATING AND MAINTENANCE COSTS INFLATED TO YEAR 1980

Based on 1976 Unit Cost Relationships
(Southwest)

Item (With 1976 Unit Cost	
Track Maintenance (.34/Vehicle Mile Traveled)	$ 344,838
Shelter Maintenance ($500/Shelter)	19,000
Yards & Support Maintenance ($1,000/Peak Hour Vehicle)	19,000
Electrical Maintenance (.04/Vehicle Mile Traveled)	40,569
Communications & Control Maintenance ($2,500/Track Mile)	65,500
Vehicle Maintenance (.24/Vehicle Mile Traveled)	243,415
Vehicle Energy Consumption (.14/Vehicle Mile Traveled)	141,992
Maintenance Facility Energy Consumption ($50/Peak Hour Vehicle)	950
Vehicle Storage Energy Consumption ($400/Peak Hour Vehicle)	7,600
MTC Operators Salary plus Benefit ($16,867)	439,143
Other Transportation (.17/Vehicle Mile Traveled)	172,419
SUBTOTAL	$1,534,426
General & Administrative (15% of Subtotal)	230,914
1976 TOTAL COST	$1,765,340
Inflated at 10%/Annum to 1980	$2,584,634
TOTAL	$2,584,634
USE	$2,585,000

Unit Cost Source: Light Rail Transit, A State of the Art, U.S. Department of Transportation, 1976.

Operator's Cost Source: Metropolitan Transit Commission.

TABLE IV-9

TOTAL ANNUAL LRT OPERATING AND MAINTENANCE COSTS INCLUDING ANNUALIZED CAPITAL COSTS - SOUTHWEST	
Operating and Maintenance Costs	$ 5,378,500
Annualized Capital Costs	$12,900,000
TOTAL	$18,278,500

Annualized capital costs are in 1980 dollars. The relationship between annualized capital costs and annual operating and maintenance costs is only accurate for the first year of a capital investment.

Operating Cost Versus Revenues

Based on a $.50 fare, annual revenues of $3.7 million are anticipated. When compared to annual operating and maintenance costs of $5.4 million, costs exceed revenues by $1.7 million as is shown in Table IV-10.

TABLE IV-10

ESTIMATED LRT OPERATING COSTS VERSUS REVENUES IN 1980 DOLLARS - SOUTHWEST	
Total Annual LRT Passengers	7,480,300
LRT Revenue Generated - @ $.50 fare	$3,740,150
Total LRT and Bus Costs	$5,378,500
Surplus/(Deficit)	($1,638,350)

Impact Analysis

Land Use. Unlike in the West, the Southwest alignment does not follow, to any appreciable extent, a major truck highway. It does cross some major highways at several points (e.g. Lake Street, TH100, TH7, County Road 18, I-494, and County Road 101), but for the most part it runs an independent course through both densely and sparsely developed areas. Establishment of an LRT line along this route should significantly increase the accessibility of this corridor and become a positive developmental influence. At the same time, however, existing land uses and community tendencies leave major new development unlikely for most portions of the Southwest alignment.

The Southwest corridor as a whole, like the West, is expected to enjoy continuing residential, commercial, and industrial development during the period 1990 to 2000. As shown in Table IV-11, the Metropolitan Council's social and economic data base indicates that an estimated 2,430 acres of land is expected to be developed in this general corridor area during the 1990's. This amounts to about 7 percent of the development activity expected for the entire Twin Cities Metropolitan area over the same 10 year period.

The primary land use impacts associated with development of an LRT line along the present C&NW right-of-way will occur within one-half mile of the individual LRT stops. While there is developable land at several points along the Southwest alignment, the likelihood of major new development occurring before the end of the century remains in doubt. The analysis of individual sites and discussions with municipal planners strongly suggest that future development must be compatible with existing land uses. In that respect, LRT construction would not be in itself a strong inducement to development along the alignment.

The projected land development patterns along the Southwest (C&NW) alignment are indicated in Table IV-12.* In total, an estimated 127 acres of land are expected to be developed within a half-mile radius of individual LRT stops between 1990 and 2000. Of this development, about 65 percent or 83 acres of land could be expected to develop as a direct consequence of LRT development. Almost two-thirds of this amount would be new

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*Pertinent charts and maps reflecting the land use impact analysis at each LRT stop are provided in the Technical Supplement to this report.

TABLE IV-11

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

Southwest Corridor Acreage**	1990	2000	Change 1990-2000
Residential	14,806	15,890	1,174
Commercial	1,639	2,058	419
Industrial	3,683	4,521	838
TOTAL	20,128	22,559	2,431
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

*Since these figures are based on utilized acreage, the estimates do not reflect redevelopment activity where the land use remains unchanged.

**Includes an area 1 to 3 miles on either side of the Southwest corridor alignment. These estimates also include the Minnepolish CBD.

Source: Socio-Economic and Land Use File, Metropolitan Council, 1980.

TABLE IV-12

PROJECTED LAND DEVELOPMENT WITHIN ONE-HALF MILE
OF THE SOUTHWEST ALIGNMENT LRT STOPS, 1990-2000
(In Acres)

	New Development	Redevelopment	Total
Acreage Projected to Develop Around LRT Stops, 1990-2000	71.3	55.6	126.9
Acreage of Development, LRT Induced			
Residential	46.0	13.5	59.5
Commercial	2.3	11.0	13.3
Industrial	5.0	5.0	10.0
TOTAL	53.3	29.5	82.8

Source: Midwest Research Institute.

development, while about one-third of the acreage would be in redevelopment. It is estimated that establishment of an LRT line along the Southwest alignment would result in development of 60 acres of residential property, 13 acres of commercial property, and 10 acres of industrial property.

Based upon current municipal land use controls and density allowances, the direct impact of LRT development along the Southwest alignment would be the construction of 1,245 high and medium density multi-family housing units, more than 153,000 square feet of retail and office commercial space, and 218,000 square feet of industrial space. As indicated in Table IV-13, the construction impacts in 1980 dollars of this LRT-induced residential, commercial, and industrial development would be on the order of $53 million.

TABLE IV-13

PROJECTED LRT-INDUCED LAND USE CHANGES AND CONSTRUCTION IMPACTS, SOUTHWEST ALIGNMENT, 1990-2000

	New Development	Redevelopment*	Total
Projected LRT-Induced Land Use Changes			
• Residential Multi-Family Units:			
High Density	0	574	574
Medium Density	597	74	671
Low Density	0	0	0
Total Units	597	648	1,245
• Commercial Square Footage:			
Retail	15,000	48,800	63,800
Office	0	89,350	89,350
Total Sq. Ft.	15,000	138,150	153,150
• Industrial Square Footage	108,900	108,900	217,800
Projected LRT-Induced Building Construction (in 1980 Construction $'s)**			
• Residential	$20.7 Million	$22.8 Million	$43.5 Million
• Commercial	1.0 Million	4.8 Million	5.8 Million
• Industrial	1.95 Million	1.95 Million	3.9 Million
Total Construction Impact	$23.65 Million	$29.55 Million	$53.2 Million

* Does not include rehabilitation activity.
** Does not include costs of demolition, relocation, parking, landscaping or other site preparation costs.

Source: Midwest Research Institute

To gain a perspective on the land use impacts associated with LRT development along the Southwest alignment, it is important to recognize that this is not new regional development but, rather, is development shifted from other locations within the Southwest corridor. It also represents only 83 acres out of an estimated 2,430 acres projected to develop during the decade 1990 to 2000 in the Southwest corridor.

As with the analysis of the West alignment, the land use impacts along the Southwest alignment are based on prevailing land use density allowances and control policies. By giving greater emphasis to available control policies and development strategies, it is likely that higher densities and larger scale development efforts could be achieved along the Southwest LRT alignment. Three potential strategies for generating more concentrated development around the LRT stops were set out previously in the Chapter III discussion of the West alignment. These strategies give emphasis to public coordination, innovative development incentive techniques, and effective land use control techniques.

Energy. The energy impacts attributable to operation of an LRT line with feeder buses in the Southwest corridor are shown in Table IV-14. For the year 2000, the LRT system is projected to consume about 142,000 MBTU's of energy. Of this total, about two-thirds would be coal-based electrical energy used in powering the LRT vehicles. The remaining one-third would be petroleum-based energy required in operating the feeder bus system.

Environment. The pollution impacts from operation of an LRT line along the Southwest alignment are projected in Table IV-15. As shown, a total of more than 3.1 million pounds of pollution can be linked to LRT operations. The most significant pollutant impacts occur outside of the corridor in the mining of coal and the generation of electricity. Within the corridor, the highest levels of pollution are associated with the engine exhaust of the diesel powered feeder buses.

Evaluating the impact of noise from moving vehicles in a corridor is complex. While measurements of sound intensity are important, they can only be used to analyze the magnitude of sound and not the human reaction to it. In general, however, the acoustical impact of an LRT line in the Southwest corridor should not increase disturbance and in some areas can be an improvement. Based on published noise data there is evidence that LRT operations should be quieter than buses and in some areas may be below automobile noise levels.

TABLE IV-14

PROJECTED ENERGY CONSUMPTION WITH
LRT OPERATION, SOUTHWEST ALIGNMENT, YEAR 2000

	LRT LINE	FEEDER BUSES
Annual Vehicle Miles	1,014,200 miles	1,232,000 miles[1]
Projected Fuel Efficiency	8 KWH/Vehicle mile[2]	4 miles/gallon (diesel)[3]
Annual Energy Consumption	8,113,600 KWH	308,000 gallons
BTU's of Energy Consumed[4]	93,300 M BTU's	48,700 M BTU's

Total Annual Energy Consumption: 142,000 M BTU's

[1]MTC estimate of total bus miles required in the year 2000 to service an LRT line along the Southwest alignment.

[2]LRT vehicle fuel efficiency based on estimate of the Boeing Company.

[3]Based on projections provided by the Metropolitan Transit Commission.

[4]Reflects total energy used in obtaining the source fuels from the mine and well head, to refine and transport them, as well as consume them.

TABLE IV-15

PROJECTED POLLUTANT LOADS[1] - SOUTHWEST ALIGNMENT LRT SYSTEM, YEAR 2000

(In Pounds)

	LRT Operations[2]	Feeder Buses	Total
Air Pollution			
Particulate	289,200	4,700	293,900
Carbon Monoxide (CO)	-	97,800	97,800
Hydrocarbons (HC)	7,200	34,100	41,300
Nitrogen Oxides (NO_x)	66,900	72,400	139,300
Sulphur Oxides (SO_x)	656,800	16,300	673,100
Water Pollution			
Suspended Solids (SS)	-	100	100
Chemical Oxygen Demand (COD)	-	700	700
Biochemical Oxygen Demand (BOD)	-	200	200
Other	-	16,000	16,000
Solid Waste			
Mining/Drilling Wastes	1,618,700	4,400	1,623,100
Other Solid Wastes	264,100	5,300	269,400
Total Pollutant Loads	2,902,900	252,000	3,154,900

1 MRI's REEPA analysis projects a "cradle to grave" estimate of pollution, i.e. pollutant loads at the well head and mine through to combustion of the coal and petroleum fuels.

2 Assumes that electricity for LRT operation would be coal generated. To the extent that this electricity is available from existing capacity or from other electrical sources, this estimate may overstate actual pollution impacts. The emphasis on coal is judged reasonable given current NSP source projections and prevailing industry trends.

Along the Southwest alignment, the acoustical disturbance will be less than was the case with C&NW railroad activity. In the Hopkins area, reduced speeds should keep LRT noise levels within acceptable limits. The setback distances through Minnetonka Mills and Minnetonka should also negate any potential vehicle noise problems.

In terms of visual impacts, a carefully designed and landscaped LRT system can blend into the surrounding environment better than most other modes of transit. The greatest visual problem is likely to be the LRT overhead traction power support system. The use of modern designs and materials is expected to reduce the likelihood of this being a major problem. One problem that is being experienced in other cities, is the parking around LRT stops. Where parking has been insufficient, commuters have been forced to park on surrounding neighborhood streets. This has been a major visual and noise complaint among residents in these impacted neighborhoods.

NON-LRT ALTERNATIVE

The Non-LRT alternative in the Southwest is an improved bus system.

Ridership Forecasts

Table IV-16 shows the impacts that an improved bus system would have on local bus ridership and daily auto trips. The improved bus system is forecast to carry 30,100 passengers or 2.8 percent of total corridor travel. Automobiles are forecast to carry 1,064,500 people or 97.2 percent of all corridor travel.

Capital Costs

One hundred and eleven buses, including 15 spares will be required for improved Southwest bus service according to the plan prepared by the MTC. At $150,000 each, bus costs will total $16.7 million.

TABLE IV-16

FORECAST TRAVEL BY MODE - SOUTHWEST NON-LRT

	DAILY TRIPS	PERCENT	PEAK PERIOD	PERCENT
AUTO				
Drivers	651,600	59.5	94,100	58.3
Passengers	412,900	37.7	59,600	36.9
SUBTOTAL	1,064,500	97.2	153,700	95.2
TRANSIT				
Bus	30,000	2.8	7,700	4.8
TOTAL TRIPS	1,094,600	100.0	161,400	100.0

Added to this are the capital costs associated with garaging and overhauling these buses at $55,200 each or $6.1 million. Total costs are $22.8 million. Costs reflect actual MTC experience.

111 buses	$16,650,000
Maintenance Facility ($43,560/bus)	4,835,160
Overhaul Facility ($11,660/bus)	1,294,371
TOTAL	$22,779,531
USE	$22,780,000

Operating Plan

The Southwest Non-LRT alternative consists of an improved bus system to carry the forecasted number of transit passengers. This system would feature significantly shorter headways on corridor bus routes (particularly during peak periods) than those existing today.

Operating and Maintenance Costs. Southwest Non-LRT operating and maintenance costs are based on current MTC unit costs. System costs are estimated at $6.75 million as shown in Table IV-17.

TABLE IV-17

NON-LRT OPERATING AND MAINTENANCE COST - SOUTHWEST

ITEM	UNIT COST	COST
Annual Bus Miles 2,964,000	$1.10/mile	$3,260,400
Annual Bus Hours 190,000	$18.34/hour	$3,484,600
	TOTAL	$6,744,600
	USE	$6,745,000

Annualized Capital Costs. Annualized capital costs for the Non-LRT alternative are estimated at $3 million. Calculations appear in the Technical Supplement. Table IV-18 combines annual operating and maintenance costs with annualized capital costs.

TABLE IV-18

TOTAL ANNUAL OPERATING AND MAINTENANCE COSTS
INCLUDING ANNUALIZED CAPITAL COSTS
NON-LRT SOUTHWEST

Operating and Maintenance Cost	$6,745,000
Annualized Capital Cost	3,013,099
TOTAL	$9,758,099
USE	$9,758,000

Operating Costs Versus Revenues

Based on a $0.50 fare, annual Non-LRT operating and maintenance costs exceed revenues by $3.8 million. When annualized capital costs are included in this deficit increases to $6.8 million. Table IV-19 compares costs to revenues.

TABLE IV-19

OPERATING COSTS VERSUS REVENUES
NON-LRT - SOUTHWEST

Total Annual Non-LRT Passengers	5,978,000
Total Operating & Maintenance Cost	$6,475,000
Revenue Generated (at $0.50 fare)	$2,989,000
Surplus/(Deficit)	($3,756,000)

COMPARISON OF LRT AND NON-LRT - SOUTHWEST

Table IV-20 presents a summary of comparative data on LRT and Non-LRT. LRT's cost is higher when annualized capital costs are included. The cost differential between LRT and Non-LRT (Annual Operating Surplus/Deficit including Capital Costs, as shown in Table IV-20) will decrease over time since annualized capital costs are constant for the life of the bonds used to finance the initial system. Other annual costs are subject to inflation.

TABLE IV-20

SUMMARY COMPARISON - LRT VERSUS NON-LRT - SOUTHWEST

		LRT	Non-LRT
24 Hour Ridership	LRT	25,400	-
	Bus	9,800	30,100
TOTAL TRANSIT		35,200	30,100
Capital Cost		$133.8 million	$22.8 million
Annual Operating & Maintenance Cost		5.38 million	6.75 million
Annualized Capital Costs		12.9 million	3.01 million
Annual Operating Surplus/ (Deficit) Excluding Capital Cost		(1.64 million)	(3.76 million)
Annual Operating Surplus/ (Deficit) Including Capital Cost		(14.22 million)	(6.79 million)

Impact Analysis

Energy. The energy impacts projected for the Non-LRT system designated for the Southwest corridor are indicated in Table IV-21. As shown, an improved bus system would consume on an annual basis, about 117,200 MBTU's of energy. To permit a balanced comparison with the LRT model, the analysis also includes the estimated 4.4 million automobile miles driven by individuals that could be persuaded to ride the LRT but not the bus. By adding these shifted automobile miles into the Non-LRT model, the annual energy impact reaches 136,700 MBTU's.

TABLE IV-21

PROJECTED ENERGY CONSUMPTION FOR THE
NON-LRT ALTERNATIVE, SOUTHWEST ALIGNMENT, YEAR 2000

	Bus Service	LRT Riders Shifting To Automobiles
Annual Vehicle Miles	2,964,000 miles[1]	4,374,720 miles[2]
Projected Fuel Efficiency[3]	4 miles/gallon (diesel)	32.4 miles/gallon (gasoline)
Annual Fuel Consumption	741,000 gallons	135,000 gallons
BTU's of Energy Consumed[4]	117,200 MBTU's	19,500 MBTU's

Total Annual Energy Consumption: 136,700 MBTU's

[1]Based on MTC estimates for the year 2000.

[2]Determined on the basis of the difference between the number of projected auto driver trips with LRT and the number of trips with the Non-LRT alternative.

[3]Based on projections by the Minnesota Energy Agency and the Metropolitan Transit Commission.

[4]Energy consumption estimates include all energy required to obtain the petroleum at the well head, to refine it, to transport it, and ultimately to consume it directly as fuel.

In terms of overall energy consumption, the LRT and Non-LRT alternative models again emerge very close, with the LRT only about four percent higher than the Non-LRT alternative (142,000 MBTU's to 136,700 MBTU's for the Non-LRT alternative).

The potential for actual petroleum fuel conservation with institution of the LRT model is shown in Table IV-22. As indicated, an estimated 568,000 gallons of petroleum fuel could be conserved during the year 2000. About three-quarters of this saving would result from reduced bus service needs in the corridor. The remaining 135,000 gallons of gasoline would occur because of the ability of the LRT to entice more auto drivers to public transit than would the bus alternative. This gasoline saving, however, accounts for just half of one percent of the 28 million gallons of gasoline that will still be required to fuel the automobile fleet in the Southwest corridor.

TABLE IV-22

PROJECTED PETROLEUM SAVINGS WITH OPERATING OF AN LRT LINE, SOUTHWEST CORRIDOR YEAR 2000

Gasoline Savings with Reduced Automobile Use	135,000 gallons
Diesel Fuel Savings with Reduced Bus Service Needs	433,000 gallons
Annual Petroleum Savings	568,000 gallons
Remaining Gasoline Consumption by Automobiles Under the LRT Model	28,246,000 gallons

Environment. The comparative pollution impacts from operation of the LRT and Non-LRT models are shown in Table IV-23. As indicated, the LRT system is responsible for more than three times the pollution levels of the Non-LRT alternative. The LRT impacts, however, are almost entirely off-site either associated with mining or electrical generation. The Non-LRT alternative with its dependence on petroleum fuel combustion reflects significantly higher levels of carbon monoxide pollution within the confines of the study corridor.

TABLE IV-23

COMPARATIVE ENVIRONMENTAL IMPACTS[1] -
LRT-VS-NON-LRT ALTERNATIVE SOUTHWEST ALIGNMENT
(In Pounds)

	LRT	Non-LRT Alternative
Air Pollution		
Particulate	293,900	13,600
Carbon Monoxide (CO)	97,800	515,000
Hydrocarbons (HC)	41,300	110,300
Nitrogen Oxides (NO_x)	139,300	193,600
Sulfur Oxides (SO_x)	673,100	42,700
Water Pollution		
Suspended Solids (SS)	100	400
Chemical Oxygen Demand (COD)	700	2,100
Biochemical Oxygen Demand (BOD)	200	600
Other	16,000	45,400
Solid Waste		
Mining/Drilling Wastes	1,623,100	12,500
Other Solid Wastes	269,400	15,100
Total Pollutant Loads	3,154,900	951,300

[1] MRI's REEPA analysis projects a "cradle to grave" estimate of pollution, i.e. pollutant loads at the mine and well head through to final combustion of the coal and petroleum as fuel.

CHAPTER V

UNIVERSITY CORRIDOR

INTRODUCTION

There are several major transportation facilities in the University Corridor that connect the Minneapolis and St. Paul downtowns. Though most of the land between the downtowns is developed there is considerable redevelopment potential. The University Corridor is distinct from others in that it is the only corridor with high trip generating multiple nodes. Operations in the corridor would serve short trips to downtown Minneapolis and St. Paul, the University of Minnesota, the Midway, and the TH280 industrial area. Transit use in the corridor is presently characterized as heavy with frequent stops at the major activities.

ALIGNMENT SELECTION

The alternative alignments tested in the University Corridor are shown in Figure II-1. They are:

- o BN Railroad
- o University Avenue
- o I-94

Since the sketch planning analysis showed little variation in patronage between the alternative alignments, alignment selection was based on other factors as described in Chapter II, as well as input from the various committees overseeing the project. University Avenue emerged as the preferred alignment.

LRT ALTERNATIVE

LRT Stop Locations

Figure V-1 shows the alignment details and stop locations. Throughout thelength of the alignment operations would take place in a physically separated right-of-way, isolated from automotive traffic.

Stops are spaced, on average, 0.2 miles apart in the St. Paul and Minneapolis downtowns and 0.5 miles apart along the length of University Avenue and Washington Avenue between the two downtowns.

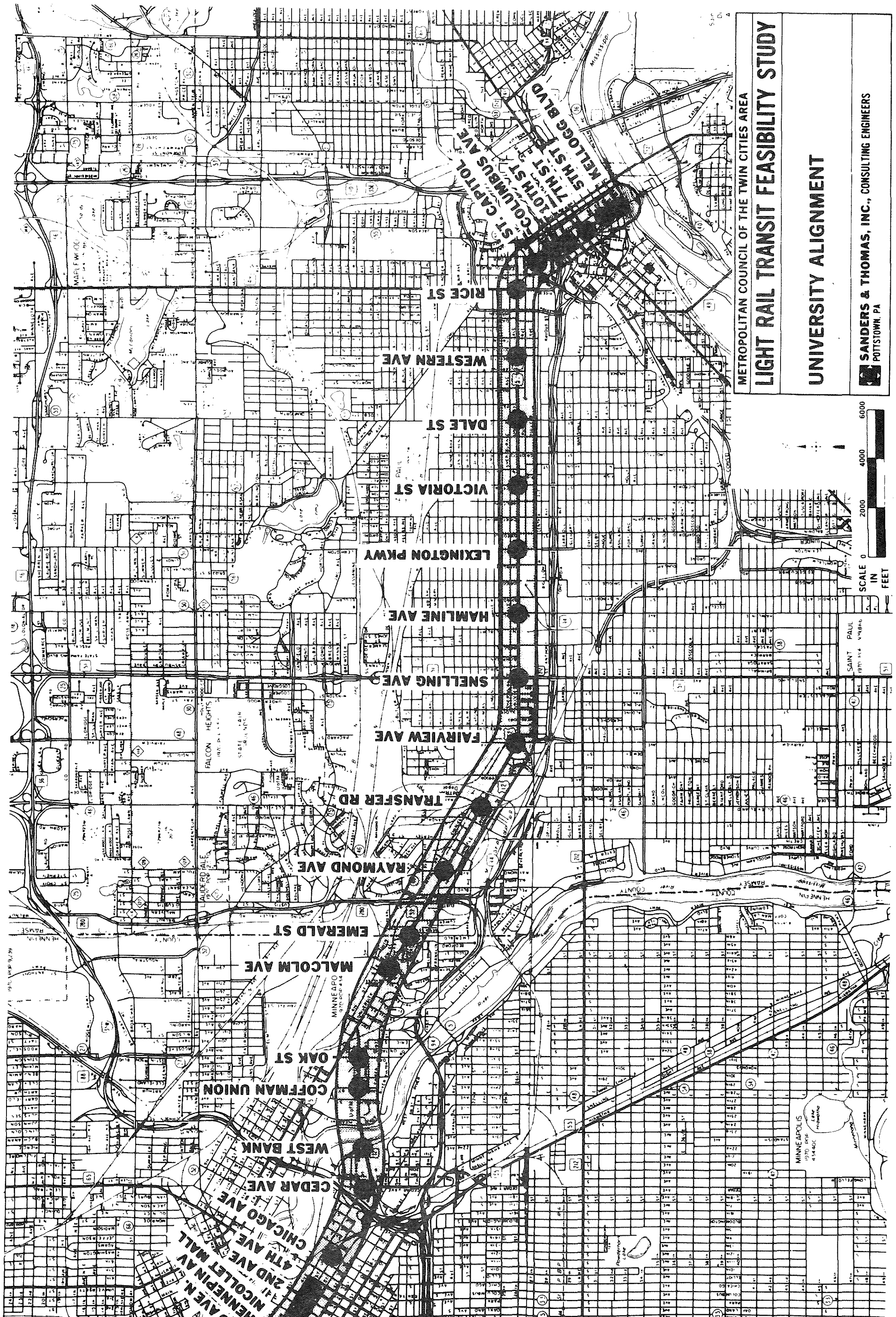
TABLE V-1

PROPOSED LRT STOPS - UNIVERSITY

Kellogg Blvd & Wabasha St.	Transfer Rd & University Ave.
E. 5th St. & Wabasha St.	Raymond Ave & University Ave.
E. 7th St. & Wabasha St.	Emerald St. & University Ave.
E. 10th St. & Wabasha St.	Malcolm Ave. & University Ave.
Columbus Ave. & Wabasha St.	Oak St. & Washington Ave.
State Capitol & Wabasha St.	Coffman Union & Wash. Ave.
Rice St. & University Ave.	W. Bank and Washington Ave.
Western Ave. & University Ave.	Cedar Ave. & Washington Ave.
Dale St. & University Ave.	Chicago Ave. & 3rd St.
Victoria St. & University Ave.	4th Ave. S & 3rd St.
Lexington Parkway & Univ. Ave.	2nd Ave. S and 3rd St.
Hamline Ave. & University Ave.	Nicollet Mall & 3rd St. S
Snelling Ave. & University Ave.	Hennepin Ave. & 3rd St. S
Fairview Ave. & University Ave.	2nd Ave. N & 3rd St. S

Operating Plan

The operating plan for the University alignment is shown in Table V-2. During the peak hours LRT would operate on 7 minute headways. On weekday non-peak hours LRT would operate on 9 minute headways. A turnback is planned at Oak Street and Washington Avenue for some Minneapolis trips.



2ND AVE N.
HENNEPIN AV
NICOLLET MALL
2ND AVE
4TH AVE
CHICAGO AVE
CEDAR AVE
WEST BANK
COFFMAN UNION
OAK ST
MALCOLM AVE
EMERALD ST
RAYMOND AVE
TRANSFER RD
FAIRVIEW AVE
SNELLING AVE
HAMLINE AVE
LEXINGTON PKWY
VICTORIA ST
DALE ST
WESTERN AVE
RICE ST
ST. CAPITOL
COLUMBUS AVE
10TH ST
7TH ST
5TH ST
KELLOGG BLVD
SCALE IN FEET
0
2000
4000
6000
METROPOLITAN COUNCIL OF THE TWIN CITIES AREA
LIGHT RAIL TRANSIT FEASIBILITY STUDY
UNIVERSITY ALIGNMENT
SANDERS & THOMAS, INC., CONSULTING ENGINEERS
POTTSTOWN, PA

FIGURE V-I

LRT ALTERNATIVE

LRT Stop Locations

Figure V-1 shows the alignment details and stop locations. Throughout thelength of the alignment operations would take place in a physically separated right-of-way, isolated from automotive traffic.

Stops are spaced, on average, 0.2 miles apart in the St. Paul and Minneapolis downtowns and 0.5 miles apart along the length of University Avenue and Washington Avenue between the two downtowns.

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E. 7th St. & Wabasha St.	Emerald St. & University Ave.
E. 10th St. & Wabasha St.	Malcolm Ave. & University Ave.
Columbus Ave. & Wabasha St.	Oak St. & Washington Ave.
State Capitol & Wabasha St.	Coffman Union & Wash. Ave.
Rice St. & University Ave.	W. Bank and Washington Ave.
Western Ave. & University Ave.	Cedar Ave. & Washington Ave.
Dale St. & University Ave.	Chicago Ave. & 3rd St.
Victoria St. & University Ave.	4th Ave. S & 3rd St.
Lexington Parkway & Univ. Ave.	2nd Ave. S and 3rd St.
Hamline Ave. & University Ave.	Nicollet Mall & 3rd St. S
Snelling Ave. & University Ave.	Hennepin Ave. & 3rd St. S
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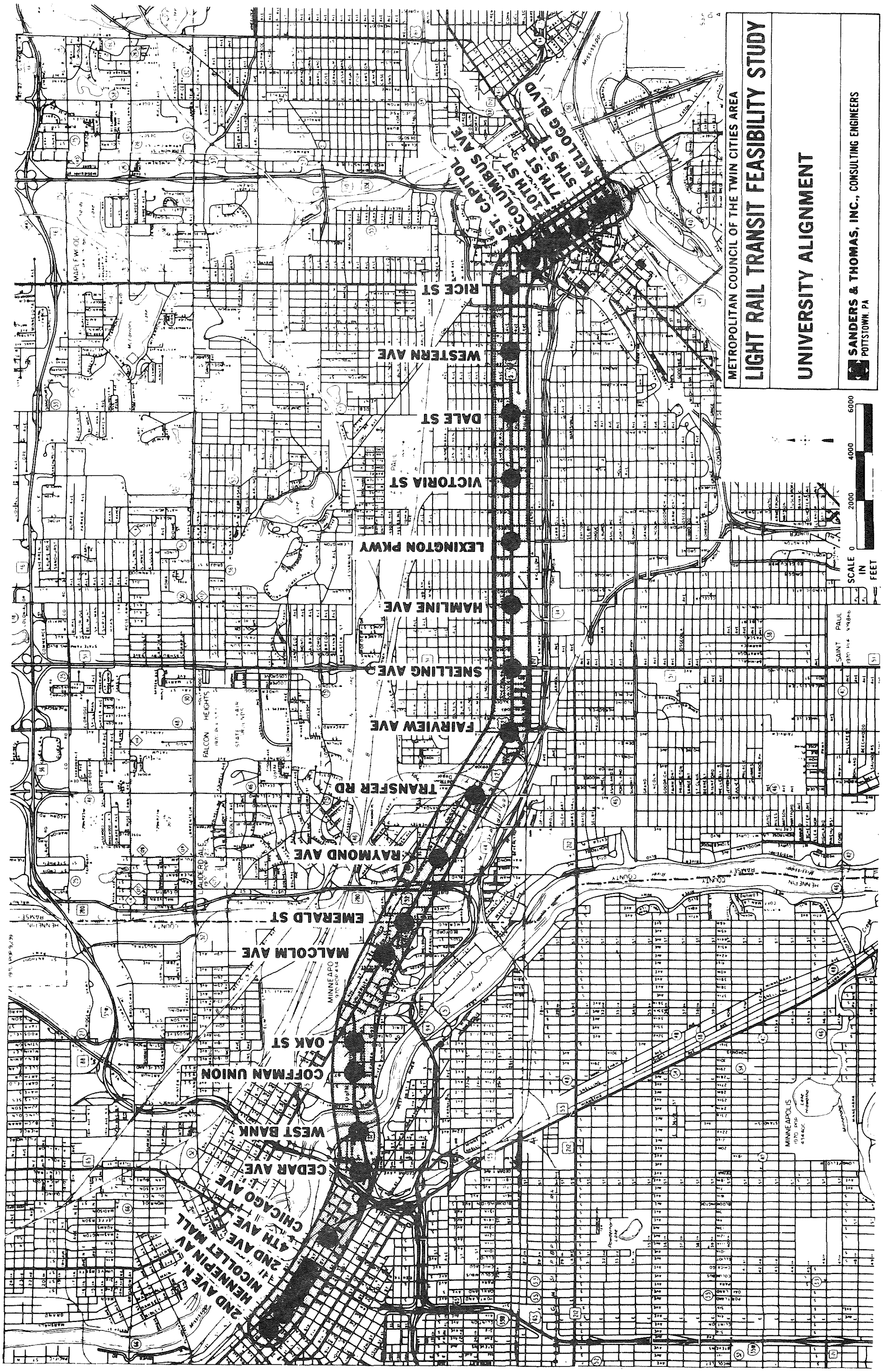


METROPOLITAN COUNCIL OF THE TWIN CITIES AREA
LIGHT RAIL TRANSIT FEASIBILITY STUDY
UNIVERSITY ALIGNMENT
SANDERS & THOMAS, INC., CONSULTING ENGINEERS
POTTSTOWN, PA
SCALE IN FEET
0
2000
4000
6000
KELLOGG BLVD
5TH ST
7TH ST
10TH ST
COLUMBUS AVE
CAPITOL
RICE ST
WESTERN AVE
DALE ST
VICTORIA ST
LEXINGTON PKWY
HAMLINE AVE
SNELLING AVE
FAIRVIEW AVE
TRANSFER RD
RAYMOND AVE
EMERALD ST
MALCOLM AVE
OAK ST
COFFMAN UNION
WEST BANK
CEDAR AVE
CHICAGO AVE
4TH AVE
2ND AVE
NICOLLET MALL
HENNEPIN AV
2ND AVE N

FIGURE V-I

TABLE V-2

OPERATING HEADWAYS - UNIVERSITY
(Minutes)

	5 A.M.- 7 A.M.	7 A.M.- 9 A.M.	9 A.M.- 4 P.M.	4 P.M.- 6 P.M.	6 P.M.- 11 P.M.	11 P.M.- 1 A.M.
Weekdays	9	7	9	7	9	9
Saturdays	20	20	20	20	20	20
Sundays & Holidays		30	30	30	30	

Table V-3 shows scheduled speeds and times between LRT stops as well as cumulative time and distance from the terminal point. Average scheduled speed along the 9.5 mile line is approximately 16 miles per hour necessitating 34 minutes to traverse the length of the route.

Annual Vehicle Miles

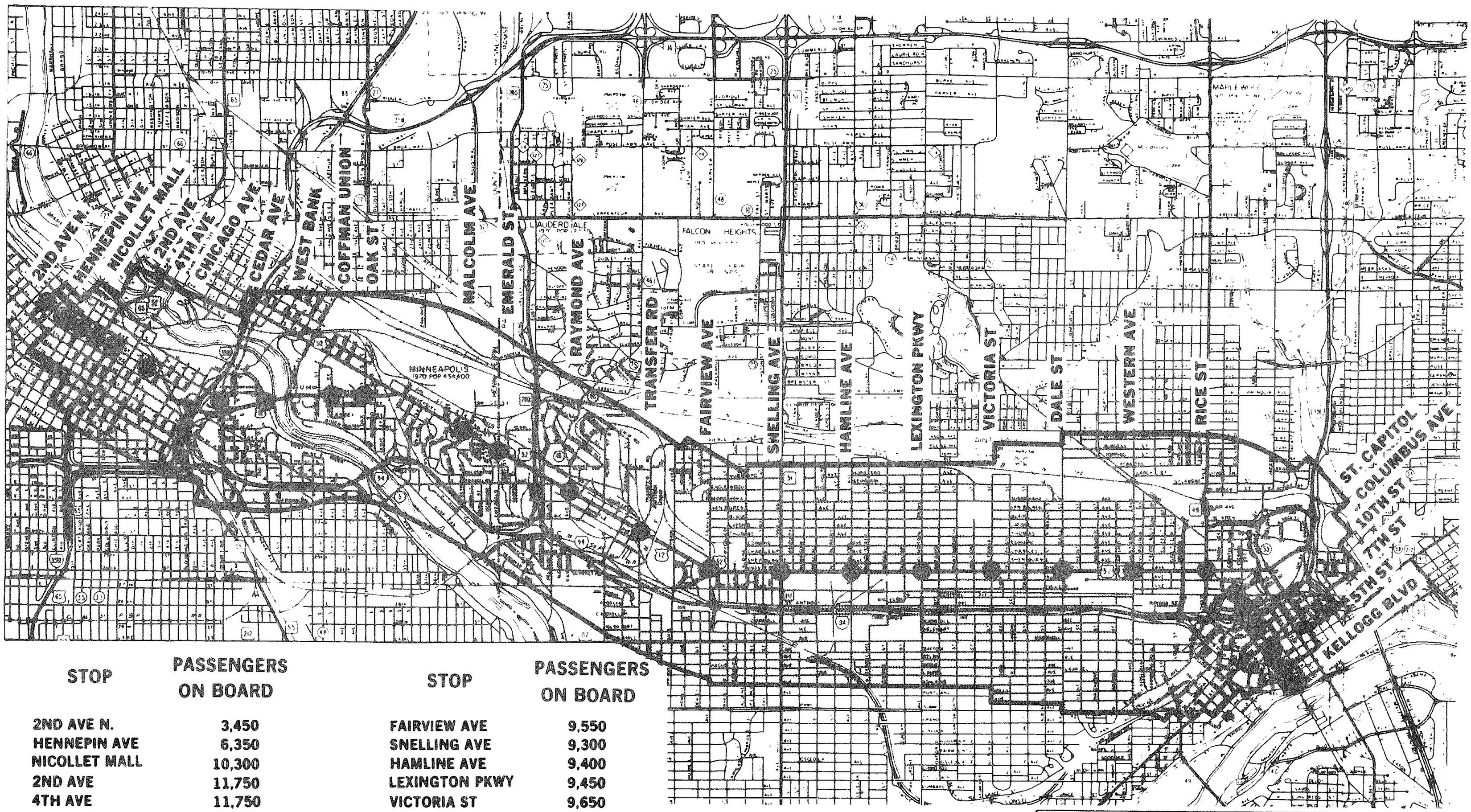
Total annual vehicle miles have been calculated at 704,400 for the University alignment. (See Technical Supplement for calculations.)

Ridership Forecasts

Ridership was forecast for the University alignment using the sketch planning model and adjusted to better account for student trips to the University of Minnesota. Total daily ridership is forecasted to be 43,600. The number of passengers passing the maximum load point during the peak hour is 3,260.

Ridership on the 94B Express Bus between downtown St. Paul and downtown Minneapolis was not diverted to the LRT because passengers would be carried more effeciently and speedily on the one-stop freeway express service than on the multistop LRT.

Table V-4 compares forecasted LRT travel to total corridor travel and corridor travel by other modes. Daily eastbound ridership is shown in Figure V-2.



STOP	PASSENGERS ON BOARD	STOP	PASSENGERS ON BOARD
2ND AVE N.	3,450	FAIRVIEW AVE	9,550
HENNEPIN AVE	6,350	SNELLING AVE	9,300
NICOLLET MALL	10,300	HAMLINE AVE	9,400
2ND AVE	11,750	LEXINGTON PKWY	9,450
4TH AVE	11,750	VICTORIA ST	9,650
CHICAGO AVE	12,150	DALE ST	9,750
CEDAR AVE	11,750	WESTERN AVE	9,850
WEST BANK	11,300	RICE ST	9,900
COFFMAN UNION	10,800	STATE CAPITOL	8,000
OAK ST	10,000	COLUMBUS AVE	8,000
MALCOLM AVE	9,850	10TH ST	7,300
EMERALD ST	9,900	7TH ST	4,500
RAYMOND AVE	9,850	7TH ST	4,500
TRANSFER RD	9,650	5TH ST	2,300
		KELLOGG BLVD	0

SCALE IN FEET 0 2000 4000 6000

METROPOLITAN COUNCIL OF THE TWIN CITIES AREA

LIGHT RAIL TRANSIT FEASIBILITY STUDY

UNIVERSITY ALIGNMENT
DAILY PASSENGERS ON BOARD
ST. PAUL TO MINNEAPOLIS

SANDERS & THOMAS, INC., CONSULTING ENGINEERS
POTTSTOWN, PA

FIGURE V-2

TABLE V-3

SCHEDULED SPEEDS, TIME, AND DISTANCE - UNIVERSITY

Kellogg & Wabasha St.	Distance (Miles)	Scheduled Speed (MPH)	Scheduled Time (Minutes)	Cumulative Time from Terminal (Minutes)	Cumulative Distance From Terminal (Miles)
5th & Wabasha Sts.	0.14	12	.70	0.70	0.14
7th & Wabasha Sts.	0.14	12	.70	1.40	0.28
10th & Wabasha Sts.	0.34	12	1.70	3.10	0.62
Columbus Ave. & Wabasha St. (Veteran's Bldg)	0.19	12	.95	4.05	0.81
Capitol Ave. & Wabasha St. (Capitol)	0.24	12	.95	5.25	1.05
Rice St. & University Ave.	0.24	12	1.20	6.45	1.29
Western Ave. & University Ave.	0.50	21	1.43	7.88	1.79
Dale St. & University Ave.	0.50	21	1.43	9.31	2.29
Victoria St. & University Ave.	0.50	21	1.43	10.74	2.79
Lexington Pkwy. & University Ave.	0.50	21	1.43	12.17	3.29
Hamline Ave. & University Ave.	0.50	21	1.43	13.60	3.79
Snelling Ave. & University Ave.	0.50	19	1.58	15.18	4.29
Fairview Ave. & University Ave.	0.50	21	1.43	16.61	4.79
Transfer & University Ave. (AMTRAK)	0.50	21	1.43	18.05	5.29
Raymond & University Ave.	0.50	21	1.43	19.50	5.79
Emerald & University Ave. (City Limits)	0.50	21	1.43	20.90	6.29
Malcolm St. & University Ave.	0.30	21	.85	21.75	6.79
Oak St. & Washington Ave. SE	0.50	20	1.50	23.26	7.09
Coffman Union & Washington Ave. SE (U. of M.)	0.43	10	2.58	25.85	7.52
West Bank & Washington Ave. S (U. of M.)	0.33	15	1.32	27.16	7.85
Cedar Ave. & Washington Ave.	0.24	18	.80	27.96	8.09
Chicago Ave. & 3rd St. S (Stadium)	0.63	18	2.10	30.07	8.72
4th Ave. & 3rd St. S	0.27	12	1.35	31.42	8.99
2nd Ave. & 3rd St. S.	0.14	12	.70	32.12	9.13
Nicollet Ave. & 3rd St. S	0.14	12	.70	32.82	9.27
Hennepin Ave. & 3rd St. S	0.05	12	.25	33.07	9.32
2nd Ave. N & 3rd St. S	0.14	12	.70	33.37	9.46

TABLE V-4

FORECASTED TRAVEL BY MODE - UNIVERSITY

	24 Hours	&	Peak Period	%
Auto Driver	470,000	65.2	66,900	56.3
Carpool Passenger	117,100	16.2	16,600	14.0
Local Bus Passenger	90,500	12.6	22,900	19.3
LRT Passenger	43,600	6.0	12,300	10.4
TOTAL TRAVEL	721,200	100.0	118,700	100.0

Feeder Bus Requirements

Existing bus services intersecting University Avenue will provide satisfactory LRT-feeder service. Additional feeder service will probably not be required.

Capital Requirements and Costs

Capital construction costs are itemized in Table V-5. The 9.45 mile long line is estimated to cost $80.7 million.

Right-of-Way Acquisition. Since the LRT alignment would be entirely within existing public rights-of-way no costs have been included for right-of-way acquisition.

Parking Lots. No parking spaces will be required for a University LRT.

Vehicles. Twenty-one vehicles, including two spares, will be required for revenue service. Total vehicle costs are therefore estimated at $20.3 million.

Capital costs for a University LRT are summarized in Table V-6. Total capital costs are estimated at $101.0 million, in 1980 dollars or about $10.6 million per double-tracked mile.

TABLE V-5

CONSTRUCTION COST ESTIMATE - UNIVERSITY

Item	Quantity	Unit	Unit Price $	Amount
Street, Sidewalk & Center Island Remodeling	8.0	Miles	1,500,000	$12,000,000
Cross Ties	53,328	Each	47	2,506,416
Stone Ballast	35,557	Linear Yards	35	1,224,320
115# Rail	106,656	Linear Feet	75	7,999,200
Excavation	20,150	Cubic Yards	23	463,450
Crossovers (Including 2 turnouts)	8		70,000	560,000
Stop Equipment	54		6,525	352,350
Utility Relocation in the CBD's	46		500,000	23,000,000
Shelters (2)	-		3,000	
Signs	-		975	
Light Fixtures (5)	-		1,075	
Poles (5)	-		1,075	
Conduit Wires	-		400	
Substation	8	Each	405,000	3,240,000
Roadway: 6" Concrete	30,230	Square Yards	30.45	920,503
Car Shop	1	Each	975,000	975,000
Simple Catenary System	12.5	Route Miles	798,000	9,975,000
Pavement Removal	272,050	Square Feet	4,92	1,338,486
	1980 PRICES:	SUBTOTAL		$64,554,725
		+ 15% Contingency		9,683,208
		+ 10% Engineering & Mobilization		6,455,472
		TOTAL		$80,693,000
		USE		$80,693,000

TABLE V-6

CAPITAL COST SUMMARY - UNIVERSITY

Category	Cost in Millions of Dollars
Right-of-Way Acquisition	$ -
Construction	80.7
Vehicles	20.3
Parking Lots	-
TOTAL	$101.0

Operating and Maintenance Costs*

Estimated annual operating and maintenance costs by category of expense are shown in Table V-7. Total annual operating and maintenance costs, exclusive of annualized capital costs, are estimated at $1.9 million. Costs per passenger are calculated at $0.15.

Annualized Capital Costs

Annualized capital costs are estimated at $7.6 million. Table V-8 shows total annual operating and maintenance costs including LRT annualized capital costs. Annualized capital costs are calculated in the Technical Supplement.

Annualized capital costs of $9.6 million are in 1980 dollars. The relationship between annualized capital costs and annual operating and maintenance costs is only accurate for the first year of capital investments.

*No feeder system has been costed out for the LRT alternative in this alignment.

TABLE V-7

ANNUAL LRT OPERATING AND MAINTENANCE COSTS INFLATED TO YEAR 1980

Based on 1976 Unit Cost Relationships
(University)

Item (With 1976 Unit Cost)	
Track Maintenance (.34/Vehicle Mile Traveled)	$ 239,496
Shelter Maintenance ($500/Shelter)	27,000
Yards & Support Maintenance ($1,000/Peak Hour Vehicle)	16,000
Electrical Maintenance (.04/Vehicle Mile Traveled)	28,176
Vehicle Maintenance (.24/Vehicle Mile Traveled)	169,056
Vehicle Energy Consumption (.14/Vehicle Mile Traveled)	98,616
Maintenance Facility Energy Consumption ($50/Peak Hour Vehicle)	800
Vehicle Storage Energy Consumption ($400/Peak Hour Vehicle)	6,400
MTC Operators Salary plus Benefit ($16,867)	404,808
Other Transportation (.17/Vehicle Mile Traveled)	119,748
SUBTOTAL	$1,110,100
General & Administrative (15% of Subtotal)	166,515
1976 TOTAL COST	$1,276,615
Inflated at 10%/Annum to 1980	$1,869,091
TOTAL	$1,869,091
USE	$1,869,000

Unit Cost Source: *Light Rail Transit, A State of the Art*, U.S. Department of Transportation.

Operator's Cost Source: Metropolitan Transit Commission.

TABLE V-8

TOTAL ANNUAL LRT OPERATING AND MAINTENANCE COSTS INCLUDING ANNUALIZED CAPITAL COSTS - UNIVERSITY	
Operating and Maintenance Costs	$1,869,000
Annualized Capital Costs	9,600,000
TOTAL	$11,469,000

Operating Costs Versus Revenues

The $1.9 million operating cost will be offset by annual revenues of $6.4 million, based on a $.50 fare. As shown in Table V-9, this will result in an operating surplus of approximately $4.5 million.

TABLE V-9

ESTIMATED LRT OPERATING COST VERSUS REVENUES IN 1980 DOLLARS - UNIVERSITY	
Total Annual LRT Passengers	12,845,531
Total LRT Operating & Maintenance Costs	$1,869,000
LRT Revenue Generated at $.50 fare	$6,423,000
Surplus/(Deficit)	$4,554,000

Impact Analysis

Land Use. From a land use perspective, the University alignment reflects an entirely different development situation from the other four test alignments. Unlike the other alignments, the University Avenue area is almost entirely developed and demand does not appear strong enough to bring about major additional redevelopment. Because public transit, in the form of buses serving both core cities and the University of Minnesota, is already well established, it is doubtful that future LRT development will introduce sufficient behavioral change to affect existing corridor land use patterns. The only land parcels likely to be affected by LRT development are those within two or three blocks of individual LRT stops.

The lack of available developable land in the University corridor is shown in the Metropolitan Council's projections that only 22 acres of new development will be accomplished in this general area between 1990 and 2000. As shown in Table V-10, this growth is insignificant when compared to the growth projected for the metropolitan area as a whole.

It is clear that any significant development during the study period will have to occur through publicly or privately financed redevelopment. At the same time, the problems of multiple ownership and the availability of low cost land in other areas of the metropolitan area will leave major new redevelopment projects unlikely, at least through this century. The final point is that the commercial and industrial structures in this corridor are essentially sound, though aging, and will likely require little more than new facades or minor rehabilitation to remain serviceable. Impacts of this kind are not reflected in this analysis.

The land development patterns projected for the University alignment between 1990 and 2000 are indicated in Table V-II.[1] In total, approximately 47 acres are expected to be impacted within a quarter-mile radius of the individual LRT stops during the 1990's. Of this amount, about 45 percent, or 21 acres, could be expected to develop as a direct consequence of LRT development. Less than one acre of the LRT-induced total would be new development, while over 20 acres would be in small parcel redevelopment. It is estimated that establishment of an LRT

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[1] Pertinent charts and maps reflecting the land us impact analysis at each LRT stop are provided in the Technical Supplement.

TABLE V-10

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

University Avenue Corridor Acreage**	1990	2000	Change 1990-2000
Residential	4,350	4,365	15
Commercial	668	679	11
Industrial	1,936	1,932	(4)
TOTAL	6,954	6,976	22
Metro Area Acreage			
Residential	174,532	196,005	21,473
Commercial	15,841	20,174	4,333
Industrial	53,528	63,368	9,840
TOTAL	243,901	279,547	35,646

*Since these figures are based on utilized acreage, the estimates do not reflect change due to redevelopment activity.

**Includes an area 1 or 2 miles north and south of University Avenue alignment. These estimates also include both the Minneapolis and St. Paul CBD's.

Source: Socio-Economic and Land Use File, Metropolitcan Council, 1980.

line along University Avenue would result in development of 7 acres of residential property, 11 acres of commercial property, and 2 acres of industrial property.

The direct impact of LRT development along the University Avenue alignment, based upon current municipal land use controls and density allowances, would be the construction of 480 high

TABLE V-11

PROJECTED LAND DEVELOPMENT WITHIN ONE-HALF MILE OF THE UNIVERSITY AVENUE ALIGNMENT LRT STOPS, 1990-2000 (In Acres)

	New Development	Redevelopment	Total
Acreage Projected to Develop Around LRT Stops, 1990-2000	5.4	41.6	47.0
Acreage of Development LRT Induced			
Residential	0.0	7.3	7.3
Commercial	0.7	10.8	11.5
Industrial	0.0	2.3	2.3
TOTAL	0.7	20.4	21.1

Source: Midwest Research Institute

and medium density multifamily housing units, more than 168,000 square feet of retail and office commercial space, and 52,000 square feet of industrial space. As indicated in Table V-12, the construction impacts in 1980 dollars of this LRT-induced residential, commercial, and industrial development would amount to about $26 million.

As with the analysis of the other alignments, the land use impacts along the University Avenue alignment are based on prevailing land use density allowances and control policies. By giving greater emphasis to available control policies and development strategies--as the city of St. Paul is attempting in the Energy Park project and others--greater development impacts could be achieved.

Energy. The energy impacts attributable to operation of an LRT line in the University corridor are presented in Table V-13.

TABLE V-12

PROJECTED LRT-INDUCED LAND USE CHANGES AND CONSTRUCTION IMPACTS, UNIVERSITY AVENUE ALIGNMENT, 1990-2000

	New Development	Redevelopment*	Total
Projected LRT-Induced Land Use Changes			
. Residential Multi-Family Units:			
High Density	0	290	290
Medium Density	0	190	190
Low Density	0	0	0
Total Units	0	480	480
. Commercial Square Footage:			
Retail	0	120,100	120,100
Office	10,100	38,200	48,300
Total Sq. Ft.	10,100	158,300	168,400
. Industrial Square Footage	0	52,100	52,100
Projected LRT-Induced Building Construction (In 1980 Construction $'s)**			
. Residential	0	$ 20.6 million	$ 20.6 million
. Commercial	$ 0.4 million	4.4 million	4.8 million
. Industrial	0	0.9 million	0.9 million
Total Construction Impact	$ 0.4 million	$ 25.9 million	$ 26.3 million

* Does not include rehabilitation activity.
** Does not include costs of demolition, relocation, parking, landscaping, or other site preparation costs.

Source: Midwest Research Institute

TABLE V-13

PROJECTED ENERGY CONSUMPTION WITH
LRT OPERATION, UNIVERSITY ALIGNMENT, YEAR 2000

	LRT Line	Feeder Buses[1]
Annual Vehicle Miles	704,400	--
Projected Fuel Efficiency	8 KWH/ vehicle mile[2]	--
Annual Energy Consumption	5,635,200 KWH	--
BTU's of Energy Consumed[3]	64,800 MBTU's	--

TOTAL ANNUAL ENERGY CONSUMPTION - 64,800 MBTU's

[1] Current bus service in the University corridor will provide a high level of feeder bus service to the LRT. Therefore, no additional feeder bus service is required.

[2] Source: Boeing Company.

[3] Based on total energy used in mining coal, refining and transporting it, and ultimately consuming it.

For the year 2000, the LRT is projected to consume about 64,800 MBTU's of energy. This impact is associated with the coal-based electrical energy likely to be used in powering the LRT vehicles, and reflects not only the energy obtained in burning coal, but also the energy required in mining, refining, and transporting the coal to the electrical utility.

Environment. The pollution impacts from operation of a University LRT are projected in Table V-14. As shown, more than 2.0 million pounds of pollution can be linked to LRT operations. All of this impact would occur outside of the University corridor, in the mining of coal and the generation of the electricity.

Other noise and visual impacts from LRT operation along the University alignment are less quantifiable. In the case of noise impacts, measurement of sound intensity is possible and important. The ultimate impact, however, is not in terms of magnitude but in the human reaction to it. In general, LRT acoustical impact should not increase disturbance and in some areas can be an improvement. Based on published noise data, there is evidence that LRT operations should be quieter than buses and in some areas may be below automobile noise levels.

In terms of visual impacts, a carefully designed and landscaped LRT system can blend into the surrounding environment better than most other transit modes. Though parking is often a noise and visual problem the high number of stops along University Avenue and the strong use of feeder buses in this corridor will preclude the need for additional parking facilities.

NON-LRT ALTERNATIVE

The non-LRT alternative in the University alignment is electric trolley bus operations on the Route 16 bus line with Transportation Systems Management (TSM) techniques to enhance operating speed.

The trolley bus is a conventional form of transit that has been in use since the 1920's. Most systems disappeared in the United States along with the decline of the streetcar. However, in the last decade there has been renewed interest in the electric trolley bus. All systems have acquired new vehicles, and some route extensions have taken place. Vehicles are identical in appearance to diesel-powered buses except for twin trolley poles rising to contact overhead wires which collect and return

TABLE V-14

PROJECTED POLLUTANT LOADS[1] - UNIVERSITY ALIGNMENT LRT LINE, YEAR 2000
(In Pounds)

	LRT Operations[2]	Feeder Buses[3]	Total
Air Pollution			
Particulate	200,900	-	200,900
Carbon Monoxide (CO)	-	-	-
Hydrocarbons (HC)	5,000	-	5,000
Nitrogen Oxides (NO_x)	46,400	-	46,400
Sulfur Oxides (SO_x)	456,200	-	456,200
Water Pollution			
Suspended solids (SS)	-	-	-
Chemical Oxygen Demand (COD)	-	-	-
Biochemical Oxygen Demand (BOD)	-	-	-
Other	-	-	-
Solid Waste			
Mining Wastes	1,124,200	-	1,124,200
Other Solid Wastes	183,400	-	183,400
Total Pollutant Loads	2,016,100	-	2,016,100

[1]Pollution estimates include all pollution produced from the mine through final combustion.

[2]Assumes coal-based electricity. To the extent that this electricity is available from existing capacity or from other electrical sources - e.g. hydroelectric power - this estimate may overstate actual impacts. The emphasis on coal-based generation is judged reasonable given current NSP source projections and industry trends.

[3]Current bus service in the University corridor will provide a high level of feeder bus service to the LRT. Therefore, no additional feeder bus service is required.

power for electric propulsion motors. The trolley bus must therefore follow the overhead line of wires, although it has considerable maneuverability to each side. The wire system amounts to a capital investment that is not required with self-contained diesel or gasoline-powered vehicles. However, trolley buses are non-polluting and are quieter and higher performing than internal combustion buses.

For the purposes of this study, TSM techniques include traffic signal preemption, on-street parking restrictions and bus stop bays. It should also be noted that bus Route 94B would continue to operate since it essentially provides downtown-to-downtown Minneapolis-St. Paul express service, whereas the trolley bus would provide local service for all intermediate points along University and Washington Avenues.

Ridership Forecasts

The Metropolitan Council's sketch planning model was used to prepare forecasts of non-LRT patronage. Electric trolley buses were assigned a 14 mile per hour speed, a 2 mile per hour speed advantage over conventional local buses, in order to simulate TSM improvements. The results of the model run are shown in Table V-15. It can be noted that electric trolley buses would create a shift to the local bus system and would have negligible effect on auto users.

Capital Costs

Construction costs for an electric trolley bus line on the University alignment are estimated at $455,000 per mile, based upon recent construction experience in Seattle, Washington and San Francisco. For the 9.46 mile University alignment these costs would total $4.3 million.

Vehicle costs are estimated at $183,000 per trolley bus based upon the new trolley buses soon to be delivered to Edmonton, Canada by General Motors of Canada. For 45 trolley buses, including spares, total vehicle costs are estimated at $8.2 million.

Vehicle overhaul and maintenance facilities for trolley buses are estimated at $55,200 per bus or approximately $2.5 million.

Capital costs are summarized in Table V-16.

TABLE V-15

RIDERSHIP FORECASTS
ELECTRIC TROLLEY BUS - UNIVERSITY

	24 Hours		Peak Period	
	# of People	%	# of People	%
Auto Driver	473,200	65.6	68,900	58.1
Carpool Passengers	117,700	16.3	17,200	14.4
Local Bus	95,400	13.2	23,800	20.1
Electric Trolley Bus	34,900	4.9	8,700	7.4
TOTAL	721,200	100.0	118,600	100.0

TABLE V-16

CAPITAL COST SUMMARY - UNIVERSITY - NON-LRT

Category	Cost in Millions of Dollars
Construction	$ 4.30
Vehicles	8.24
Vehicle Maintenance and Overhaul Facilities	2.48
TOTAL	$15.02

Operating and Maintenance Costs

Electric trolley bus operating and maintenance cost estimates of $17.70 per hour and $1.06 per mile are based on the cost experience of the Southeastern Pennsylvania Transportation Authority (Philadelphia) inflated to 1980.[1] Annual operating and maintenance costs exclusive of annualized capital costs are estimated at $3.8 million. On a cost per passenger basis, this works out to approximately $.37.

TABLE V-17

ANNUAL OPERATING AND MAINTENANCE COSTS*
UNIVERSITY - NON-LRT

Item	Unit Cost	Cost
Annual Trolley Bus Miles 1,340,300	$ 1.06	$1,420,718
Annual Trolley Bus Hours 131,712	$17.70	2,331,302
TOTAL		$3,752,020
USE		$3,752,000

*No feeder system has been costed out for the non-LRT alternative in this alignment.

[1] *Alternatives Analysis, Trolley Bus vs. Diesel Bus*, Southeastern Pennsylvania Transportation Authority, December 1976.

Annualized Capital Cost

Annualized capital costs for a University electric trolley bus are estimated at $1.5 million. Calculations appear in the Technical Supplement. Table V-18 combines annual operating and maintenance costs with annualized capital costs for an electric trolley bus line.

TABLE V-18

TOTAL ANNUAL OPERATING AND MAINTENANCE COSTS
INCLUDING ANNUALIZED CAPITAL COSTS
ELECTRIC TROLLEY BUS - UNIVERSITY

Operating & Maintenance Costs	$3,752,000
Annualized Capital Costs	1,600,000
TOTAL	$5,352,000

Annualized capital costs are shown in 1980 dollars. The relationship between annualized capital costs and annual operating and maintenance cost is only accurate for the first year of a capital investment.

Operating Costs Versus Revenues

Table V-19 compares electric trolley bus operating costs to the anticipated revenues. Based on a $.50 fare, annual electric trolley bus revenues would total $5.1 million. When compared to annual operating costs of $3.8 million, an annual surplus of approximately $1.4 million is realized.

COMPARISON OF LRT AND NON-LRT - UNIVERSITY

Table V-20 shows that daily LRT ridership would be 25 percent higher than electric trolley bus ridership. During the peak hour LRT ridership would be 41 percent higher. LRT's

TABLE V-19

ELECTRIC TROLLEY BUS OPERATING COSTS VERSUS REVENUES

Total Annual Trolley Bus Passengers	10,260,600
Total Trolley Bus Operating and Maintenance Costs	$3,752,000
Revenue Generated - @ $.50 fare	$5,130,300
Surplus/(Deficit)	$1,378,300

TABLE V-20

SUMMARY COMPARISON - UNIVERSITY: LRT VERSUS NON-LRT

	LRT	NON-LRT
24 Hour Ridership	43,600	34,900
Peak Hour Ridership	12,300	8,700
Capital Cost	$101 million	$15 million
Annual Operating & Maintenance Cost	$1.9 million	$3.8 million
Cost/Passenger	$0.15	$0.37
Annualized Capital Cost	$9.6 million	$1.6 million
Surplus/(Deficit)*	$4.6 million	$1.4 million
Surplus/(Deficit)**	($5.1 million)	($0.3 million)

*Excluding annualized capital costs.
**Including annualized capital costs.

capital cost exceeds non-LRT's by nearly 7 to 1, though LRT's operating and maintenance cost is one-half that of the non-LRT. LRT's cost per passenger would be one-half that of non-LRT. Both LRT and electric trolley bus operations would generate annual surpluses, $4.5 million and $1.4 million, respectively. However, when annualized capital costs are included as an annual operating and maintenance cost only electric trolley bus comes close to paying its way with an annual deficit of $200,000 versus LRT's $3.2 million deficit.

Impact Analysis

Energy. As shown in Table V-21, an electric trolley line operating along the University alignment would consume about 60,100 MBTU's of energy per year. To permit a balanced comparison with the LRT model, the analysis must also include the estimated 3.9 million automobile miles driven by individuals that could be persuaded to ride the LRT but not the electric trolley. By adding these shifted automobile miles into the non-LRT impact model, the annual energy impact reaches 77,300 MBTU's.

The LRT and non-LRT energy comparison favors the LRT model in this corridor by a factor of about 20 percent (64,800 MBTU's for the LRT to 77,300 MBTU's for the non-LRT alternative). The difference, in part, derives from LRT's higher energy efficiency and partly because of LRT's higher relative appeal to existing automobile drivers.

Table V-22 shows that an estimated 119,100 gallons of gasoline would be conserved during the year 2000 LRT operation. Because both the LRT and the electric trolley alternative would use essentially the same feeder bus system, there are no diesel fuel savings that can be linked directly to LRT operations. To put the gasoline into perspective, a savings of 119,100 gallons would amount to just seven-tenths of 1 percent of the 17 million gallons of gasoline that will still be required in the year 2000 to fuel the University corridor automobile traffic.

Environment. The comparative pollution impacts from operation of the LRT and non-LRT models are shown in Table V-23. In this case the LRT and non-LRT alternative, both of which are dependent on coal based electricity, are relatively close in total pollutant loads. Because of the automobile factor built into the non-LRT model, the non-LRT alternative ends up slightly less favorable, particularly in terms of the projected carbon monoxide levels that would occur within the University corridor.

TABLE V-21

PROJECTED ENERGY CONSUMPTION FOR THE
NON-LRT ALTERNATIVE, UNIVERSITY ALIGNMENT, YEAR 2000

	Electric Trolley	LRT Riders Shifting to Automobiles
Annual Vehicle Miles	1,340,300 miles[1]	3,857,300 miles[2]
Projected Fuel Efficiency	3.9 KWH/ vehicle mile[3]	32.4 miles/gallon (gasoline)[4]
Annual Energy Consumption	5,227,200 KWH	119,100 gallons
BTU's of Energy Consumed[5]	60,100 MBTU's	17,200 MBTU's

TOTAL ANNUAL ENERGY CONSUMPTION - 77,300 MBTU's

[1] Based on MTC estimates for the year 2000.

[2] Determined on the basis of the difference between the number of projected auto driver trips with LRT and the number of trips with the non-LRT alternative.

[3] Source: Boeing Company.

[4] Source: Minnesota Energy Agency.

[5] Energy consumtpion estimates include all energy required to obtain the coal or petroleum at the mine or well head, to refine it, to transport it, as well as to consume it.

TABLE V-22

PROJECTED PETROLEUM SAVINGS WITH OPERATION OF AN LRT LINE, UNIVERSITY CORRIDOR, YEAR 2000

Gasoline Savings with Reduced Automobile Use	119,100 gallons
Diesel Fuel Savings with Reduced Bus Service Needs	0 gallons[1]
Remaining Gasoline Consumption by Automobiles under the LRT Model	17,486,000 gallons

[1]This comparison is between electric trolley buses and LRT, and no diesel bus fuel is consumed by either mode.

TABLE V-23

COMPARATIVE ENVIRONMENTAL IMPACTS*
LRT-vs-NON-LRT ALTERNATIVE UNIVERSITY ALIGNMENT

(In Pounds)

	LRT	Non-LRT Alternative**
Air Pollution		
Particulate	200,900	188,500
Carbon Monoxide (CO)	-	246,700
Hydrocarbons (HC)	5,000	29,600
Nitrogen Oxides (NO_x)	46,400	60,100
Sulfur Oxides (SO_x)	456,200	426,300
Water Pollution		
Suspended Solids (SS)	-	100
Chemical Oxygen Demand (COD)	-	300
Biochemical Oxygen Demand (BOD)	-	100
Other	-	6,200
Solid Waste		
Mining/Drilling Wastes	1,124,200	1,044,500
Other Solid Wastes	183,400	172,200
TOTAL POLLUTANT LOADS	2,016,100	2,174,600

*MRI's REEPA model projects a full cycle estimate of pollutant impacts, i.e. pollutant loads at the mine and well head through to combustion of the coal and petroleum fuels.

**In both LRT and Non-LRT cases, feeder bus impacts are not included.

CHAPTER VI

NORTHEAST CORRIDOR

INTRODUCTION

The Northeast Corridor has several potential rights-of-way including highways and rail lines. The corridor contains a considerable amount of developable land. Travel in the corridor consists mostly of longer trips with moderate transit use. Major communities include Maplewood, North St. Paul, White Bear Lake, Birchwood and Little Canada.

ALIGNMENT SELECTION

Figure II-1 shows the alternative alignments tested in the Northeast. They are:

- I-35E
- TH61
- Soo Line RR East
- Soo Line RR West
- BN RR

The BN Railroad alignment was selected as the preferred Northeast alignment on the basis of land development factors, particularly the desire to serve the Maplewood Mall. LRT operations would take place on land parallel to the BN right-of-way. Sketch planning results are shown in the Technical Supplement.

LRT ALTERNATIVE

LRT Stop Locations

Figure VI-1 shows alignment details and LRT stop locations. Most of the LRT alignment is comprised of land parallel to the BN Railroad right-of-way. The northern extremity is located

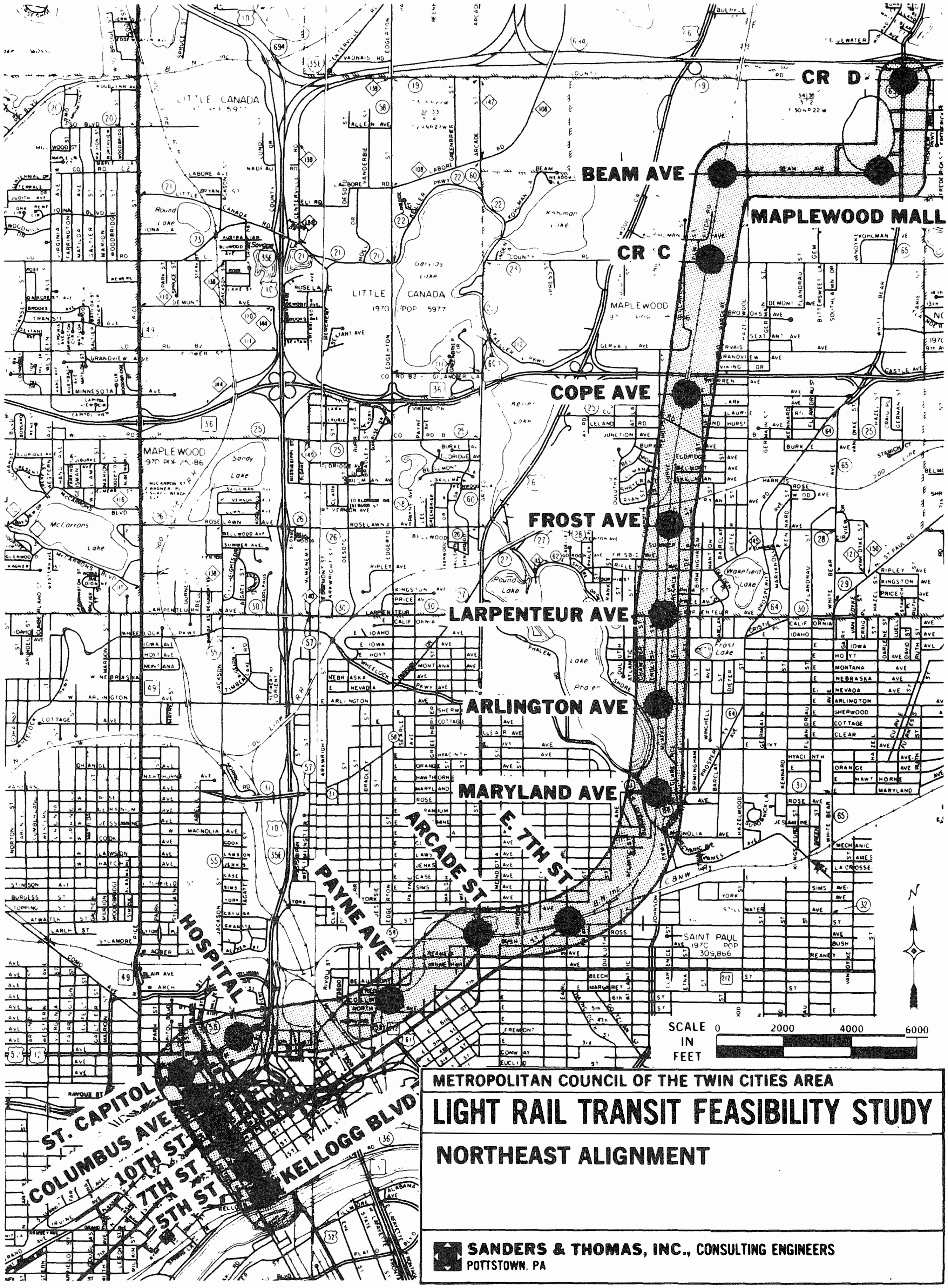

CR D
BEAM AVE
MAPLEWOOD MALL
CR C
COPE AVE
FROST AVE
LARPENTEUR AVE
ARLINGTON AVE
MARYLAND AVE
E. 7TH ST
ARCADE ST
PAYNE AVE
HOSPITAL
ST. CAPITOL
COLUMBUS AVE
10TH ST
7TH ST
5TH ST
KELLOGG BLVD
LITTLE CANADA
MAPLEWOOD
SAINT PAUL
SCALE IN FEET 0 2000 4000 6000
N
METROPOLITAN COUNCIL OF THE TWIN CITIES AREA
LIGHT RAIL TRANSIT FEASIBILITY STUDY
NORTHEAST ALIGNMENT
SANDERS & THOMAS, INC., CONSULTING ENGINEERS
POTTSTOWN, PA

FIGURE VI-1

along Beam Avenue and terminates at the Maplewood Mall. The southern portion of the route leaves the BN right-of-way in the vicinity of Collins and Payne Avenues and follows city streets to downtown St. Paul.

Table VI-1 lists each LRT stop.

TABLE VI-1

PROPOSED LRT STOPS - NORTHEAST

Kellogg Blvd. & Cedar St.	Maryland Ave. & BN Railroad
5th St. & Cedar St.	Arlington Ave. & BN Railroad
7th St. & Cedar St.	Larpenteur Ave. & BN Railroad
10th St. & Cedar St.	Frost Ave. & BN Railroad
Columbus Ave.& Cedar St.	Cope Ave. & BN Railroad
State Capital & Cedar St.	County Road C & BN Railroad
St. Paul-Ramsey Hospital	Beam Ave. & BN Railroad
Payne Ave. & Collins Ave.	Beam Ave. & Maplewood Mall
Arcade St. & BN Railroad	White Bear Ave. & County Road D
Earl St. & E. 7th St.	

Operating Plan

Table VI-2 shows the Northeast operating plan in terms of headways by hour and day. During peak periods LRT would operate on 8 minute headways. In the non-peak 20 minute headways would be in effect.

TABLE VI-2

OPERATING HEADWAYS - NORTHEAST
(Minutes)

	5 A.M.- 7 A.M.	7 A.M.- 9 A.M.	9 A.M.- 4 P.M.	4 P.M.- 6 P.M.	6 P.M.- 11 P.M.	11 P.M.- 1 A.M.
Weekdays	20	8	20	8	60	60
Saturdays	40	40	40	40	40	60
Sundays & Holidays		60	60	60	60	

Table VI-3 shows scheduled speeds and times between LRT stops as well as cumulative time and distance from the terminal point. Average schedule speed along the 8.8 mile long line is approximately 19 miles per hour. The trip from Kellogg Boulevard and Cedar Street to White Bear Avenue and County Road D will take approximately 26 minutes.

Annual Vehicle Miles

Total annual vehicle miles in the Northeast are calculated at approximately 401,000. Vehicle mile calculations are shown in the Technical Supplement.

Ridership Forecasts

Total daily LRT ridership is estimated at 18,000. Approximately 2,900 passengers will pass the maximum load point during the peak hour.

Table VI-4 compares forecasted LRT travel to total corridor travel and corridor travel by other modes. Daily inbound ridership is shown in Figure VI-2.

TABLE VI-3

SCHEDULED SPEEDS, TIME, AND DISTANCE - NORTHEAST

Kellogg & Cedar St.	Distance (Miles)	Scheduled Speed (MPH)	Scheduled Time (Minutes)	Cumulative Time From Terminal (Minutes)	Cumulative Distance From Terminal (Miles)
5th & Cedar St.	0.14	12	.70	0.70	0.14
7th & Cedar St.	0.14	12	.70	1.40	0.28
10th & Cedar St.	0.19	12	.95	2.35	0.47
Columbus Ave. & Cedar St.	0.19	12	.95	3.30	0.66
Central & Cedar St. (Capital)	0.14	12	.70	4.00	0.80
St. Paul - Ramsey Hospital	0.25	12	1.25	5.25	1.05
Payne & Collin	0.85	15	2.00	7.25	1.90
Arcade & BN Railroad	0.82	18	2.73	9.98	2.72
Earl & East 7th	0.50	18	1.67	11.65	3.22
Maryland & BN Railroad	0.85	25	2.03	13.68	4.07
Arlington & BN Railroad	0.50	25	1.20	14.88	4.57
Larpenteur & BN Railroad	0.50	25	1.20	16.08	5.07
Frost & BN Railroad	0.50	25	1.20	17.28	5.57
Cope & BN (TH36)	0.75	25	1.80	19.08	6.32
C. R. C & BN Railroad	0.70	25	1.67	20.75	7.02
Beam & BN Railroad	0.50	25	1.20	21.95	7.52
Beam Ave. & Maplewood Mall	0.65	18	2.17	24.12	8.17
White Bear & C.R. D (I-694)	0.60	18	2.00	26.12	8.77

STOP	PASSENGERS ON BOARD
CR D	3,700
MAPLEWOOD MALL	4,300
BEAM AVE	4,350
CR C	4,500
COPE AVE	5,650
FROST AVE	5,900
LARPENTEUR AVE	6,450
ARLINGTON AVE	6,500
MARYLAND AVE	7,000
E. 7TH ST	7,100
ARCADE ST	7,450
PAYNE AVE	7,400
HOSPITAL	7,100
STATE CAPITOL	6,200
COLUMBUS AVE	6,050
10TH ST	4,800
7TH ST	3,300
5TH ST	1,500
KELLOGG BLVD	0

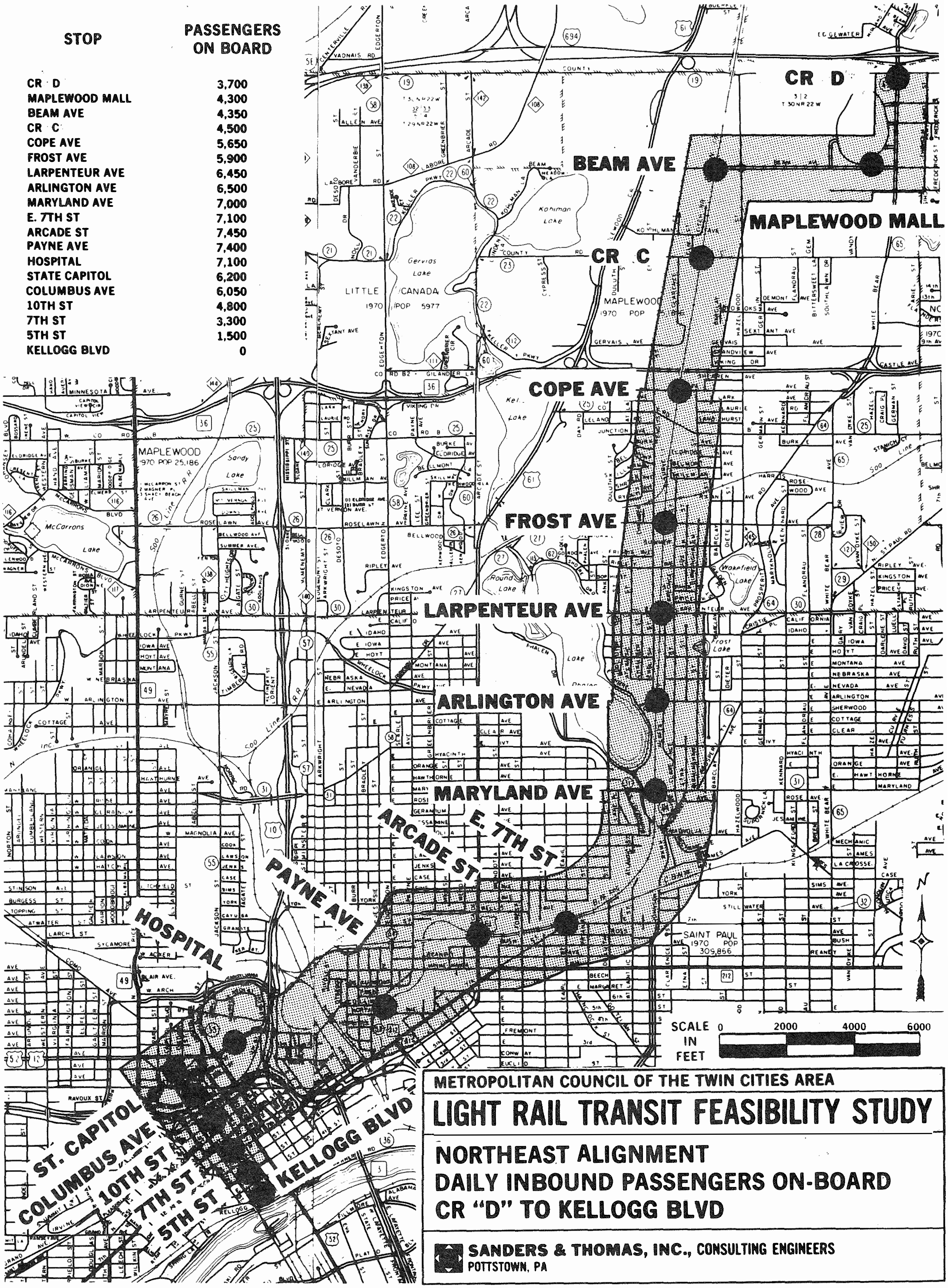


FIGURE VI-2

TABLE VI-4

FORECASTED CORRIDOR TRAVEL BY MODE - NORTHEAST - LRT				
	24 Hours	%	Peak Period	%
Auto Driver	419,600	66.4	60,400	62.2
Carpool Passenger	131,600	20.8	16,600	17.1
Local Bus Passenger	62,600	9.9	15,600	16.1
LRT Passenger	18,000	2.9	4,500	4.6
TOTAL TRAVEL	631.800	100.0	97,100	100.0

Feeder Bus Requirements

A feeder bus service, particularly in Maplewood and North St. Paul, will be required to complement the Northeast LRT line. Current bus service in St. Paul would be reoriented to feed the LRT line. In addition to the reoriented service, the MTC has calculated that, based upon the projected volume of feeder bus riders and corridor characteristics, six additional buses, including one spare, will be required for feeder operations.

Capital Requirements and Costs

Table VI-5 shows estimated capital construction costs of $55.8 million.

Right-of-Way Acquisition. Costs are estimated at $4.5 million for the nearly 6 miles of right-of-way not located on city streets.

Parking Lots. Approximately 1400 parking spaces will be required at a cost of $3,000 each including land, or a total of $4.2 million.

Vehicles. Seventeen vehicles, including two spares, will be required for revenue service. Total vehicle costs are estimated at $16.46 million.

TABLE VI-5

CONSTRUCTION COST ESTIMATE - NORTHEAST

Item	Quantity	Unit	Unit Price $	Amount
Cross Ties	44,880	Each	47	$ 2,109,360
Stone Ballast	29,920	Linear Yards	35	1,047,200
115# Rail	89,760	Linear Feet	75	6,732,000
Excavation	81,743	Cubic Yards	23	1,880,089
Electric Grade Crossings	-	Each	275,000	-
Crossovers (Including 2 turnouts)	8	Each	70,000	560,000
Platforms	37	Each	14,133	522,921
Utility Relocation in the CBD	20	Per Block	500,000	10,000,000
Base Grading	5.6	Mile	500,000	2,800,000
Substation	6	Each	405,000	2,430,000
Roadway: 6" Concrete	8,213	Square Yards	30.45	250,086
Car Shop	1	Each	975,000	975,000
Simple Catenary System	10.4	Route Miles	798,000	8,299,200
Signal Comm + Wayside Controls	7.3	Route Miles	784,550	5,727,215
Pavement Removal	73,920	Square Feet	4.92	363,686
Bridge Widening	1	Per Bridge	216,000	216,000
Fill	19,500	Cubic Yards	10	195,000
	1980 PRICES:	SUBTOTAL		$44,107,757
		+ 15% Contingency		6,616,164
		SUBTOTAL		$50,723,920
		+ 10% Engineering & Mobilization		5,072,392
		TOTAL		$55,796,312
		USE		$55,796,000

Feeder Buses. Six feeder buses, including one spare, at $150,000 each plus $55,200 per bus for maintenance and overhaul would cost a total of $1 million.

Table VI-6 summarizes the capital costs involved in construction of a Northeast LRT.

TABLE VI-6

CAPITAL COST SUMMARY - NORTHEAST - LRT

Category	Cost in Millions of Dollars
Right-of-Way Acquisition	$ 4.5
Construction	55.8
Vehicles	16.5
Parking Lots	4.2
SUBTOTAL	$81.0
Feeder Bus	$ 1.0
TOTAL	$82.0

Total capital costs, exclusive of feeder bus costs, are estimated at $81.0 million in 1980 dollars, or about $9.2 million per double-tracked mile.

Operating and Maintenance Costs

Table VI-7 (next page) shows estimated annual operating costs by category of expense. Total annual operating and maintenance costs, exclusive of annualized capital costs, are estimated at $1.6 million. On a cost per passenger basis, this works out to $0.31.

Feeder bus costs of $273,220 are based upon the need for approximately 115,000 bus miles at $1.10 per mile and 8,000 bus hours at $18.34 per hour (Table VI-8) and would cover only a small portion of the total required feeder system.

TABLE VI-7

ANNUAL LRT OPERATING AND MAINTENANCE COSTS INFLATED TO YEAR 1980

Based on 1976 Unit Cost Relationships
(Northeast)

Item (With 1976 Unit Cost)	
Track Maintenance (.34/Vehicle Mile Traveled)	$ 136,340
Shelter Maintenance ($500/Shelter)	19,000
Yards & Support Maintenance ($1,000/Peak Hour Vehicle)	14,000
Electrical Maintenance (.04/Vehicle Mile Traveled)	16,040
Communications & Control Maintenance ($2,500/Track Mile)	36,500
Vehicle Maintenance (.24/Vehicle Mile Traveled)	96,240
Vehicle Energy Consumption (.14/Vehicle Mile Traveled)	56,140
Maintenance Facility Energy Consumption (($50/Peak Hour Vehicle)	700
Vehicle Storage Energy Consumption ($400/Peak Hour Vehicle)	5,600
MTC Operators Salary plus Benefit ($16,867)	354,210
Other Transportation (.17/Vehicle Mile Traveled)	68,170
SUBTOTAL	$ 802,940
General & Administrative (15% of Subtotal)	120,441
1976 TOTAL COST	$ 923,381
Inflated at 10%/Annum to 1980	1,351,922
TOTAL	$1,351,922
USE	$1,352,000

Unit Cost Source: Light Rail Transit, A State of the Art, U.S. Department of Transportation, 1976.

Operator's Cost Source: Metropolitan Transit Commission.

TABLE VI-8

FEEDER BUS SERVICE ANNUAL OPERATING AND MAINTENANCE COSTS*
(1980 Dollars)

Item	Unit Cost	Cost
Annual Bus Miles 115,000	$ 1.10/mile	$126,500
Annual Bus Hours 8,000	$18.34/hour	$146,720
TOTAL		$273,220

Annualized Capital Costs

Annualized capital costs are estimated at approximately $7.9 million (calculations appear in the Technical Supplement). Table VI-9 shows total annual operating and maintenance costs including LRT annualized capital costs in the Northeast.

Annualized capital costs are in 1980 dollars. The relationship between capital costs and annual operating and maintenance costs is only accurate for the first year of a capital investment.

TABLE VI-9

TOTAL ANNUAL LRT OPERATING AND MAINTENANCE COSTS
INCLUDING ANNUALIZED CAPITAL COSTS - NORTHEAST

Operating and Maintenance Costs	$1,625,220
Annualized Capital Costs	7,900,000
TOTAL	$9,525,220

*Represents only a portion of the total feeder system required.

Operating Cost Versus Revenues

As shown in Table VI-10, a $.50 fare will generate annual revenues of $2.65 million and produce a $1.15 million surplus when compared to annual operating and maintenance costs of $1.51 million for the combined LRT and feeder bus system.*

TABLE VI-10

ESTIMATED LRT OPERATING COST VERSUS REVENUES
IN 1980 DOLLARS - NORTHEAST

Total Annual LRT Passengers	5,301,000
LRT Revenue Generated at $.50 fare	$2,650,500
Total LRT & Bus Costs - Operating & Maintenance	$1,625,220*
Surplus/(Deficit)	$1,025,280

Impact Analysis

Land Use. The Northeast alignment uses an existing rail right-of-way for most of the length of the alignment. This existing rail alignment extends from a point outside of the St. Paul CBD to within a short distrance of the outbound terminus point near Maplewood Mall. Over its length, the LRT would pass through very different areas of current land use: large industrial areas near East Seventh Street, residential uses in the Lake Phalen and Maplewood areas, and commercial uses in the vicinity of Phalen Shopping Center and Maplewood Mall.

As reflected in the Metropolitan Council's corridor and regional estimates, development of approximately 2,300 acres of land is expected in the Northeast between 1990 and 2000. As shown in Table VI-11, this growth is projected to total about 6

*Only a small portion of the feeder bus system has been included in the analysis.

percent of the new development expected in the metropolitan region. This figure is not so much reflective of development opportunity in St. Paul--which is heavily developed with the exception of limited pockets of vacant land north of Maryland Avenue--but is an indication of the heavy residential growth and larger tracts of developable land in the Maplewood and White Bear Lake area.

TABLE VI-11

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

Northeast St. Paul Corridor Acreage**	1990	2000	Change 1990-2000
Residential	13,583	14,890	1,307
Commercial	1,143	1,475	332
Industrial	2,699	3,334	635
TOTAL	17,425	19,699	2,274
Metro Area Acreage			
Residential	174,532	196,005	21,473
Commercial	15,841	20,174	4,333
Industrial	53,528	63,368	9,840
TOTAL	243,901	279,547	35,646

*Since these figures are based on utilized acreage, estimates do not reflect changes due to redevelopment activity.

**Includes an area of approximately 2 miles east and west of the northeast St. Paul alignment. These estimates also include the St. Paul CBD and the city of White Bear Lake.

Source: Socio-Economic and Land Use File, Metropolitan Council, 1980.

The primary land use impacts associated with LRT development along the currently operating rail right-of-way will occur within one-half mile of the individual LRT stops. While there will be developable land along this alignment, development opportunities will be tempered by existing land use patterns and the fact that the right-of-way may have to be hsared with continuing heavy freight traffic. In some cases the access to downtown St. Paul and Maplewood Mall offered by the LRT would be a positive inducement to development. In other cases, the area would develop either with or without the existence of LRT.

The projected land development within 0.5 mile of the Northeast LRT stops is indicated in Table VI-12.[1] In total, 182 acres of land should develop sometime between the years 1990 and 2000. Of this development, about 35 percent or 63 acres could be expected to take place as a direct consequence of LRT development. About 86 percent of this development would be new development. It is estimated that establishment of a Northeast LRT line would result in the development or redevelopment of 38 acres of residential property and 25 acres of commercial property. Despite passing along the East Seventh Street industrial area, LRT would not provide inducement for any additional industrial development in the area.

The direct impact of LRT development in the Northeast would be the construction of 650 high, medium, and low density multifamily housing units and nearly 357,000 square feet of retail and office commercial space. As indicated in Table VI-13, the construction impacts in 1980 dollars of this LRT-induced residential and commercial development are estimated at $36.6 million.

The analysis was based on current land use control policies and density allowances. The potential for accelerated development and higher densities could increase with aggressive use of available control policies and strategies. The fact that much of the Northeast alignment passes through established single-family areas reduces the flexibility that municipalities will have in exercising these policies and techniques. Real opportunities do exist, however, in the Phalen Shopping Center and Maplewood Mall areas. Three general development strategies were previously identified in the Chapter III West alignment analysis.

[1]Pertinent charts and maps reflecting the land use analysis at each LRT stop are found in the Technical Supplement

TABLE VI-12

PROJECTED LAND DEVELOPMENT WITHIN ONE-HALF MILE OF THE NORTHEAST ST. PAUL ALIGNMENT LRT STOPS, 1990-2000 (In Acres)

	New Development	Redevelopment	Total
Acreage Projected to Develop Around LRT Stops, 1990-2000	168.8	12.8	181.6
Acreage of Development LRT Induced			
Residential	38.4	0.0	38.4
Commerical	15.7	8.9	24.6
Industrial	0.0	0.0	0.0
TOTAL	54.1	8.9	63.0

Source: Midwest Research Institute

Energy The energy impacts associated with a Northeast LRT line and supporting feeder bus system are indicated in Table VI-14. A total annual consumption of 41,400 million BTU's of energy is projected for the year 2000. Of this total, nearly 90 percent would be coal-based electrical energy used in powering the LRT vehicles. The remaining energy impacts are associated with the diesel fuel required to operate the feeder bus system. In the case of both the coal and petroleum fuel sources, the energy impact analysis considers total energy requirements from the mine and drill head through to the final combustion of the fuel.

Environment. Projected pollutant loads from Northeast LRT operations are shown in Table VI-15. As indicated, a total of nearly 1.2 million pounds of pollution can be linked to LRT operations. The most significant pollutant impacts occur outside

TABLE VI-13

PROJECTED LRT-INDUCED LAND USE CHANGES AND CONSTRUCTION IMPACTS, NORTHEAST ST. PAUL ALIGNMENT, 1990-2000

	New Development	Redevelopment*	Total
Projected LRT-Induced Land Use Changes			
. Residential Multi-Family Units:			
High Density	450	0	450
Medium Density	190	0	190
Low Density	10	0	10
Total Units	650	0	650
. Commercial Square Footage			
Retail	104,200	103,300	207,500
Office	123,600	25,900	149,400
Total Sq. Ft.	227,800	129,200	356,900
. Industrial Square Footage	0	0	0
Projected LRT-Induced Building Construction (In 1980 Construction $'s)**			
. Residential	$25.6 million	0	$25.6 million
. Commercial	7.5 million	$ 3.5 million	11.0 million
. Industrial	0	0	0
Total Construction Impact	$33.1 million	$ 3.5 million	$36.6 million

* Does not include rehabilitation activity.
** Does not include cost of demolition, relocation, parking, landscaping, or other site preparation costs.

Source: Midwest Research Institute

TABLE VI-14

PROJECTED ENERGY CONSUMPTION WITH
LRT OPERATION, NORTHEAST ALIGNMENT, YEAR 2000

	LRT Line	Feeder Buses
Annual Vehicle Miles	401,000	115,000 miles[1]
Projected Fuel Efficiency	8 KWH/ vehicle mile[2]	4 miles/ gallon (diesel)[3]
Annual Energy Consumption	3,208,000 KWH	28,750 gallons
BTU's of Energy Consumed[4]	36,900 MBTU's	4,500 MBTU's

TOTAL ANNUAL ENERGY CONSUMPTION - 41,400 MBTU's

[1] Since many of the existing bus routes in the Northeast corridor could serve as feeder bus routes, the impact analysis considers only the bus additions required to support the LRT line.

[2] Source: Boeing Company.

[3] Source: Year 2000 projections by the Metropolitan Transit Commission.

[4] MRI's REEPA model projects the total cycle of energy impacts from the mine or well head through to final combustion.

of the corridor in the mining of coal and the generation of electricity at the power plant. Within the corridor, the highest pollution levels are associated with diesel feeder bus exhaust.

Other LRT noise and visual impacts are less subject to physical measurement. In the case of noise impacts, the measurement

TABLE VI-15

PROJECTED POLLUTANT LOADS[1] -
NORTHEAST LRT ALIGNMENT, YEAR 2000
(In Pounds)

	LRT Operations[2]	Feeder Buses[3]	Total
Air Pollution			
Particulate	114,400	400	114,800
Carbon Monoxide (CO)	-	9,100	9,100
Hydrocarbons (HC)	2,900	3,200	6,100
Nitrogen Oxides (NO_x)	26,400	6,800	33,200
Sulfur Oxides (SO_x)	259,700	1,500	261,200
Water Pollution			
Suspended Solids (SS)	-	*	*
Chemical Oxygen Demand (COD)	-	100	100
Biochemical Oxygen Demand (BOD)	-	*	*
Other	-	1,500	1,500
Solid Waste			
Mining/Drilling Waste	640,000	400	640,400
Other Solid Wastes	104,400	500	104,900
Total Pollutant Loads	1,147,800	23,500	1,171,300

[1] MRI's REEPA model projects the total cycle of energy impacts from the mine or well head through to final combustion.

[2] Assumes coal-based electrical generation. To the extent that electricity is available from existing capacity or from other electrical generation sources - e.g. hydroelectric power - these estimates may overstate actual impacts. The emphasis on coal-based electricity is judged reasonable given current NSP source projections and prevailing industry trends.

[3] Since many of the existing bus routes in the Northeast corridor could serve as feeder bus routes, the impact analysis considers only the bus addition required to support the LRT line.

* The pollutant load is less than 50 pounds.

of sound intensity is important. The ultimate impact, however, is a function not of just the intensity but the human reaction to it. Based on published noise data, there is evidence that LRT operations should be quieter than buses and in some areas may be below automobile noise levels. Since the Northeast alignment parallels, for much of its length, an existing active freight railway line, the additional accoustical impacts from LRT operations should be negligible.

Experience in Europe and Japan has clearly shown that visual problems associated with the vehicles, tracks, support poles and wires can be overcome. Through careful design and landscaping, LRT systems can blend into the surrounding environment better than most other modes of transit. Given the neighborhoods and topography in the Northeast, there should not be any major visual problems associated with LRT development. The most critical noise and visual problem may related not to the LRT line, but to parking spillover into neighborhood streets. This is a recurring problem in many U.S. and Canadian cities.

NON-LRT ALTERNATIVE

The Northeast Non-LRT alternative consists of metering I-35E entrance ramps and including high-occupancy vehicle (buses and carpools) bypass ramps around the metered entrances. Operations would be similar to the I-35W ramps now in use in South Minneapolis. Access to I-35E would be controlled by traffic signals at Mayland, Larpenteur, TH36, Little Canada Road, County Raod E, and County Road G. The bypass ramps would permit easy access for buses while automobiles would be delayed.

Ridership Forecasts

Forecasts were prepared by the Metropolitan Council using the Council's HOV sketch planning model. The results of the analysis comparing LRT to Non-LRT forecasted ridership is shown in Table VI-16. This shows that express buses operating on I-35E with ramp metering would attract 14,000 patrons or 2.2 percent of corridor travel. During the peak hour, express buses would attract 3,400 patrons or 3.6 percent of corridor travel.

Construction Cost. The capital cost of constructing metered entrance ramps with bus bypass lanes is estimated at $465,000 per interchange or a total of $2.8 million. The source for these

TABLE VI-16

FORECASTS BY MODE - NORTHEAST NON-LRT

	24 Hours		Peak Period	
	# of People	%	# of People	%
Auto Driver	421,900	66.8	54,200	61.0
Carpool Passengers	132,300	20.9	18,600	19.1
Local Bus	63,600	10.1	15,900	16.4
I-35E Express Bus	14,000	2.2	3,400	3.6
TOTAL	631,800	100.0	97,100	100.0

costs is the Minnesota Department of Transportation. MnDOT costs are based on their experience in constructing similar ramps on I-35W.

Other costs include additional express buses, overhaul and maintenance facilities for the buses, and commuter parking lots.

Vehicles. Fifty-eight express buses, including 8 spares will be required for service. At $150,000 each, 58 buses would cost $8.7 million.

Maintenance Facilities. Maintenance and overhaul facilities would cost $55,220 per bus or $3.2 million

Parking Lots. Parking space will be required for 1,000 cars. At $3,000 per space, including land, costs will total $3.0 million.

Feeder Buses. No feeder bus system is needed in the non-LRT alternative as the express buses circulate in neighborhoods prior to entering the freeway.

Capital Costs

Capital costs are summarized as follows:

TABLE VI-17

CAPITAL COST SUMMARY - NON-LRT - NORTHEAST

Category	Cost in Millions of Dollars
Construction	$ 2.79
Express Buseses	8.70
Express Bus Maintenance and Overhaul Facilities	3.20
Parking Lots	3.00
Additional Feeder Buses	.90
Feeder Bus Maintenance and Overhaul Facilities	.33
TOTAL	$18.92

Operating Plan

Express buses would circulate within the corrdior and use I-35E non-stop to downtown St. Paul, stopping at the Capitol.

Operating and Maintenance Costs

Annual operating and maintenance costs of $2.5 million are based on cost indices used by the MTC for systemwide bus operations and the Minnesota Department of Transportation for metered freeway bypass ramps.

TABLE VI-18

ANNUAL EXPRESS BUS OPERATING AND MAINTENANCE COST - NORTHEAST - NON-LRT

Item	Unit Cost	Cost
Annual Vehicle Miles = 1,229,000	$1.10/mile	$1,351,900
Annual Vehicle Hours = 61,000	$18.34/hour	1,118,700
Operating & Maintenance of 5 Ramps	$15,000/year	75,000
TOTAL		$2,545,600

Total annual operating and maintenance costs exclusive of annualized capital costs are estimated at $2.5 million. This works out to a cost per passenger of $0.61.

Operating Costs Versus Revenues

Table VI-19 compares express bus operating cost to the anticipated revenues. Based on a $.50 fare, annual express bus operating and maintenance costs would exceed revenues by approximately $490,000.

Annualized Capital Costs

Annualized capital costs for the express buses operating on metered I-35E are estimated at $2.4 million. Calculations appear in the Technical Supplement. Table VI-20 shows I-35E express bus annual operating and maintenance costs combined with annualized capital costs. Total combined costs are approximately $4.8 million.

Annualized capital costs are in 1980 dollars. The relationship between annualized capital costs and annual operating and maintenance costs is only accurate for the first year of a capital investment.

TABLE VI-19

EXPRESS BUS OPERATING COSTS VS. REVENUES*

Total Annual Express Bus Passengers	4,115,000
Total Annual Express Bus Revenues	$2,058,000
Total Operating & Maintenance Costs	$2,545,600
Surplus/(Deficit)	($487,600)

*Not including annualized capital costs.

TABLE VI-20

TOTAL ANNUAL OPERATING AND MAINTENANCE COSTS INCLUDING ANNUALIZED CAPITAL COSTS EXPRESS BUSES - NORTHEAST

Operating & Maintenance Costs	$2,545,600
Annual Capital Cost	2,400,000
TOTAL	$4,945,600

COMPARISON OF LRT AND NON-LRT - NORTHEAST

Table VI-21 shows that LRT will carry 28 percent more daily passengers than non-LRT in the Northeast. During the peak period LRT ridership will be 32 percent higher. Capital costs for LRT are considerably higher ($82 million versus $18.9 million). LRT's low operating and maintenance cost will produce an annual surplus of $1.1 million versus non-LRT's annual deficit of $500,000. When annualized capital costs are included, however, LRT's annual deficit is twice as large as the deficit for the non-LRT system.

TABLE VI-21

SUMMARY COMPARISON - NORTHEAST: LRT VERSUS NON-LRT

	LRT	NON-LRT
24 Hour Ridership	18,000	14,000
Peak Hour Ridership	4,500	3,400
Capital Cost	$82 million	$18.9 million
Annual Operating & Maintenance Cost	$1.6 million	$2.5 million
Surplus/(Deficit)*	$1.0 million	($0.5 million)
Surplus/(Deficit)**	($6.8 million)	($2.8 million)

*Excluding annualized capital costs.
**Including annualized capital costs.

Energy. The energy impacts associated with the Northeast non-LRT alternative are shown in Table VI-22. An improved bus system (line haul and feeder buses) would consume an estimated 48,600 MBTU's of energy. To permit a balanced comparison with the LRT model, the analysis must also incorporate the estimated 3.3 million automobile miles driven by individuals that would probably ride the LRT but would not choose to ride a bus system. By adding these impacted automobile miles into the non-LRT model, the annual non-LRT energy impact totals 63,400 MBTU's.

Based on overall energy consumption, the LRT emerges as clearly more energy efficient than the non-LRT alternative (41,400 MBTU's for the LRT system and 63,400 MBTU's for the non-LRT alternative). The difference appears in part to be related to the LRT's efficiency as well as the minimal feeder bus additions required. The LRT and its feeder system are more efficient than the improved bus system even without consideration of displaced automobile drivers.

TABLE VI-22

PROJECTED ENERGY CONSUMPTION FOR THE
NON-LRT ALTERNATIVE, NORTHEAST CORRIDOR, YEAR 2000

	Bus System	LRT Riders Shifting to Automobiles
Annual Vehicle Miles	1,229,000 miles[1]	3,313,400 miles[2]
Projected Fuel Efficiency[3]	4 miles/gallon (diesel)	32.4 miles/gallon (gasoline)
Annual Energy Consumption	307,250 gallons	102,300 gallons
BTU's of Energy Consumed[4]	48,600 MBTU's	14,800 MBTU's

TOTAL ANNUAL ENERGY CONSUMPTION - 63,400 MBTU's

[1] Reflects the required bus miles (feeder and line haul) over and above what would exist in the corridor in any event.

[2] Determined on the basis of the difference between the number of projected auto driver trip miles with LRT and those miles assuming existence of the LRT alternative.

[3] Sources: Minnesota Energy Agency; Metropolitan Transit Commission

[4] MRI's REEPA model projects a full cycle estimate of energy impacts, from the well head, through refining and transportation, to final fuel combustion.

The relative petroleum fuel savings from LRT operation of a Northeast LRT are shown in Table VI-23. As indicated, an estimated 380,800 gallons of petroleum fuel could be conserved during the year 2000. About three-quarters of this saving would result from reduced bus service needs in the corridor. The remaining 102,300 gallons of gasoline would occur because of the relative attractiveness of the LRT to existing automobile users. This gasoline saving, however, accounts for only half of 1 percent of the 18 million gallons of gasoline that will be consumed that year by automobiles operating in the Northeast corridor.

TABLE VI-23

PROJECTED PETROLEUM SAVINGS WITH OPERATION
OF AN LRT LINE, NORTHEAST CORRIDOR, YEAR 2000

Gasoline Savings with Reduced Automobile Use	102,300 gallons
Diesel Fuel Savings with Reduced Bus Service Needs	278,500 gallons
Annual Petroleum Savings	380,800 gallons
Remaining Gasoline Consumption by Automobiles Under the LRT Model	18,657,000 gallons

Environment. Comparative pollution impacts between LRT and non-LRT are presented in Table VI-24. As indicated, the LRT system is responsible for more than twice the pollution levels of the non-LRT alternative. However, with the exception of the feeder bus component of the LRT model, nearly all of the LRT impacts are off-site, at the mine or electric power plant. The non-LRT alternative, with its dependence on petroleum based fuels, has most of its impact within the Northeast corridor.

TABLE VI-24

COMPARATIVE ENVIRONMENTAL IMPACTS*
LRT-vs-NON-LRT ALTERNATIVE NORTHEAST ALIGNMENT

(In Pounds)

	LRT	Non-LRT Alternative
Air Pollution		
Particulate	114,800	6,500
Carbon Monoxide (CO)	9,100	309,500
Hydrocarbons (HC)	6,100	55,500
Nitrogen Oxides (NO_x)	33,200	86,900
Sulfur Oxides (SO_x)	261,200	18,900
Water Pollution		
Suspended Solids (SS)	**	200
Chemical Oxygen Demand (COD)	100	1,000
Biochemical Oxygen Demand (BOD)	**	300
Other	1,500	21,200
Solid Waste		
Mining/Drilling Wastes	640,400	5,900
Other Solid Wastes	104,900	7,000
TOTAL POLLUTANT LOADS	1,171,300	512,900

*MRI's REEPA model projects a "full cycle" estimate of pollutant impacts, i.e. pollutant loads at the mine and well head through to final combustion of the coal and petroleum fuels.

**Less than 50 pounds of pollution.

CHAPTER VII

NORTHWEST CORRIDOR

INTRODUCTION

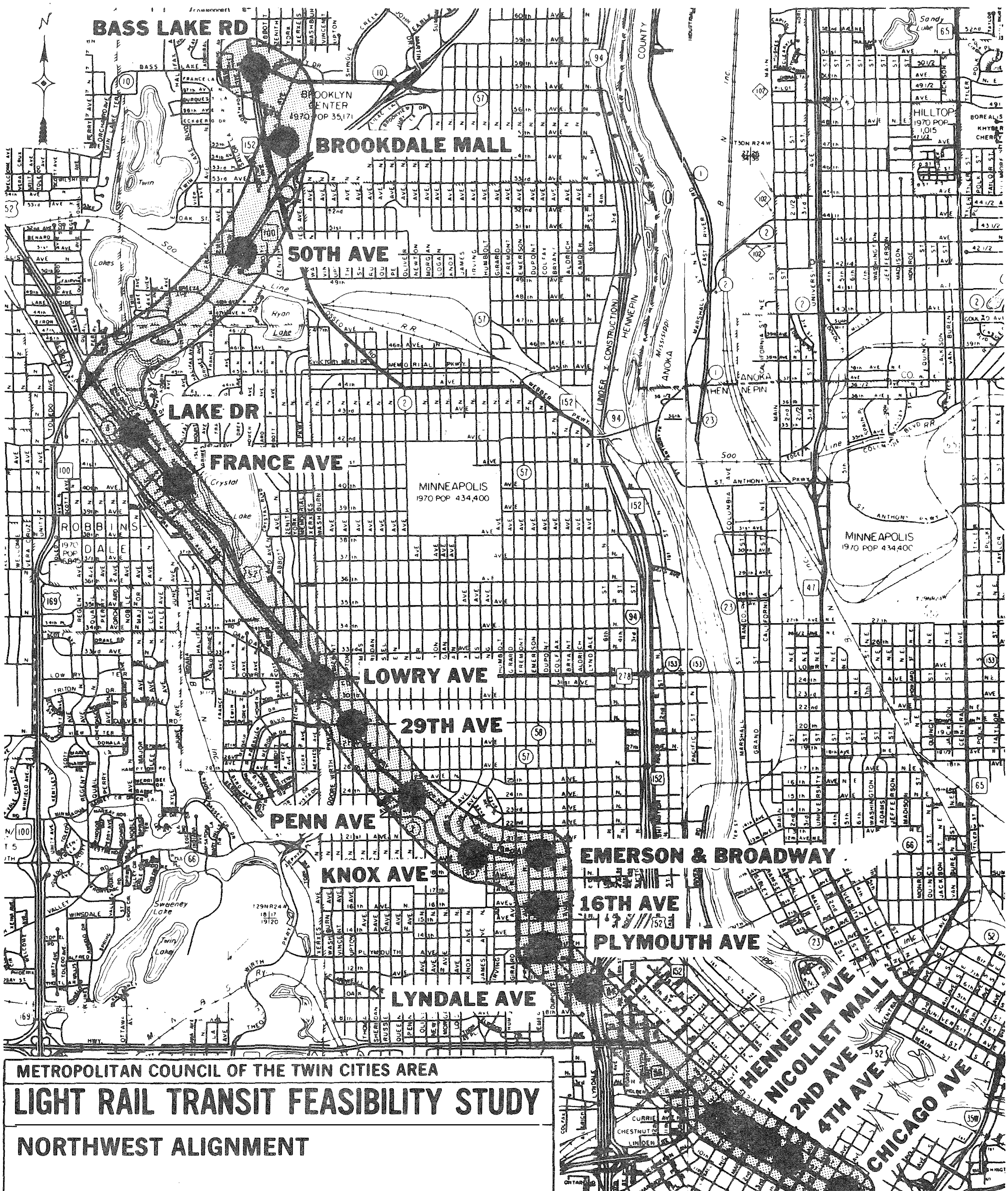
The Northwest Corridor is representative of Metropolitan Area corridors with combinations of long and short trips, heavy transit use, and those requiring operations duplicating local as well as high speed service. Major communities in the corridor include Robbinsdale, Crystal and Brooklyn Center.

ALIGNMENT SELECTION

The alternative alignments tested in the Northwest are shown in Figure II-1. They are:

- BN Railroad
- TH52
- TH169
- TH152
- I-94

The sketch planning analysis showed that TH52, from downtown Minneapolis to the vicinity of TH100, was clearly superior to the other alignments in terms of potential patronage. North of TH100, TH152 was superior. Results of the analysis are shown in the Technical Supplement. On the basis of potential patronage, the desire to serve the Brookdale Shopping Center, field surveys, and input from the various committees overseeing the study, an alignment consisting of TH52, TH100, and TH152 was selected as the Northwest alignment. Termini are downtown Minneapolis and the Brookdale Shopping Center.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BROOKDALE MALL
50TH AVE
LAKE DR
FRANCE AVE
LOWRY AVE
29TH AVE
PENN AVE
KNOX AVE
EMERSON & BROADWAY
16TH AVE
PLYMOUTH AVE
LYNDALE AVE
HENNEPIN AVE
NICOLLET MALL
2ND AVE
4TH AVE
CHICAGO AVE
BROOKLYN CENTER
1970 POP 35,171
MINNEAPOLIS
1970 POP 434,400
ROBBINSDALE
HILLTOP
1970 POP 1,015
METROPOLITAN COUNCIL OF THE TWIN CITIES AREA
LIGHT RAIL TRANSIT FEASIBILITY STUDY
NORTHWEST ALIGNMENT
SANDERS & THOMAS, INC., CONSULTING ENGINEERS
POTTSTOWN, PA
SCALE IN FEET
0
2000
4000
6000

FIGURE VII-1

LRT ALTERNATIVE

Stop Locations

Alignment details and LRT stop locations are shown in Figure VII-1. The southernmost portion of the route would consist of operations on city streets in a physically separated right-of-way isolated from automotive traffic by low concrete medians, railings, plantings, or the like. Between 7th Avenue N. and Lowry Avenue, northbound operations would be on Emerson Avenue North and southbound operations on Fremont Avenue North.

Table VII-1 shows each proposed LRT stop:

TABLE VII-1

PROPOSED LRT STOPS - NORTHWEST	
Chicago Ave. & 8th St. S.	Knox Ave. & North Broadway
4th Ave. & 8th St. S.	Penn Ave. & North Broadway
2nd Ave. & 8th St. S.	29th Ave. & North Broadway
Nicollet Mall & 8th St. S.	Lowry Ave. & North Broadway
Hennepin Ave. & 8th St. S.	France Ave. & N. Broadway
Lyndale Ave. & 7th Ave. N.	Lake Dr. & North Broadway
Plymouth Ave & Emerson Ave N.	50th Ave. & Drew
16th Ave. & Emerson Ave. N.	55th Ave. & Brookdale Mall
Broadway & Emerson Ave. N.	Bass Lake Rd. & Brooklyn Blvd

Operating Plan

Table VII-2 shows the Northwest operating plan in terms of headways by hour and day. During the peak periods service would be provided at 5 minute intervals between Lowry Avenue and downtown Minneapolis and 10 minute intervals between the Brookdale Shopping Center and Lowry Avenue. During non-peak hours all service would operate to the Brookdale Shopping Center.

Table VII-3 shows schedule speeds and times between LRT stops as well as the cumulative time and distance terminal point. Average schedule speed along the 8.3 mile long line is approximately 17 miles per hour. Approximately 28

TABLE VII-2

OPERATING HEADWAYS - NORTHWEST

	5 A.M.- 7 A.M.	7 A.M.- 9 A.M.	9 A.M.- 4 P.M.	4 P.M.- 6 P.M.	6 P.M.- 11 P.M.	11 P.M.- 1 A.M.
Weekdays	15	5	15	5	15	15
Saturdays	30	30	30	30	30	30
Sundays & Holidays		60	60	60	60	

minutes are required to make the trip from Chicago Avenue and 8th Street South to the Brookdale Shopping Center.

Annual Vehicle Miles

Total annual vehicle miles are calculated at 572,000 in the Northwest. Vehicle mile calculations are shown in the Technical Supplement.

Ridership Forecasts

Total daily LRT ridership is estimated at 34,700 or 5.0 percent of total corridor travel. The number of passengers passing the maximum load point during the peak hour is 4,500.

Table VII-4 compares forecasted LRT travel to total corridor travel and corridor travel by other modes. Daily inbound ridership is shown on Figure VII-2.

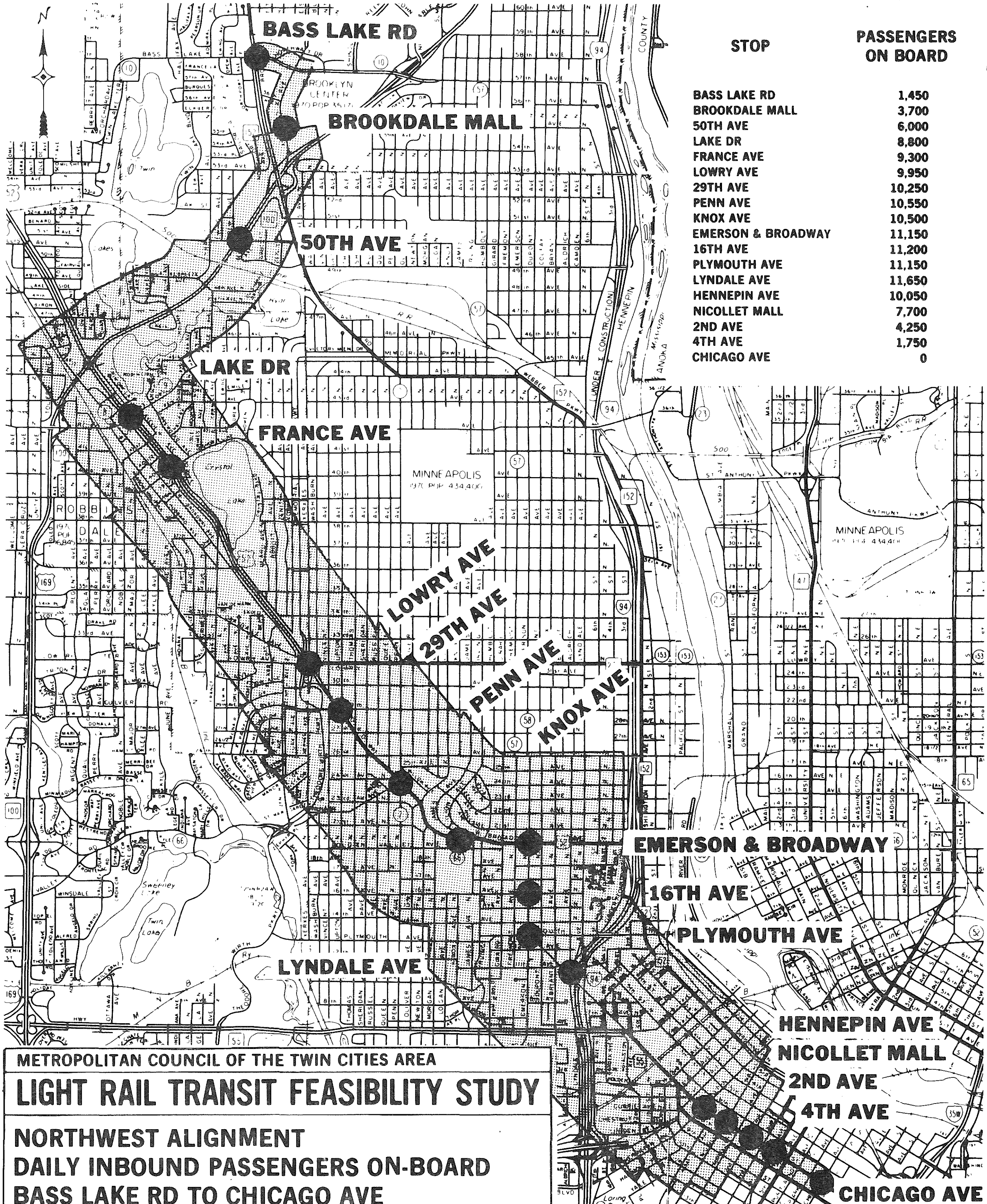
Feeder Bus

A feeder bus system will be required for passenger collection and distribution, particularly at the Brookdale Center and Robbinsdale stops. Current bus service in Minneapolish and close-in suburban areas would be reoriented to serve the LRT line. Based upon the projected volume of feeder bus riders and

TABLE VII-3

SCHEDULED SPEEDS, TIME, AND DISTANCE - NORTHWEST

Chicago & 8th St. S (Hospital)	Distance (Miles)	Scheduled Speed (MPH)	Scheduled Time (Minutes)	Cumulative Time from Terminal (Minutes)	Cumulative Distance From Terminal (Miles)
4th Ave. & 8th St. S	0.30	12	1.50	1.50	0.30
2nd Ave. & 8th St. S	0.14	12	.70	2.20	0.44
Nicollet Ave. & 8th St. S	0.14	12	.70	2.90	0.58
Hennepin Ave. & 8th St. S	0.15	12	.75	3.65	0.73
Lyndale Ave. & 7th Ave. N	1.10	20	3.30	6.95	1.83
Plymouth Ave. & Emerson Ave. N	0.30	17	1.07	8.02	2.13
16th Ave. & Emerson Ave. N	0.20	16	.75	8.77	2.33
Broadway & Emerson Ave. N	0.24	16	.90	9.67	2.57
Knox Ave. & N. Broadway	0.34	17	1.20	10.87	2.91
Penn Ave. & N. Broadway	0.50	17	1.78	12.64	3.41
29th Ave. & N. Broadway	0.55	17	1.93	14.57	3.96
Lowry Ave. & N. Broadway	0.34	21	.97	15.54	4.30
France Ave. & N. Broadway	0.82	21	2.33	17.87	5.12
Lake Dr. & N. Broadway	0.77	21	2.20	20.07	5.89
50th Ave. & Drew	1.40	25	3.65	23.72	7.29
55th Ave. & Brooklyn Blvd. (Brookdale)	0.62	18	2.07	25.79	7.91
Bass Lake Rd. & Brooklyn Blvd.	0.39	12	1.95	27.74	8.30



STOP	PASSENGERS ON BOARD
BASS LAKE RD	1,450
BROOKDALE MALL	3,700
50TH AVE	6,000
LAKE DR	8,800
FRANCE AVE	9,300
LOWRY AVE	9,950
29TH AVE	10,250
PENN AVE	10,550
KNOX AVE	10,500
EMERSON & BROADWAY	11,150
16TH AVE	11,200
PLYMOUTH AVE	11,150
LYNDALE AVE	11,650
HENNEPIN AVE	10,050
NICOLLET MALL	7,700
2ND AVE	4,250
4TH AVE	1,750
CHICAGO AVE	0

METROPOLITAN COUNCIL OF THE TWIN CITIES AREA

LIGHT RAIL TRANSIT FEASIBILITY STUDY

NORTHWEST ALIGNMENT
DAILY INBOUND PASSENGERS ON-BOARD
BASS LAKE RD TO CHICAGO AVE

SANDERS & THOMAS, INC., CONSULTING ENGINEERS
POTTSTOWN, PA

FIGURE VII-2

TABLE VII-4

FORECASTED CORRIDOR TRAVEL BY MODE - NORTHWEST

	24 Hours	%	Peak Period	%
Auto Driver	454,100	65.9	64,500	60.0
Carpool	144,100	20.9	20,300	18.9
Local Bus Passenger	55,800	8.2	14,000	13.0
LRT Passenger	34,700	5.0	8,700	8.1
TOTAL TRAVEL	688,700	100.0	107,500	100.0

operating characteristics in the corridor, as calculated by the MTC, seven additional feeder buses will be required, including one spare.

Capital Requirements and Costs

Capital construction costs are shown in Table VII-5. Total construction costs are estimated at a $52.4 million.

Right-of-Way Acquisition. No costs are provided for right-of-way acquisition since the entire alignment will be within existing street and highway rights-of-way.

Parking Lots. Approximately 5,400 parking spaces will be required at a cost of $3,000 each including land, or a total of $16.2 million.

Vehicles. Twenty-nine vehicles will be required for revenue service. This includes three spares. Total vehicle costs are estimated at $28.1 million. Calculations for vehicle requirements are shown in the Technical Supplement.

Feeder Buses. Seven feeder buses, including one spare at $150,000 each plus $55,200 per bus for maintenance and overhaul facilities would cost a total of $1.4 million.[1]

Capital costs are summarized on Table VII-6.

[1]Only the additional feeder bus service required has been included in the analysis.

TABLE VII-5

CONSTRUCTION COST ESTIMATE - NORTHWEST

Item	Quantity		Unit Price $	Amount
Cross Ties	44,800		47	$ 2,072,136
Stone Ballast	29,392		35	1,028,720
115# Rail	88,176		75	6,613,200
Excavation	77,910		23	1,791,930
Electric Grade Crosssings	-		275,000	-
Crossovers (Including 2 turnouts)	7		70,000	490,000
Platforms	35		14,133	494,655
Utility Relocation in CBD	26		500,000	13,000,000
Substation	7		405,000	2,835,000
Roadway: 6" Concrete	56,731		30.45	1,727,449
Car Shop	1		975,000	975,000
Simple Catenary System	9.9		798,000	7,900,200
Pavement Removal	510,576		4.92	2,512,034
Traffic Signal Preemption Equip.	-		8,000	-
	1980 PRICES:	SUBTOTAL		$41,440,324
		+ 15% Contingency		6,216,049
		SUBTOTAL		$47,656,372
		+ 10% Engineering & Mobilization		4,765,637
		TOTAL		$52,422,009
		USE		$52,422,000

TABLE VII-6

CAPITAL COST SUMMARY - NORTHWEST

Category	Cost in Millions of Dollars
Right-of-Way Acquisition	-
Construction	$52.4
Vehicles	28.1
Parking Lots	16.2
SUBTOTAL	$96.7
Feeder Bus	1.4
TOTAL	$98.1

Total capital costs, exclusive of feeder bus costs are estimated at $95.3 million in 1980 dollars, or about $11.5 million per double-tracked mile.

Operating and Maintenance Costs

Table VII-7 shows estimated LRT annual operating costs by category of expense. Total annual operating and maintenance costs, exclusive of annualized capital costs, are estimated at $1.9 million. On a cost per passenger basis this works out to $0.18.

Feeder bus costs of $1.9 million are based upon the need for approximately 149,000 bus miles at $1.10 per mile and 10,000 bus hours at $18.34 per hour (Table VII-8).

Annualized Capital Costs. Annualized capital costs assume that total project costs would be locally financed. Each category of capital expense (for example: buildings, vehicles, tracks, etc.) has been amortized over a useful life expectancy ranging from 12 to 40 years depending on the category. Table VII-9 shows total annual operating and maintenance costs including annualized capital costs for LRT in the Northwest. Annualized capital costs are calculated in the Technical Supplement.

TABLE VII-7

ANNUAL LRT OPERATING AND MAINTENANCE COSTS INFLATED TO YEAR 1980

Based on 1976 Unit Cost Relationships
(Northwest)

Item (With 1976 Unit Cost	
Track Maintenance (.34/Vehicle Mile Traveled)	$ 194,480
Shelter Maintenance ($500/Shelter)	17,000
Yards & Support Maintenance ($1,000/Peak Hour Vehicle)	21,000
Electrical Maintenance (.04/Vehicle Mile Traveled)	28,880
Vehicle Maintenance (.24/Vehicle Mile Traveled)	137,280
Vehicle Energy Consumption (.14/Vehicle Mile Traveled)	80,080
Maintenance Facility Energy Consumption ($50/Peak Hour Vehicle)	1,050
Vehicle Storage Energy Consumption ($400/Peak Hour Vehicle)	8,400
MTC Operators Salary plus Benefit ($16,867)	522,877
Other Transportation (.17/Vehicle Mile Traveled)	97,240
SUBTOTAL	$1,108,287
General & Administrative (15% of Subtotal)	166,243
1976 TOTAL COST	$1,274,530
Inflated at 10%/Annum to 1980	1,866,039
TOTOAL	$1,866,039
USE	$1,866,000

Unit Cost Source: *Light Rail Transit, A State of the Art,* U.S. Department of Transportation, 1976.

Operator's Cost Source: Metropolitan Transit Commission.

TABLE VII-8

FEEDER BUS SERVICE ANNUAL
OPERATING AND MAINTENANCE COSTS - NORTHWEST[1]
(1980 Dollars)

Item	Unit Cost	Cost
Annual Bus Miles = 149,000	$ 1.10/mile	$163,900
Annual Bus Hours = 10,000	$13.34/hour	$183,400
TOTAL		$347,300

TABLE VII-9

TOTAL ANNUAL LRT OPERATING AND MAINTENANCE COSTS
INCLUDING ANNUALIZED CAPITAL COSTS - NORTHWEST

Operating and Maintenance Costs	$ 2,213,300
Annualized Capital Costs	9,400,000
TOTAL	$11,613,300

Annualized capital costs are in 1980 dollars. The relationship between annualized capital costs and annual operating and maintenance costs is only accurate for the first year of a capital investment.

Operating Costs Versus Revenues

Table VII-10 compares annual operating costs to the annual revenues anticipated. A fare of $.50 was used to calculate revenues. LRT is anticipated to generate a $2,353,600 surplus.

[1]Only the additional feeder bus service required has been included in the analysis.

TABLE VII-10

ESTIMATED LRT OPERATING COSTS VERSUS REVENUES IN 1980 DOLLARS - NORTHWEST	
Total Annual LRT Passengers	10,201,800
LRT Revenue Generated at $.50 Fare	$5,100,900
Total LRT and Bus Operating & Maintenance Costs	$2,213,300
Surplus/(Deficit)	$2,887,900

Impact Analysis

Land Use. LRT-induced development in the Northwest is limited by the character and density of development that already exists along this route. LRT will provide support to land use trends along this alignment, but will provide little inducement to concentrate the significant amount of development expected in the northwest suburbs through the end of this century.

According to projections drawn from the Metropolitan Council's social and economic profile data base, the Northwest alignment will experience a greater amount of new development than any of the other four study alignments during the period 1990 to 2000. As shown in Table VII-11, an estimated 3,600 acres of land is expected to develop during the 10 year study period. This amounts to 10 percent of the development activity expected for the entire Twin Cities Metropolitan Area over the same period. Nearly all of this growth is likely in the second ring suburb portions of the corridor and to some extent in the removal areas of North Minneapolis.

Based on the experience of other rail transit systems in other cities, the principal land use impacts in the Northwest alignment should occur within one-half mile of the individual LRT stops. Because most of the stops along this alignment are well-developed intersections, are economically stable, and are controlled by relatively conservative land use policies, the actual development impacts will be small--only a small fraction of the 3,600 acres of development projected for the full corridor over the 10 year period.

TABLE VII-11

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

Northwest Minneapolis Corridor Acreage**			Change 1990-2000
Residential	16,700	18,000	1,300
Commercial	1,600	2,000	400
Industrial	5,600	7,500	1,900
TOTAL	23,900	27,500	3,600
Metro Area Acreage			
Residential	174,500	196,000	21,500
Commercial	15,900	20,200	4,300
Industrial	53,500	63,400	9,900
TOTAL	243,900	279,600	35,700

*Since these figures are based on utilized acreage, the estimates do not reflect change due to redevelopment activity.

**Includes an area of 1 to 3 miles either side of the Northwest alignment. These estimates also include the Minneapolis CBD and the communities of Maple Grove, Osseo, and Brooklyn Park to the north and southwest of the alignment terminus point.

Source: Socio-Economic and Land Use File, Metropolitan Council, 1980.

The projected land development patterns along the Northwest alignment are indicated in Table VII-12.[1] In total, an estimated

[1]Pertinent charts and maps reflecting the land use impact analysis at each LRT stop are provided in the Technical Supplement.

73 acres of land are expected to develop within a half-mile radius of individual LRT stops between 1990 and 2000. Of this development, nearly half or 35 acres could be expected to take place because of the introduction of LRT into this area. About 55 percent of this amount would be redevelopment. It is estimated that establishment of a Northwest LRT line would result in the development of 11 acres of residential real estate, 13 acres of commercial property and 11 acres of industrial property.

TABLE VII-12

PROJECTED LAND DEVELOPMENT WITHIN ONE-HALF MILE OF THE NORTHWEST ALIGNMENT LRT STOPS, 1990-2000 (In Acres)

	New Development	Redevelopment	Total
Acreage Projected to Develop Around LRT Stops, 1990-2000	40.0	33.0	73.0
Acreage of Development LRT Induced			
Residential	3.0	8.0	11.0
Commercial	6.0	7.0	13.0
Industrial	6.0	5.0	11.0
TOTAL	15.0	20.0	35.0

Source: Midwest Research Institute

As shown in Table VII-13, the direct impact of a Northwest LRT would be the construction of 500 low and medium density multi-family housing units, more than 173,600 square feet of retail and office commercial space, and 235,200 square feet of industrial space. The impact in 1980 construction dollars of this LRT-

TABLE VII-13

PROJECTED LRT-INDUCED LAND USE CHANGES AND CONSTRUCTION IMPACTS, NORTHWEST MINNEAPOLIS ALIGNMENT, 1990-2000

	New Development	Redevelopment*	Total
Projected LRT-Induced Land Use Changes			
. Residential Multi-Family Units:			
High Density	0	0	0
Medium Density	20	420	440
Low Density	60	0	60
Total Units	80	420	500
. Commercial Square Footage:			
Retail	33,100	52,100	85,200
Office	53,900	34,500	88,400
Total Sq. Ft.	87,000	86,600	173,600
. Industrial Square Footage	132,900	102,400	235,200
Projected LRT-Induced Building Construction (In 1980 Construction $'s)**			
. Residential	$ 2.7 million	$ 10.2 million	$ 12.9 million
. Commercial	3.0 million	2.6 million	5.6 million
. Industrial	2.4 million	1.8 million	4.2 million
Total Construction Impact	$ 8.1 million	$ 14.6 million	$ 22.7 million

* Does not include rehabilitation activity.
** Does not include costs of demolition, relocation, parking, landscaping, or other site preparation costs.

Source: Midwest Research Institute

induced residential, commercial, and industrial development would total an estimated $23 million.

The land use impacts along this alignment were based on current municipal land use policies and development strategies. More aggressive policies and greater use of inducement strategies would result in greater development potential. The desirability of concentrating development along key nodes must be assessed on the basis of relevant municipal and regional development policies and long range plans.

Energy. The LRT energy impacts in the Northwest are shown in Table VII-14. As indicated, a total annual consumption of 58,500 million MBTU's of energy is projected for the year 2000. Of this total, nearly 90 percent would be coal-based electrical energy used in powering the LRT vehicles. The remaining energy impacts relate to feeder bus diesel fuel consumption. In the case of both the coal and petroleum fuel, the energy impact analysis considers total energy requirements from the mine and drill head through the final combustion of the fuel.

Environment. Pollutant loads from the Northwest LRT operation are shown in Table VII-15. Most of the 1.7 million pounds of pollution occurs instead at the mine and electrical generation plant. Within the corridor, the highest levels of pollution are associated with feeder bus diesel exhausts.

Other LRT noise and visual impacts are less subject to physical measurement. In the case of noise impacts, the measurement of sound intensity is important. The ultimate impact, however, is a function not of just the intensity but the human reaction to it.

In general, a Northwest LRT should not significantly raise perceived noise levels. Based on published noise data, there is evidence that LRT operations should be quieter than buses and in some areas may be below automobile noise levels. At a speed of 40 miles per hour and a distance of 50 feet, a light rail vehicle will have an exterior noise level of 80 decibels (dBA's). By comparison, noise levels for buses on city streets are between 80 and 88 dBA's, and automobiles at highway speeds approach 75 to 80 dBA.

Experience in other cities has demonstrated that visual problems associated with the vehicles, tracks, support poles and wires can be overcome. Through careful design and landscaping, LRT systems can blend into the surrounding environment better than most other modes of transit. Given the neighborhoods and

TABLE VII-14

PROJECTED ENERGY CONSUMPTION WITH
LRT OPERATION, NORTHWEST ALIGNMENT, YEAR 2000

	LRT Line	Feeder Buses
Annual Vehicle Miles	572,000	149,000 miles[1]
Project Fuel Efficiency	8 KWH/ vehicle mile[2]	4 miles/ gallon (diesel)[3]
Annual Energy Consumption	4,576,000 KWH	37,250 gallons
BTU's of Energy Consumed[4]	52,600 MBTU's	5,900 MBTU's

TOTAL ANNUAL ENERGY CONSUMPTION - 58,500 MBTU's

[1] Since many existing bus routes in the Northwest corridor could serve, with little change, as feeder bus routes, the impact analysis only considers the bus system additions required to support the LRT line.

[2] Source: Boeing Company.

[3] Source: Year 2000 projections by the Metropolitan Transit Commission.

[4] MRI's REEPA model projects a full cycle estimate of energy impacts, i.e., energy consumed at the mine or well head, through refining and transportation, to final fuel combustion.

topography in the Northwest corridor, there should not be any major visual problems associated with LRT development. The most critical noise and visual problem may relate not to the LRT line, but to parking spillover into neighborhood and commercial

TABLE VII-15

PROJECTED POLLUTANT LOADS[1] -
NORTHWEST LRT ALIGNMENT, YEAR 2000
(In Pounds)

	LRT Operations[2]	Feeder Buses[3]	Total
Air Pollution			
Particulate	163,100	600	163,700
Carbon Monoxide (CO)	-	11,800	11,800
Hydrocarbons (HC)	4,100	4,100	8,200
Nitrogen Oxides (NO_x)	37,700	8,800	46,500
Sulfur Oxides (SO_x)	370,440	2,000	372,400
Water Pollution			
Suspended Solids (SS)	-	*	*
Chemical Oxygen Demand (COD)	-	100	100
Biochemical Oxygen Demand (BOD)	-	*	*
Other	-	1,900	1,900
Solid Waste			
Mining/Drilling Waste	912,900	500	913,400
Other Solid Wastes	149,000	600	149,600
Total Pollutant Loads	1,637,200	30,400	1,667,600

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[1] MRI's REEPA model projects a full cycle estimate of pollution, from the mine or well head through to final combustion.

[2] Assumes coal-based electrical generation. To the extent that electricity is available from existing capacity or from other electrical generation sources - e.g. hydroelectric power - these estimates may overstate actual impacts. The emphasis on coal is judged reasonable given NSP projections and prevailing industry trends.

[3] Since many existing bus routes in the Northwest corridor could serve, with little change, as feeder bus routes, the impact analysis only considers the additional bus requirements to support the LRT line.

*The pollutant load is less than 50 pounds.

streets. This is a problem faced by many U.S. and Canadian cities with fast growing LRT systems.

NON-LRT ALTERNATIVE

The non-LRT alternative in the Northwest consists of exclusive bus lane express bus operations on Broadway following the LRT alignment. Bus operations would closely follow that of the LRT.

Characteristics

Express buses would operate in mixed-traffic on TH152, TH100, Emerson/Fremont Avenues, and North 7th Street; but would use exclusive bus lanes on Broadway Avenue. Average bus speeds would be about 14 mph, about 3½ mph less than average light rail vehicle speeds. Average stop spacing was assumed to be about 1/3 of a mile outside of downtown Minneapolis, slightly less than the LRT alternative.

Ridership Forecasts

The Metropolitan Council's sketch planning model was used to forecast express bus patronage. The model was run with a 2 mile per hour differential between the local bus system and the buses operating in the exclusive bus lane. Table VII-16 shows the results of this analysis.

Capital Costs

Capital requirements for the Northwest non-LRT alternative consist of 59 buses included 8 spares. Added to this are the capital costs associated with garaging and overhauling these additional buses. In addition, street improvements including striping, meter relocation, bus bays, etc., are needed on Broadway Avenue. Capital costs are shown in Table VII-17.

Operating and Maintenance Costs

Northwest non-LRT operating and maintenance costs are based on current MTC unit costs. System costs are estimated at $3.1 million as shown in Table VII-18.

TABLE VII-16

FORECAST BY MODE NORTHWEST - EXPRESS BUS LANES

	24 Hours		Peak Period	
Mode	# of People	%	# of People	%
Auto Driver	455,900	66.2	64,700	60.2
Carpool	143,400	20.8	20,400	19.0
Local Bus	67,200	9.8	16,800	15.6
Express	22,200	3.2	5,600	5.2
TOTAL	688,700	100.0	107,500	100.0

TABLE VII-17

NON-LRT CAPITAL COSTS - NORTHWEST

59 Buses	$ 8,850,000
Maintenance and Overhaul Facilities @ $55,200/bus	3,257,980
Street Improvements @ $150,000/mile	600,000
TOTAL	$12,707,980
USE	$12,700,000

TABLE VII-18

NON-LRT OPERATING AND MAINTENANCE COST - NORTHWEST

Item	Unit Cost	Cost
Annual Bus Miles - 1,297,000	$1.10/mile	$4,426,700
Annual Bus Hours - 92,600	$18.34/hour	$1,698,284
TOTAL		$3,124,984
USE		$3,125,000

Annualized Capital Costs. Annualized capital costs for the non-LRT alternative are shown in Table VII-19. Calculations are shown in the Technical Supplement. The combined operating and maintenance costs and annualized capital cost equals $4.8 million.

TABLE VII-19

TOTAL ANNUAL OPERATING AND MAINTENANCE COSTS INCLUDING ANNUALIZED CAPITAL COSTS - NON-LRT NORTHWEST

Operating & Maintenance Costs	$3,125,000
Annualized Capital Cost	$1,658,000
TOTAL	$4,783,000

Operating Costs Versus Revenues

Based on a $.50 fare, annual non-LRT operating and maintenance costs exceed revenues by $1.5 million. Table VII-20 compares costs to revenues.

TABLE VII-20

OPERATING COSTS VERSUS REVENUES - NON-LRT - NORTHWEST

Total Annual Express Bus Passengers	6,526,800
Annual Operating and Maintenance Cost	$3,125,000
Revenue Generated @ $.50 fare	$3,263,400
Surplus/(Deficit)	$ 138,400
Total Annual Capital & Maintenance Cost	$4,783,000
Surplus/(Deficit)	($1,519,600)

COMPARISON OF LRT AND NON-LRT NORTHWEST

Table VII-21 presents a summary of comparative data on LRT and non-LRT. LRT's cost is higher when annualized capital costs are included. The cost differential between LRT and non-LRT (Annual Operating Surplus/Deficit including Capital Costs are shown in Table VII-21) will change over time since annualized capital costs are constant for the lives of the bonds used to finance the initial system. Operating and maintenance cost items are subject to inflation on a year-to-year basis.

Impact Analysis

Energy. Non-LRT energy impacts in the Northwest are presented in Table VII-22. An improved bus system (line haul and feeder buses) would consume an estimated 51,300 MBTU's of energy. To permit a balanced comparison with the LRT model, the analysis

TABLE VII-21

SUMMARY COMPARISON - LRT VERSUS NON-LRT NORTHWEST

	LRT	NON-LRT
24 Hour Ridership	34,700	22,200
Capital Cost	$96.7 million	$12.7 million
Annual Operating & Maintenance Cost	$ 2.2 million	$ 3.1 million
Annualized Capital Cost	$ 9.4 million	$ 1.7 million
Annual Operating Surplus/(Deficit)*	$ 2.9 million	$ 0.1 million
Annual Operating Surplus/(Deficit)**	($6.5 million)	($1.5 million)

*Excluding Capital Cost
**Including Annualized Capital Cost

must also incorporate the estimated 2.5 million automobile miles driven by individuals that would probably ride the LRT but would not choose to ride a bus system. By adding these impacted automobile miles into the non-LRT model, the annual non-LRT energy impacts total 62,400 MBTU's.

Based on overall energy consumption, the two LRT and non-LRT models emerge relatively comparable with the LRT system only slightly (less than 7 percent) more energy efficient than the non-LRT alternative.

The relative petroleum fuel savings from operation of Northwest LRT are shown in Table VII-23. As indicated, an estimated 363,800 gallons of petroleum fuel could be conserved during the year 2000. Nearly 80 percent of this saving would result from reduced bus service needs in the corridor. The remaining 76,800 gallons of gasoline would be saved because of the relative

TABLE VII-22

PROJECTED ENERGY CONSUMPTION FOR THE NON-LRT ALTERNATIVE, NORTHWEST CORRIDOR, YEAR 2000

	Bus System	LRT Riders Shifting to Automobiles
Annual Vehicle Miles	1,297,000 miles[1]	2,487,240 miles[2]
Projected Fuel Efficiency[3]	4 miles/gallon (diesel)	32.4 miles/gallon (gasoline)
Annual Energy Consumption	324,250 gallons	76,800 gallons
BTU's of Energy Consumed[4]	51,300 MBTU's	11,100 MBTU's

TOTAL ANNUAL ENERGY CONSUMPTION - 62,400 MBTU's

[1]Reflects the required bus miles (feeder and line haul) over and above what would exist in the corridor in any event.

[2]Difference between the number of projected auto driver trip miles with LRT and those miles assuming existence of the LRT alternative.

[3]Source: Minnesota Energy Agency;
Metropolitan Transit Commission

[4]MRI's REEPA model projects a full cycle estimate of energy impacts, from the mine and well head, through refining and transportation, to final fuel combustion.

TABLE VII-23

PROJECTED PETROLEUM SAVINGS WITH OPERATION OF AN LRT LINE, NORTHWEST CORRIDOR, YEAR 2000	
Gasoline Savings with Reduced Automobile Use	76,800 gallons
Diesel Fuel Savings with Reduced Bus Service Needs	287,000 gallons
Annual Petroleum Savings	363,800 gallons
Remaining Gasoline Consumption by Automobiles Under the LRT Model	19,367,000 gallons

attractiveness of the LRT to existing automobile commuters. This gasoline saving, however, accounts for only 0.4 of 1 percent of the 19 million gallons of gasoline that will be consumed that year by automobiles operating in the Northeast corridor.

Environment. The comparative pollution impacts from operation of the LRT and non-LRT models are presented in Table VII-24. As indicated, the Northwest LRT would be responsible for almost four times the pollution of the non-LRT alternative. However, with the exception of the feeder bus component of the LRT model, nearly all of the LRT pollution impacts would occur outside of the corridor, at the mine site or electric power plant. The non-LRT alternative, with its dependence on petroleum based fuels, will have most of its impact within the corridor. More than half of the non-LRT pollution is in the form of carbon monoxide from engine exhaust.

TABLE VII-24

COMPARATIVE ENVIRONMENTAL IMPACTS*
LRT-vs-NON-LRT ALTERNATIVE NORTHWEST ALIGNMENT

(In Pounds)

	LRT	Non-LRT Alternative
Air Pollution		
Particulate	163,700	6,300
Carbon Monoxide (CO)	11,800	262,100
Hydrocarbons (HC)	8,200	52,000
Nitrogen Oxides (NO_x)	46,500	87,300
Sulfur Oxides (SO_x)	372,400	19,100
Water Pollution		
Suspended Solids (SS)	**	200
Chemical Oxygen Demand (COD)	100	1,000
Biochemical Oxygen Demand (BOD)	**	300
Other	1,900	20,800
Solid Waste		
Mining/Drilling Wastes	913,400	5,700
Other Solid Wastes	149,600	6,900
TOTAL POLLUTANT LOADS	1,667,600	461,700

*MRI's REEPA model projects a full cycle estimate of pollutant impacts, from the mine and well head through the refinement and transportation stages to final combustion of the coal and petroleum fuels.

**Pollutant loads of less than 50 pounds.

CHAPTER VIII

SUMMARY

This summary includes the major conclusions of the LRT Feasibility Study grouped in the following manner:

- o Operational Characteristics
- o Ridership/Productivity
- o Interface with Other Modes
- o Capital Costs
- o Operating and Maintenance Costs
- o Impact on Land Use
- o Impact on Energy
- o Impact on the Environment

Operational Characteristics

1. All LRT alignments analyzed would operate at higher average speed than the corresponding non-LRT alternative with the exception of buses operating on HOV lanes or on a metered freeway.

2. An LRT line on an exclusive right-of-way with grade separation would achieve greater operating speeds than one for which the right-of-way is part of an existing roadway.

Ridership/Productivity

1. Each LRT line analyzed would generate more daily patronage than its corresponding non-LRT alternative. The HOV

lane option, however, produced ridership estimates similar to those of the LRT line.

2. LRT productivity, in terms of passengers per vehicle-mile, would be at least twice the productivity of the non-LRT alternative in each corridor considered.

3. LRT productivity, in terms of passengers per route-mile, increases as the population densities of areas contiguous to the alignment increases.

4. LRT can serve peak loads in all corridors analyzed with adequate ability to carry additional passengers.

Interface with Other Modes

1. Substantial realignments of existing bus routes to feed into an LRT line would be required except where the LRT line would exactly replace an existing bus route.

2. In areas presently not well served by transit, LRT requires major improvements in the local transit system to adequately serve the line.

3. All alignments analyzed that serve suburban areas would require a substantial number of park/ride spaces.

Capital Costs

1. Capital cost per mile ranges from 9 to 12 million dollars on all LRT alignments considered. Any right-of-way requiring major relocation or grading would result in higher unit costs.

2. Construction cost per mile would be generally lower along an existing railroad right-of-way than a highway right-of-way as a result of saving in excavation,paving and structural costs.

3. Construction costs would be strongly affected by the amount of right-of-way on downtown streets where utility relocation could be a major expense.

4. The capital cost per mile of each LRT alignment analyzed is substantially higher than the cost per mile of its corresponding non-LRT alternative.

Operating and Maintenance Costs

1. The extent of the additional bus service required to feed into an LRT line would have a major impact on the overall operating cost of the system serving a corridor.

2. Although an LRT line by itself could operate at a surplus, the overall operation would usually result in a deficit if the cost of providing the required feeder service were added.

3. The operating cost per passenger in each LRT alignment analyzed was lower than that of the non-LRT alternative. When annualized capital costs were added, however, the non-LRT alternative would be substantially less expensive than the LRT line, at least during the first few years of operation.[1]

4. Farebox revenues would cover a greater proportion of the operating cost in high density alignments where the LRT operation would be more productive than in low density alignments.

Impact on Land Use

1. Induced development because of the construction of an LRT line would be limited unless substantially expanded land use controls and development incentives were utilized by local units of government.

2. A modest increase in density of development around LRT stops would likely occur if an LRT line were built.

3. In each alignment analyzed, the non-LRT alternative would not have a measurable impact on land development.

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[1] Operating costs increase with inflation whereas annualized capital costs remain constant over the financial lifetime of a project. Therefore, persistently high inflation rates could accentuate over time any operating cost advantage of an LRT line over its non-LRT alternative. This could in turn at least partially offset the higher annualized capital cost of the LRT option.

Impact on Energy

1. The overall energy consumption, measured in BTU's, of the LRT and non-LRT alternatives in each alignment analyzed would be approximately the same.

2. The petroleum consumed by the LRT alternative would be substantially lower than in the non-LRT option in each alignment analyzed.

3. Petroleum saved by the LRT alternative would be less than 2 percent of the total petroleum consumed in the corridor, for each of the alignments analyzed.

Impact on the Environment

1. The total pollution produced by the LRT alternative would be higher than the amount produced by the non-LRT alternative (with the exception of electric buses) in each of the alignments analyzed.

2. The amount of pollution produced within the corridor by the LRT alternative would be lower than the amount produced by the non-LRT alternative in each alignment analyzed, since most of the pollution generated by the LRT alternative is at the mine or electrical generating plant.

3. Noise pollution from LRT is less than noise pollution from most other modes and can be screened.

SUMMARY TABLE

	WEST ALIGNMENT		SOUTHWEST ALIGNMENT		UNIVERSITY ALIGNMENT		NORTHEAST ALIGNMENT		NORTHWEST ALIGNMENT	
	LRT	HOV	LRT	Improved Bus	LRT	Electric Trolley Bus	LRT	Bus Bypass of Ramp Metering	LRT	Bus Lanes
Annual Express Passengers (000's)	8,187	7,421	7,480	5,978	12,845	10,260	5,301	4,116	10,202	6,527
Daily Express Passengers	27,800	25,200	25,400	20,300	43,600	34,900	18,000	14,000	34,700	22,200
Express Length (miles)	12.50	9.5	14.10	n.a.	9.46	9.46	8.77	8.00	8.30	8.30
Daily Express Passengers/Route Mile	2,224	2,653	1,801	n.a.	4,609	3,689	2,052	1,750	4,181	2,675
% Daily Travel in Corridor	2.6	2.4	2.3	1.9	6.0	4.9	2.9	2.2	5.0	3.2
% of Transit in Corridor	63.4	64.8	46.9	40.5	32.2	27.1	22.6	18.0	37.9	24.6
Construction Cost ($ millions)	85.4	44.6	83.7	n.a.	80.7	4.3	55.8	2.8	51.0	0.6
Capital Cost ($ millions)	138.9	77.2	133.8	22.8	101.0	15.0	81.0	18.9	96.7	12.7
Capital Cost/Mile ($ millions)	11.1	8.1	9.5	n.a.	10.7	1.6	9.2	2.4	11.7	1.5
Annualized Capital Cost ($ millions)	13.6	8.0	12.9	3.0	9.6	1.6	7.9	2.4	9.4	1.7
Express Line Annual Oper. & Maintenance Cost ($ millions)	2.42	2.98	2.59	n.a.	1.87	3.75	1.35	2.20	1.87	2.76
Total Annual Oper. & Maintenance Cost ($ millions)	6.33	6.89	5.42	6.75	1.87[1]	3.75[1]	1.63[1]	2.55[1]	2.21[1]	3.13[1]
Annual Passenger Revenues ($ millions)	4.1	3.71	3.74	2.99	6.42	5.13	2.65	2.06	5.10	3.26
Annual Surplus/(Deficit) without Capital Cost ($ millions)	(2.23)	(3.18)	(1.68)	(3.76)	4.55[1]	1.38[1]	1.3[1]	(0.49)[1]	2.89[1]	.13[1]
Annual Surplus/(Deficit) with Capital Cost ($ millions)	(15.8)	(11.2)	(14.2)	(6.8)	(5.1)[1]	(0.3)[1]	(6.8)[1]	(2.8)[1]	(6.5)[1]	(1.5)[1]
Transit Induced Development & Redevelopment 1990-2000 (acres)	136.4	N/A	82.8	N/A	21.1	N/A	63.0	N/A	34.5	N/A
Transit Induced Residential Development & Redevelopment 1990-2000 (housing units)	1,175	N/A	1,245	N/A	480	N/A	650	N/A	500	N/A
Total Corridor Development 1990-2000 (acres)	1,904	1,904	2,431	2,431	22	22	2,274	2,274	3,590	3,590
Annual Air Pollution (000's lbs.)	1313.4	968.8	1245.4	875.2	708.5	951.2	424.4	477.3	602.6	426.8
Annual Water Pollution (000's lbs.)	27.9	58.7	17.0	48.5	0	6.7	1.6	22.7	2.0	22.3
Annual Solid Waste (000's lbs.)	1858.2	33.4	1892.5	27.6	1307.6	1216.7	745.3	12.9	1063.0	12.6
Annual Petroleum Consumed (000's gallons)	505	1,060	308	876	0	119	29	410	37	401
Annual Petroleum Consumed in Corridor by all Modes (000's gallons)	27,534	28,090	28,554	29,122	17,486	17,605	18,686	19,066	19,404	19,767
Annual Energy Consumed (MBTU's)	171,150	166,200	142,000	136,700	64,800	77,300	41,400	63,400	58,500	62,400

[1] Differences in the methodologies employed in the analysis of alignments make comparisons among all LRT alternatives or all non-LRT alternatives inappropriate. Comparisons of the LRT alternative with its corresponding non-LRT alternative are appropriate for each alignment.