MICHIGAN BUS RAPID TRANSIT DEMONSTRATION PROGRAM – PHASE 1A

PRELIMINARY DESIGN OF BUS RAPID TRANSIT IN THE SOUTHFIELD/JEFFRIES CORRIDOR

prepared for
The Michigan State Highway Commission

April 1976
EP-76024

GM Transportation Systems

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EXECUTIVE SUMMARY

GM Transportation Systems

EXECUTIVE SUMMARY - PHASE IA

BUS RAPID TRANSIT DEMONSTRATION PROGRAM PRELIMINARY DESIGN OF BUS RAPID TRANSIT IN THE SOUTHFIELD/JEFFRIES CORRIDOR

1.0 INTRODUCTION

In September 1975, this program was initiated to accomplish the preliminary operational and physical design of a Bus Rapid Transit (BRT) system serving the Southfield/Jeffries corridor. This program grew out of two previous related efforts:

- A study of potential BRT corridors conducted for the Michigan Department of State Highways and Transportation (MDSH&T) by GM Transportation Systems Division (GM TSD) in early 1975[1]

- A study of the feasibility of the use of a reserved lane for buses and carpools on the Jeffries Freeway, conducted by an interagency group from Southeastern Michigan Transportation Authority (SEMTA), Detroit Department of Transportation (DDOT), Southeast Michigan Council of Governments (SEMCOG), and MDSH&T.[2]

The purpose of this program was to accomplish preliminary design for a BRT system which would extend the Jeffries bus lane northward to serve the area of lower Oakland County and northwest Detroit along the Southfield Freeway/Greenfield Road corridor; and, further, provide service to the Dearborn area at the southern end of the Southfield/Greenfield corridor.

Although it was recognized at the outset that the Southfield/Jeffries corridor would not generate as much transit demand as the most promising of the corridors identified in the BRT Phase I study, there are compelling reasons to consider this corridor for early BRT implementation. These reasons include the following:

- The Jeffries Freeway is not yet open to full use, and it presently operates under capacity.

- The Jeffries Freeway has no less than four lanes in each direction, and there is good potential for reserving lanes for buses.

- There is strong transit ridership in northwest Detroit which can serve as the ridership base for BRT operations.

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(1) "Michigan Bus Rapid Transit Demonstration Program - Phase I, Final Report," GM TSD No. EP-750012, May 1975.

(2) "Feasibility Study of Reserved Bus - Carpool Lanes for the Jeffries Freeway (I-96)," SEMTA, et al, June 1975.

In order to compare the BRT potential of the Southfield/Jeffries corridor with the corridors studied in Phase I of the BRT Demonstration Program, the initial work in this contract was to study this corridor to the same depth of analysis and planning conducted in Phase I. This initial effort was designated Stage I; and the results of the Stage I study are presented as a section of this report.

Upon completion of the Stage I work, Stage II was initiated. Stage II was the preliminary operational and physical design and refined analysis of the total BRT system in the Southfield/Jeffries corridor. This effort represents the major work under the contract and comprises the major portion of this report.

2.0 PROGRAM OBJECTIVES

The objectives of this program are stated in the contract between Michigan Department of State Highways and Transportation and GM Transportation Systems Division as follows:

> "The objective of this project is to produce feasible Preliminary Engineering and Operating Plans for the extension of the proposed Jeffries Freeway Transit corridor exclusive bus lane north to Nine Mile Road. To accomplish this, two alternative routes will be analyzed in detail; the Southfield Freeway (M-39) and Greenfield Road. Alternative priority treatments will also be evaluated for each of the two major routes. The most viable route will be identified, and, if deemed feasible, will be carried through preliminary physical design including feeder considerations and first-order cost estimates. The final report will document all aspects of the activity and serve as a basic plan for subsequent detailed design and ultimate implementation of the Bus Rapid Transit (BRT) operation. An additional objective of this project is to provide a plan for the inclusion of the portion of the Southfield corridor south of the Jeffries/Southfield intersection. This addition is to provide service between the Southfield area and the Dearborn area."

3.0 SYSTEM OVERVIEW

The proposed BRT system evolved as the result of an iterative process which involved analyses of existing express bus service in the Southfield/Jeffries corridor, demand estimates and sensitivities, and requirements for new construction. These analyses, including the results of some preliminary iterations, are described in this final report. In addition to the system design rationale, discussion of physical design and construction requirements, demand estimates, system sizing and cost, and cost revenue considerations are presented. An overview of the proposed BRT system concept is presented in the following paragraphs.

3.1 Proposed BRT System

The objective of the BRT system is to substantially improve the quality of bus transit service provided in the Southfield/Jeffries corridor to destinations in the Detroit CBD and New Center by utilizing a reserved bus lane on the Jeffries Freeway and other treatments on other high-speed links. In peak periods, each BRT route consists of three segments: collection, line-haul, and distribution. The first segment involves local collection in which the BRT bus interfaces with park-and-ride lots, feeder buses, and local bus stops along the route. As illustrated in Figure 1, BRT collection routes are designated on each of the "mile" roads in Detroit from Eight Mile Road to Joy Road. In Oakland County, collection buses originate at various park-and-ride lots. In general, BRT collection buses which originate west of Southfield are routed onto the Southfield Freeway, where they operate in mixed traffic to the Jeffries Freeway. At the Jeffries Freeway, BRT buses weave across to the median lane of the inner roadway, which is reserved exclusively for BRT vehicles. Additional BRT collection buses originate east of Southfield on each of the mile roads in Detroit. These buses travel east on the mile roads and eventually enter the Jeffries reserved bus lane via an exclusive bus entrance ramp at Wyoming. All BRT buses make an intermediate stop at Wyoming to discharge New Center transfer patrons. Frequent service to the New Center is provided by New Center shuttle buses which operate between the Wyoming transfer station and the New Center. Figure 1 indicates the number of buses which operate on the various BRT collection routes in the morning peak hour.

The line-haul portions of the BRT routes utilize the Southfield Freeway and the reserved bus lane on the Jeffries Freeway. In order to minimize the need for buses to weave across lanes of freeway traffic, exclusive bus access ramps are proposed for three locations. In addition to the proposed ramp from Wyoming to the reserved lane of the Jeffries Freeway mentioned earlier, a ramp from the reserved lane to Scotten is proposed to provide access to the New Center. The third construction project which is proposed in order to minimize weaving and to give buses priority involves the southeast terminus of the exclusive bus lane. It is proposed that the exclusive bus lanes on the Jeffries be extended on the Fisher Freeway to Third Street by using the median of the Fisher Freeway as exclusive bus lanes. A bus-only exit ramp at Third Street which permits buses to exit the reserved median lane without weaving is proposed.

The final segment of the inbound BRT trip is distribution in the CBD or New Center. Generally, distribution routes have been proposed to serve both of these areas in an efficient manner, and they are generally characterized by mixed-traffic operation on one-way streets. BRT vehicles enter the CBD distribution loop by proceeding down Grand River after exiting the Fisher Freeway via the exclusive bus ramp at Third Street. Before the Third Street ramp is completed, BRT vehicles will enter/exit the CBD loop via Michigan Avenue. A temporary link will be added on Park Place between Michigan Avenue and Grand River to accommodate the Michigan Avenue entry. As the demand in the CBD shifts, for example when the Renaissance Center opens, the route can be restructured to serve new demand patterns.

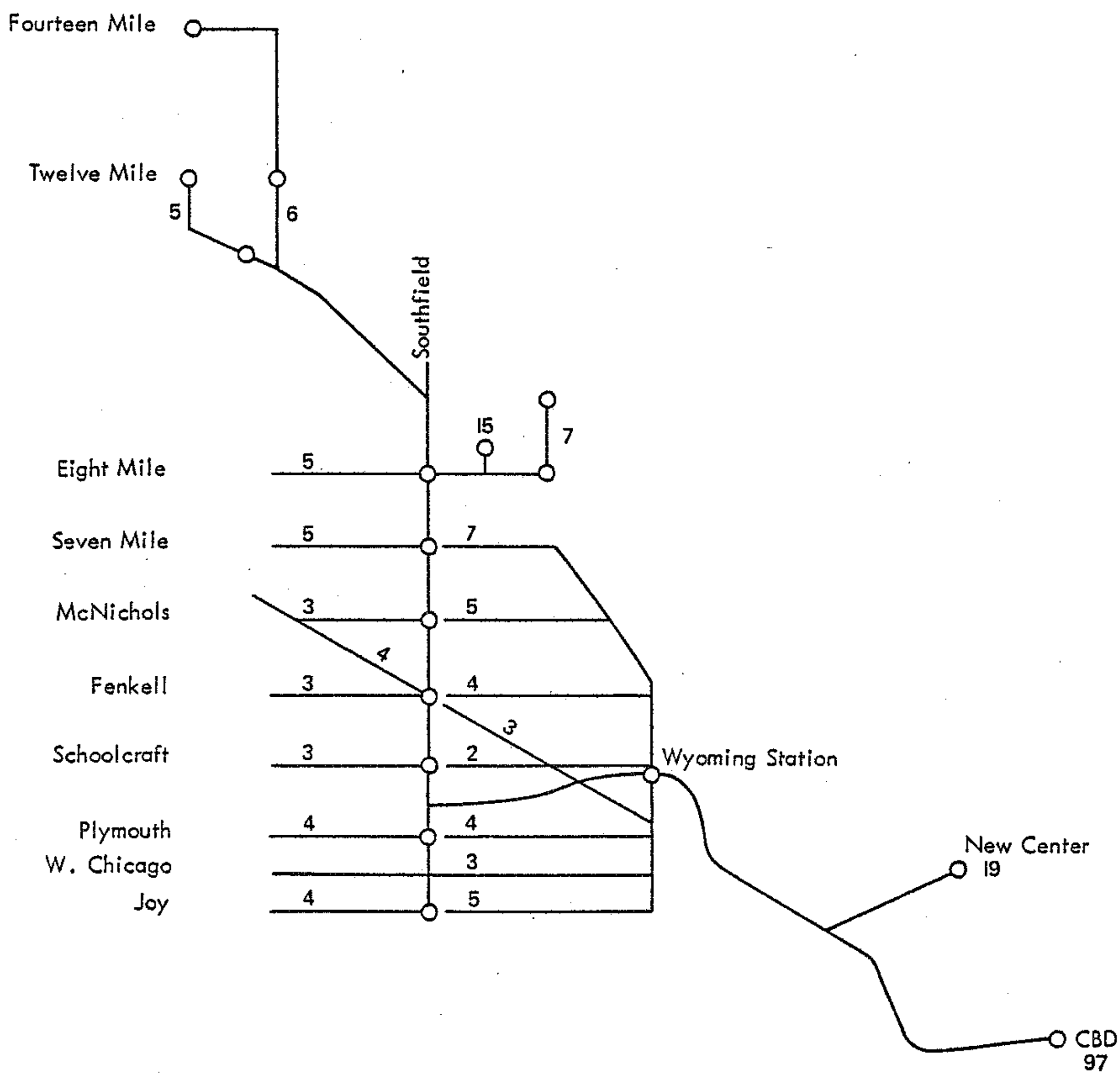

Figure 1 Number of BRT Peak-Hour Bus Trips by Route

The New Center distribution route is structured to provide convenient service to major trip attractors in the New Center, midtown area. New Center shuttle buses exit the Jeffries exclusive lane at the Scotten bus ramp and proceed east on Grand Boulevard to access the distribution route. The buses run in mixed traffic and on one-way streets where possible.

As indicated in Figure 1, a total of 97 buses use the CBD distribution loop, and 19 buses operate on the New Center route in the peak hour.

The need for local feeder service to the BRT system in Detroit during peak periods is minimized by the 1-mile spacing of BRT collection routes. However, local buses in Detroit, especially those operating on north-south streets, are assumed to provide any additional feeder service. The local bus service presently provided in Oakland County is quite limited, and the proposed BRT collection routes interface with only a small number of park-and-ride lots. Therefore, a need does exist for feeder service to the BRT system in Oakland County. To satisfy this need, a local bus system operating on the mile roads from Ten Mile to Fifteen Mile and focused on Northland Center is proposed.

In order to provide a reasonable transit alternative to BRT patrons who must return home during off-peak periods, limited BRT line-haul service is proposed for the period between the morning and evening peak periods and for a few hours after the evening peak. During off-peak periods, it is proposed that BRT vehicles complete the CBD Distribution Loop and then follow a modified Imperial Express route. The route utilizes the Jeffries reserved bus lane from the CBD to Wyoming, runs north on Wyoming to James Couzens, follows James Couzens to the Northland bus terminal and then back to Greenfield, runs south on Greenfield to Seven Mile, and then follows Seven Mile Road across the corridor. The New Center Shuttle should also operate between the New Center and the Wyoming transfer point during off-peak periods.

It should be apparent from this description of the operation of the proposed BRT system that the intersection of Wyoming and the Jeffries Freeway is the focal point of the BRT system. All BRT buses which do not enter the Jeffries reserved lane at Southfield do so at Wyoming. In addition, this area is a vital link in the BRT service to the New Center. With few exceptions, the demand for New Center service along each of the BRT collection routes is insufficient to support New Center express service at less than 30-minute headways during the peak hour. An alternative to long headways for New Center service is to require a transfer from CBD-bound collection buses, which run at relatively short headways, to New Center buses. The headway of these New Center buses is minimized by consolidating the New Center demand at a single transfer point--Wyoming. Therefore, the proposed BRT system includes construction of a passenger transfer station at Wyoming, which is integrated with the entrance/exit ramps to the Jeffries reserved bus lanes. The proposed transfer station, illustrated in Figure 2, is located at surface-street grade over the median of the Jeffries Freeway west of the Wyoming bridge. Bus access to the station, and subsequently to the exclusive bus lane, is provided from the service drive. In addition, exclusive ramps are provided from the reserved lanes on the freeway to the Wyoming Station to accommodate intermediate stops. Due to the volume of buses, the station is used only by inbound buses in the morning peak period and by outbound buses in the evening peak.

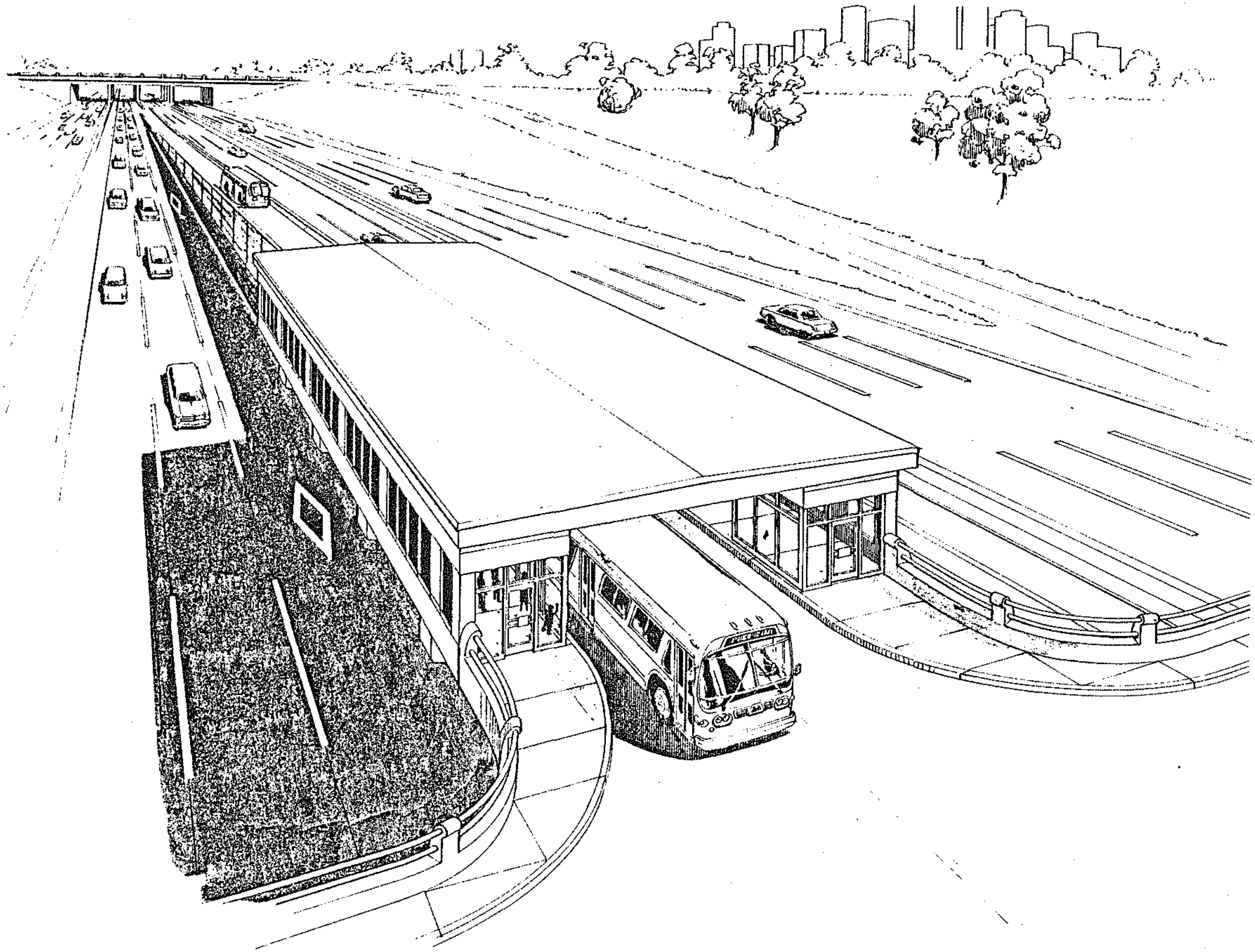

Figure 2 Proposed BRT Transfer Station at Wyoming

Figure 2 illustrates how the station would be used during the evening peak period. Since two lanes are provided in the station itself, it can be used by both inbound and outbound buses during off-peak periods provided the number of buses involved is small and ramp signals facilitate the safe use of the one-lane ramps.

3.2 Proposed Intermediate Service in the Southfield/Greenfield Corridor

The potential transit demand in the Southfield/Greenfield corridor, as estimated in Stage I, is not sufficient to support the nonstop (or one-stop) BRT service envisioned for the Southfield/Jeffries corridor. An intermediate stopping service is therefore proposed to provide improved transit service in the corridor.

The objective of the Intermediate Service is to provide a higher level of service in the Southfield/Greenfield corridor than is currently being provided by local buses, with a system that can be deployed quickly and with low capital investment.

The system which is proposed to satisfy this objective is an intermediate-level bus service operating on Greenfield Road between Southfield and Dearborn. The system is designed to provide improved travel time for relatively long transit trips (2 miles or more) by stopping only at major cross-streets and by operating with traffic signal pre-emption. The proposed system operates at constant 12-minute headways throughout the day from 7:00 a.m. to 9:00 p.m. During periods of peak work trip demand (7:00 to 10:00 a.m. and 3:00 to 6:00 p.m.), the route is configured so that direct distribution service is provided to employment sites in Dearborn and in Southfield along Northwestern Highway. A schematic representation of this route, showing stop locations, is shown in Figure 3. In addition, a shuttle bus operating at 15- to 20-minute headways between Fairlane Town Center and the Ford Rouge Plant is proposed. During off-peak periods, Southfield and Dearborn Distribution Routes are eliminated, and the Intermediate Service operates between Northland and Fairlane. Access to the Northland terminal is provided by the Oakland County Feeder System. The existing DDOT local bus system is assumed to provide feeder service to the line-haul portion of the Intermediate line. Off-peak access to the Fairlane terminal from Dearborn employment sites is provided by a proposed Dearborn Shuttle which operates on a headway of about 35 minutes.

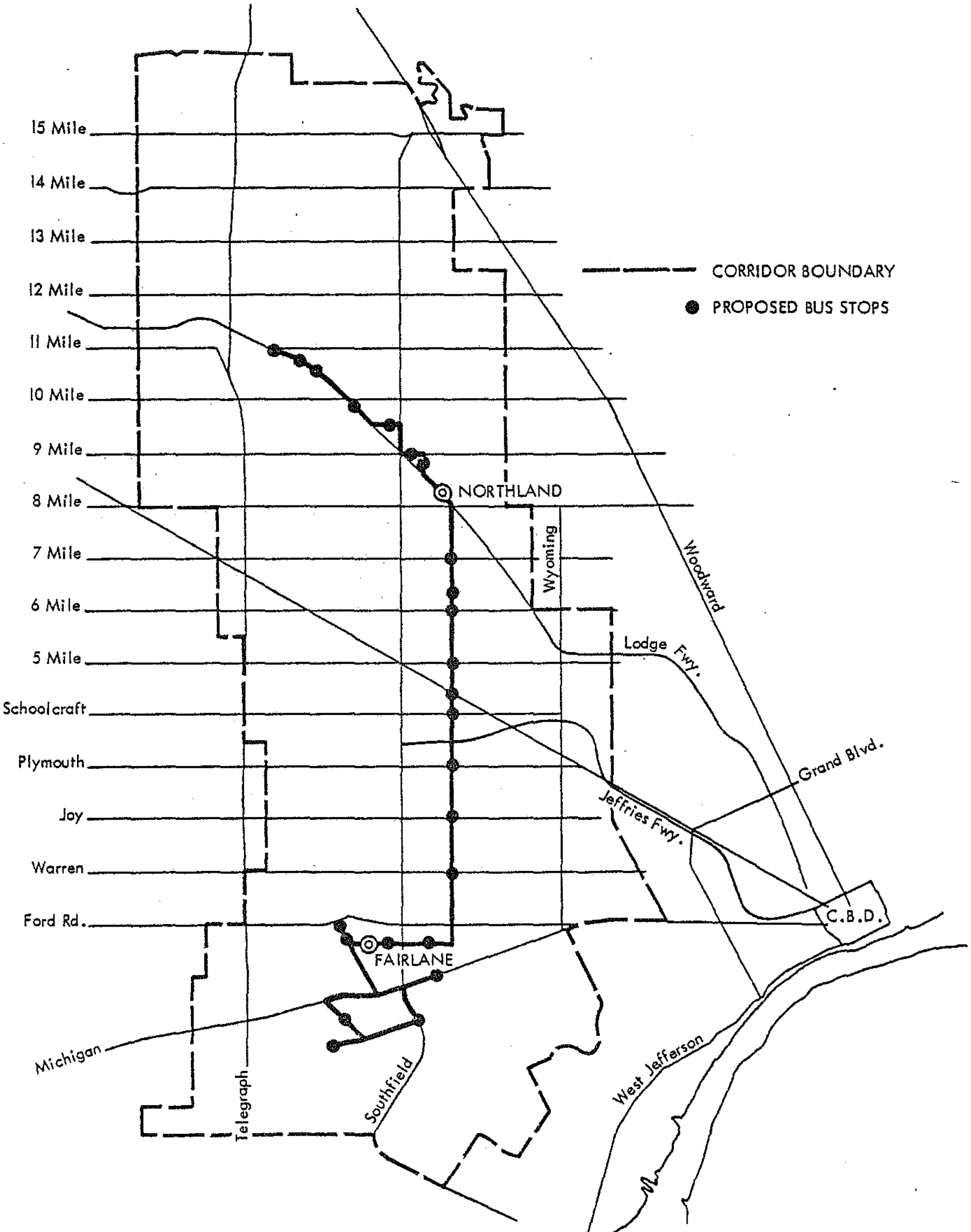

Figure 3 Schematic of Greenfield Intermediate Service Route

4.0 STAGE I EFFORT

4.1 Scope

Basically, Stage I includes the development of demand data; alternative treatment and route selection; BRT route structuring including collection, stops, and distribution functions; a limited modal split analysis; system sizing; and preliminary cost estimates. Demand data was obtained from the TALUS 1965 base and the Southfield Patronage Ridership Study. An O/D matrix was then developed to accommodate production and major attraction zones within the designated corridor. Alternative bus treatments were postulated for Greenfield and Southfield routes. The most viable treatment for each route was determined, after which the more promising route of the two was selected.

To accommodate the objectives of Stage I, the priority lane treatment on the Jeffries Freeway was accepted as described in SEMTA's Feasibility Study of Reserved Bus-Carpool Lanes for Jeffries Freeway. It was assumed, however, that the Jeffries Freeway would be completed west to the Southfield Freeway interchange in 1976, as scheduled. Distribution loops identified for the CBD and New Center area in Phase I are applicable for Stage I. Distribution in Southfield and Dearborn, however, were re-evaluated and tailored to corridor demand. The modal split analysis which was applied to Phase I corridors was applied to the Stage I corridor, utilizing appropriate income and travel time inputs. The resulting potential BRT ridership figures provided the base for system sizing and first-order cost estimates.

4.2 Development of Data

Corridor Definition - Three basic corridors were delineated:

- Southfield/Jeffries to the Detroit CBD and New Center area
- Southfield to the Dearborn area
- Southfield/Jeffries northbound to the Southfield area

Each of these corridors is based on the Jeffries Freeway being completed westward to its intersection with the Southfield Freeway. To account for the opening up of additional commuting areas when the Jeffries is extended westward beyond the Southfield Freeway, each of the three basic corridors was expanded westward. This gave a total of six corridors used in the study--three basic configurations, plus a westerly extension of each.

Travel Demand Data - Using the travel matrix obtained from the 1965 TALUS survey data, corrections for 1975 population estimates and travel data developed in a recent Southfield transit alternatives study[1], a total corridor travel demand matrix was

[1] "A Study of Public Transit Alternatives for the City of Southfield, Michigan," by Goodell, Grivas & Associates, Inc., and Barton-Aschman Associates, Inc., May 1975.

developed. Analysis showed that the peak three-hour period for travel to the CBD and New Center from origins in the corridor is 7:00 a.m. to 10:00 a.m. The major demand is to the CBD and New Center area, and this represents about 21,000 peak-period trips.

4.3 Greenfield/Southfield Alternative Routes

Alternative implementations were evaluated for the north-south extension of the corridor on Greenfield and on Southfield. For these evaluations, Greenfield was divided into northern, middle, and southern sections, and Southfield was considered in two sections--Southfield Road and Southfield Freeway. The physical characteristics, traffic patterns, traffic volumes, and average speeds were determined for each section.

A total of 63 alternative implementations were considered for the Southfield/Greenfield corridor. These included various combinations of free-flow with or without traffic signal control (progression or pre-emption) and reserved lane operation with or without signal control. Evaluations were made on the basis of five factors: effect on other traffic in the corridor, estimated BRT speed, dependability of BRT speed, ease or cost of implementation, and safety.

The recommended treatment for Greenfield was for BRT buses to operate free-flow in mixed traffic in all three sections, with existing traffic signal progression in the northern section and new signal progression in the middle and southern sections.

For the SouthfieldRoad/Southfield Freeway alternative, the Stage I recommended treatment was to operate free-flow in mixed traffic on Southfield Road between 14 Mile and 9 Mile Roads, using the existing signal progression, and to widen Southfield Road to seven lanes north of 10 Mile Road, per existing plans of the Oakland County Road Commission. On the Southfield Freeway, south of 9 Mile Road, BRT buses would operate free flow in mixed traffic.

4.4 Route Selection

Evaluation of the best alternative treatments of Southfield and Greenfield resulted in the selection of Southfield Road/Southfield Freeway for the north-south BRT line-haul segment. This selection was based on vehicle speed, compatibility with possible future implementation of a freeway flow control-metered access ramp system (i.e., SCANDI), and easier access to the reserved lanes on the Jeffries Freeway.

4.5 Modal Split Analysis*

Analysis of travel times was made for typical total trips by car, existing express bus, existing local bus, and proposed BRT service. Based on these travel times and demographic data, a limited modal split analysis, based on the set of 80 Peat, Marwick, Mitchell diversion curves, was performed. A mode split to transit of 46.2 percent was estimated for the CBD and New Center demand. The analysis resulted in an estimated 9,646 peak-period BRT trips to the CBD and New Center. However, only about 800 trips to Dearborn and about 500 to Southfield are indicated. This leads to the conclusion that non-stop BRT service to Dearborn and Southfield is not practical.

4.6 System Sizing*

Based on the estimated BRT demand at each node, a simple scheduling system, travel speeds, and other factors, bus requirements for providing service to the CBD and New Center were determined. The BRT system to serve the CBD and New Center requires 164 buses to make 238 bus trips to haul 9,646 passengers each way. It was also estimated that 30 vehicles are needed to provide the Dial-a-Bus feeder service in the Oakland County part of the corridor. An estimated 3,008 parking spaces in park-and-ride lots are also needed.

4.7 Cost Estimates

Total capital costs, annualized capital costs, and annual operating costs were estimated for the BRT and feeder systems. All costs are summarized as follows:

Corridor	System Cost Elements (Thousands of Dollars)			
	Capital	Annualized Capital	Annual Operating	Annual Total
East Jefferson	17,084	2,224	4,489	6,713
I-94/Crosstown	29,465	3,802	7,468	11,270
Lodge	30,467	3,906	7,955	11,861
Michigan/I-94	17,602	2,261	4,849	7,110
Southfield/ Jeffries	16,848	2,167	4,703	6,870

* These Stage I analysis results, including costs, were revised during Stage II.

5.0 CORRIDOR COMPARISONS

A summary of pertinent characteristics of the BRT system in the Southfield/Jeffries corridor is shown below, along with the same characteristics of BRT systems for the four corridors studied in Phase I.

Corridor Comparison

Corridor	Total BRT Demand (a.m. Peak Period)	Travel Time Ratio BRT/Auto	BRT Cost/Peak Period Passenger Trip (Excluding Feeder)
East Jefferson	9,774	1.36	1.10
I-94/Crosstown	20,585	1.21	0.91
Lodge	17,698	1.26	0.97
Michigan/I-94	9,542	1.24	1.01
Southfield/Jeffries	9,646	1.28	1.21

6.0 STAGE II EFFORT

6.1 Scope

After review of Stage I results, it was decided that the Stage II effort was to continue as a preliminary design program, but certain specific work items were to be emphasized or added:

- Evaluation of five alternatives regarding routing and intermediate stops on Southfield Freeway and Greenfield for both CBD/New Center and Southfield/Greenfield service
- Evaluation of the effects of intermediate stops on BRT performance and ridership
- Further analysis and design of capital facilities necessary for BRT implementation

Although it was concluded from Stage I results that the potential demand to the Dearborn area was too low to justify non-stop (or few-stop) service, the SEMTA 1990 plan calls for intermediate service in this corridor. Consequently, it was decided to include the preliminary design of such service in the Stage II program. This decision had the effect of expanding the Stage II objectives from a straight BRT route design to a system design involving BRT service plus an intermediate-level line between Dearborn and Southfield.

With this decision, the MDSH&T re-directed the Stage II work to include a new evaluation of alternative route and stopping policies. This evaluation was performed, and the resulting recommendations are to:

- Provide the BRT non-stop service on Southfield
- Provide the intermediate level service on Greenfield with stops about 1 mile apart
- Extend the intermediate service on Greenfield to the Fairlane Center in Dearborn

Other major efforts in Stage II were:

- Detailed analyses on the integration of existing express bus service in the corridor
- Design of feeder service, park-and-ride capability, and routes in Oakland County
- Cost analysis and fare sensitivity
- Development of an improved and integrated computer program for demand estimation; based on the use of diversion curves, origin-destination data, and travel time calculations

Preliminary design of the Greenfield intermediate level service was accomplished, including selection of traffic-signal pre-emption as the bus priority method, design of distribution loops in Southfield and Dearborn, and system sizing and cost estimates. The Greenfield intermediate service is considered independent of the BRT system serving the New Center and CBD. The major interface between the two is the Northland terminal in Southfield; other interfaces exist where the Greenfield intermediate line intersects BRT collection routes at the mile roads.

6.2 Demand Analysis Program

During Phase I and IA, ridership estimates were employed in the evaluation of service alternatives and in a preliminary system sizing. A series of modal split computer programs evolved to meet the needs for such analyses. The programs, however, were limited in their versatility and in the levels of detail and accuracy with which trips could be modeled. A refined corridor analysis package, designed to overcome many of the limitations associated with the programs used earlier in the project, has been developed. Prominent features of the new package include:

Network Definition - Instead of defining a single route for both auto and travel alternatives, the program user specifies two completely independent networks, each with a node list and a link list describing the node connectivity and link speed and/or time delays.

Route Assignment - Auto and transit routes can be modeled separately and in a more sophisticated manner.

Travel Mode Comparison - The program allows an automobile trip to be compared with up to six transit modes.

Program Outputs - The refined BRT program reads a variety of corridor definition data and run control parameters, determines the characteristics of travel by each mode for every O/D zone pair, applies the mode choice model to the corridor trip matrix, compiles a summary of the corridor analysis results, and produces a data file for subsequent output on a high-speed line printer.

6.3 BRT System

Section 3.0 of this Executive Summary describes the structure of the proposed BRT operation. Some aspects of the design process which led to the proposed BRT system are described below.

Integration of Existing Services

The purpose of the service integration task was to determine the recommended route structure for BRT collection, line-haul, and additional feeder service within the framework of the existing bus service in the corridor. The objective, of course, was to integrate the existing service with the proposed BRT service to the greatest extent possible.

For the most part, DDOT operates the routes south of Eight Mile Road while SEMTA operates those north of Eight Mile. The express routes are the prime candidates in the corridor for integration into the BRT system. In some cases, local buses can serve as feeders to the BRT collection routes. The following table shows the 10 DDOT express bus services operating in the corridor and the number of trips to the CBD in the a.m. peak period. No SEMTA service to the CBD is included because substantial portions of the SEMTA routes lie outside the corridor, and they serve several intermediate destinations in addition to the Detroit CBD.

DDOT Express Service in BRT Corridor

Route	Number of Trips A.M. Peak Period
Grand River Red Express	22
Grand River Blue Express	10
7 Mile Imperial Express	23
7 Mile Hamilton Express	6
6 Mile Second Avenue Express	4
Fenkell Express (5 Mile Road)	11
Schoolcraft (4 Mile Road)	3
Plymouth (3 Mile Road)	7
Chicago Davison (2 1/2 Mile Road)	3
Joy (2 Mile Road)	12
Total	101

BRT System Synthesis

Currently, there are no formalized park-and-ride facilities coordinated with the present express bus service in Detroit. Due to the relatively close spacing of BRT collection routes and the availability of adequate feeder service in Detroit, neither the availability of nor the demand for park-and-ride facilities within Detroit have been addressed in this study. In Oakland County, it is expected that most patrons will access the BRT system by automobile at designated park-and-ride facilities. A list of existing parking lots in Oakland County which offer some potential for use as park-and-ride facilities was presented in the Jeffries report published by SEMTA. From these and other potential sites, seven existing lots were selected as BRT park-and-ride facilities.

It was deemed necessary to provide a feeder system in Oakland County although it is expected that park-and-ride will be the dominant BRT access mode. It was decided that a local bus system with Northland as its focal point would feed the BRT system. The postulated feeder system consists of routes running across the corridor on each of the east-west mile roads and then south using both Southfield and Greenfield to access Northland. In order to evaluate the postulated feeder system, the potential demand for the system as a feeder service to the BRT was estimated.

In Stage I a dial-a-ride system was proposed to provide feeder service in Oakland County. However, it is not obvious that the high level of feeder service can be justified in an area which is characterized by an apparent lack of transit dependence and absence of potential feeder service demand. Therefore, the limited fixed-route feeder system, which requires 17 buses in the peak period, is recommended in lieu of the more pervasive DAR system, which requires about 30 buses.

The Wyoming Transfer Station is a vital element in the BRT system concept. It provides access from Wyoming to the reserved bus lane on the Jeffries for more than half the BRT vehicles in the system. It provides the flexibility necessary to serve the New Center area with high quality BRT service. In general, the station is a relatively well-isolated structure located at surface street grade over the median of the Jeffries Freeway with bus-only access ramps to and from the Service Drives and the Jeffries reserved bus lanes.

Two alternative types of New Center service were evaluated during the BRT system design process. The first type is similar to the concept proposed in Stage I. New Center and line-haul buses operate on the same routes and in parallel with the CBD service, providing direct, no-transfer service to the New Center. In the second alternative, all New Center passengers transfer to New Center shuttle buses which operate only between the Wyoming station and the New Center. The second alternative is proposed for the BRT system since peak-period service comparable to that provided by the first alternative (except for the required transfer) can be provided, with a saving of nearly 10 percent in the number of buses required and a saving of about 5 percent in the number of bus operating hours and operating miles per day.

Physical Design

During the physical design effort of the BRT program, the freeway lane on the Jeffries to be dedicated to exclusive use by BRT vehicles was selected,and exclusive access facilities for BRT vehicles were studied. Initially, it was felt that exclusive BRT access ramps to the exclusive median lanes from the overpasses at Greenfield, Schaefer, Wyoming, Livernois, and Scotten/Grand Boulevard would be desirable. However, it became evident that often there are physical constraints affecting construction of the ramps, and a considerable expense would be incurred if the ramps were constructed.

These and other proposed capital improvements for the BRT system were designated the responsibility of the MDSH&T. Drawings and cost estimates for several capital improvements were prepared by the MDSH&T. The following capital improvements are proposed for the final BRT system:

- Southfield Freeway/Eight Mile Road Proposed Exclusive Bus Ramp
- Wyoming Transfer Station
- Scotten Overpass
- Southeast Terminus of the Jeffries Freeway

BRT Demand Estimates

Following the synthesis of a BRT service concept for the Southfield/Jeffries corridor, the potential ridership of that system was evaluated. The evaluation process consisted of two parts:

- The total "pool" of trips from which BRT riders could be attracted was estimated.
- The portion of all trips which could potentially be diverted to BRT from other modes was then predicted.

The "pool" of trips was generated using the TALUS survey data, modified by population ratios (1975 to 1965) to more closely represent 1975 travel. The diversion to BRT was estimated using the diversion curves which were also used to predict demand for the 1990 Regional Transportation Plan.

BRT System Sizing

The number of buses required to provide BRT service on each collection route during the morning peak-period was determined, using a very simple bus scheduling process. In the scheduling process, buses are assigned to particular routes and are not re-assigned to other routes during the peak period. Although it is recognized that certain economies in the number of buses required for the system can probably be achieved by assigning buses to alternate routes for subsequent trips during the peak period, bus scheduling at this level of detail was not attempted.

The following table summarizes the total number of trips and buses required to satisfy the estimated BRT demand. As indicated in the table, the difference between the total number of buses required for the BRT system (151) and the number of buses currently in express service (65) is the number of additional buses required to provide BRT service. The number in parentheses in the last column of the table is the total number of BRT vehicles required including a 7 percent maintenance float to account for buses which may be out of service.

Southfield/Jeffries Peak-Period BRT Bus Requirements

	BRT Demand	No. of Bus Trips	No. of BRT Buses
BRT Collection	9584	204	132
New Center Shuttle	2088	41	19
Subtotal			151
Existing Express Service to be Integrated		85	65
Net Bus Requirement			86 (92)

The table below summarizes the total number of bus trips and buses required for the Oakland County Feeder System. This proposed feeder system is designed to feed both the BRT system and the Greenfield Intermediate Service and to operate on a policy headway of approximately 20 minutes during peak periods.

Oakland County Feeder System Peak-Period Bus Requirements

Route	A. M. Peak-Period Demand	No. of Bus Trips	No. of Buses
Fifteen Mile	233	9	4
Fourteen Mile	98	8	3
Thirteen Mile	216	9	3
Twelve Mile	263	9	3
Eleven Mile	71	8	2
Ten Mile	119	9	2
Total	1000	52	17 (18)

Cost Estimates

Capital and operating costs were estimated for both the BRT system and the Oakland County Feeder System. The following table provides a summary of annual costs for the entire BRT system, including the Oakland County feeders. An 8 percent interest rate was assumed for the annualized capital cost calculations. Also listed are the estimated number of one-way passenger trips per year on the BRT system and the Oakland County feeder system. Based on these demand and cost estimates, the total cost per trip is estimated to be $0.93 for the BRT system, and $0.68 for the Oakland County feeder system.

Summary of Annual Costs of BRT System

	System Cost Elements (Thousands of Dollars)				Annual Person Trips	Average Cost/Trip
	Capital	Annualized Capital	Annual Operating	Annual Total		
BRT System	12,430	1,492	3,261	4,753	5,109,690*	$.93
Oakland County Feeder	1,698	230	819	1,050	1,532,805**	$.68
TOTAL	14,128	1,722	4,080	5,803		

* Includes assumed off-peak demand of 150 passengers/hr during midday period and 60 passengers/hr during the 2-hr period following the evening peak period.

** Includes Greenfield Intermediate Service patrons who use the Oakland County Feeder System.

In addition to these estimated cost and ridership statistics, the values of other BRT cost/performance measures typically used to evaluate public transit systems are presented in the following table:

Measure	Value
Annual Vehicle Trips	132,855
Annual Vehicle Miles	3,618,171
Vehicle Operating Hours	155,883
Average Number of Passengers per Vehicle Trip	38.46
Average Number of Passengers per Vehicle Mile	1.41
Average Number of Passengers per Vehicle Hour	32.78
Total Annualized Cost per Vehicle Mile	$1.31
Total Annualized Cost per Vehicle Hour	$30.49
Total Annualized Cost per Seat Mile	$.025
Operating Cost per Vehicle Mile	$.90
Operating Cost per Vehicle Hour	$20.92
Operating Cost per Seat Mile	$.017
Operating Cost per Passenger	$.638

Cost/Revenue Analysis

Estimates of revenues are compared to BRT costs, both variable and fixed. The objective of this analysis is to compare revenues and costs for various fare structures to supply administrators with guidelines for selecting fare policies. Although the effect of raising fares is to decrease demand, costs were determined assuming a constant demand. Since the changes in demand were less than 5 percent, the effect on system sizing and costs is felt to be negligible. This assumption may not hold true at Northland, where the volume of passengers may be sufficiently large to be affected by a 5 percent change in demand. However, changes in overall system costs are expected to be small.

Travel Time Savings

The BRT system results in significant travel time improvement over existing local and express bus service. On the average, CBD-bound passengers who access the BRT system in Detroit west of Southfield can save more than 14 minutes over existing express bus service, and those who access the BRT system east of Southfield in Detroit can save more than three minutes. The following table summarizes the calculated travel time savings over existing express buses for each BRT route for trips to the Detroit CBD. DDOT bus schedules were used to determine express bus travel times while BRT travel speed and delay estimates were used to calculate BRT travel times.

Calculated BRT Travel Time Savings over Existing Express Bus

BRT Route	Calculated Time Savings Over Existing Bus Schedules to the CBD (Minutes)
Seven Mile, West of Southfield	13-14
Seven Mile, East of Southfield	1
McNichols, West of Southfield	19
McNichols, East of Southfield	6- 7
Fenkell, West of Southfield	19
Fenkell, East of Southfield	7- 8
Grand River, West of Southfield	5- 6
Grand River, East of Southfield	-3 (0) *
Schoolcraft, West of Southfield	16
Schoolcraft, East of Southfield	11
Joy Road, West of Southfield	14-15
Joy Road, East of Southfield	1
West Chicago	2- 3
Plymouth, West of Southfield	12-13
Plymouth, East of Southfield	2

* The existing Red Express enters the Jeffries at Schaefer. The recommended BRT route continues on Grand River to Wyoming. With this routing, the trip time of BRT patrons between Southfield and Schaefer increases relative to existing Red Express service, while BRT patrons between Schaefer and Wyoming save time relative to existing Blue Express service. If the BRT bus were routed along the Jeffries Service Drive from Schaefer to Wyoming rather than on Grand River, the trip time for patrons between Southfield and Schaefer would remain the same. Patrons along Grand River between Schaefer and Wyoming would continue to be served by the existing Blue Express.

6.4 Intermediate Service in the Southfield/Greenfield Corridor

A discussion of the structure of the Intermediate Service in the Southfield/Greenfield corridor has been given in Section 3.0 of this Executive Summary. Other aspects of this Intermediate Service, such as the evaluation of alternative routes and implementations, corridor demand analysis (including consideration of potential demand for Fairlane), and system cost estimates, are discussed briefly in the following paragraphs.

System Synthesis

Two alternative line-haul routes, one using Southfield and the other using Greenfield, were considered for the Intermediate Service. It was concluded that the best Intermediate Service implementation alternative for Southfield is the one recommended in Stage I involving mixed traffic operation with the existing signal progression system in Oakland County and mixed traffic operation without special priority on the freeway. The best alternative implementation for the Greenfield route is also similar to the one recommended in Stage I. The route is the same as the Southfield alternative north of Eight Mile but follows Greenfield instead of Southfield Freeway in Detroit. The implementation alternative recommended for the Greenfield portion of the route is mixed traffic operation with traffic signal pre-emption.

Consideration of the various evaluation factors did not result in identification of a clearly superior alternative. However, primarily because the Southfield alternative does not offer a significant speed advantage and because more frequent transit service is currently provided on Greenfield, the Greenfield alternative was selected for further design of the Intermediate Service.

Demand Estimates

The demand estimation process for the proposed intermediate-level service in the Greenfield corridor was quite similar to the BRT demand estimation effort. In estimating ridership, the trips were "screened" to eliminate any transit trips having less than two miles of travel on line-haul network links; it is assumed that such trips are taken by local bus.

The demand estimates presented are based on 1965 TALUS Survey data projected to 1975 on the basis of population changes only. They do not include the effects of new trip attractors such as the Fairlane Complex. Therefore, an attempt was made to determine the demand characteristics from the Southfield-Greenfield corridor to Fairlane including shopping as well as work trips.

System Sizing and Cost Estimates

Capital and operating costs were estimated for the Greenfield Intermediate Service using the same unit costs as were used for the BRT system, where applicable. The following table is a summary of estimated capital and operating costs. The table also shows the estimated number of annual person trips on the system. This number includes the morning and evening peak-period demand and the off-peak demand assuming the average hourly midday demand is sustained during the periods from 10:00 a.m. to 3:00 p.m. and from 6:00 p.m. to 9:00 p.m. Weekday operation (255 days per year) is assumed for both operating cost and annual demand calculations. The total system cost and demand estimates result in an estimated average cost per line-haul trip of $0.58.

Summary of Annual Costs - Greenfield Intermediate Service

System Cost Elements (Thousands of Dollars)				Annual Person Trips	Average Cost/Trip
Capital	Annualized Capital	Annual Operating	Annual Total		
1,440	197	711	908	1,562,130	$.58

7.0 STAGED IMPLEMENTATION

The goals of the proposed staged implementation plan are:

- High probability of initial success
- Provide service to areas presently with little or no transit
- Establish transit identity of BRT system early in system operation
- Lower BRT trip times than a similar trip on existing transit

The following table summarizes the proposed three-stage implementation plan for BRT and Greenfield Intermediate Service.

STAGE I (3 - 6 Months)	STAGE II (Approx. 1 Year)	STAGE III
• Bus Procurement • Begin major construction - Wyoming transfer station - Jeffries SE terminus - Scotten ramp • ROW modifications - Jeffries - Signing - Pavement markings • Negotiate for P&R lots - Stripe & sign when available • Begin BRT service from P&R lot at Lahser & Northwestern Highway - CBD only • Divert Imperial Express buses originating west of Southfield to BRT facility • Greenfield Line - Begin service Northland to Dearborn - Distribution routes during peak periods - Shuttles off-peak	• Decide between route Alternative I (Southfield) and Alternative II (Lodge) - If Alternative I is chosen, construct Northland exit ramp • Implement service from all Oakland County P&R lots • One P&R lot to provide both CBD & NC service • Implement Oakland County feeder service • Express buses on existing routes west of Southfield Freeway diverted to BRT facilities - CBD only buses exit at Myrtle - New Center transfer service buses exit at Grand Blvd. then proceed to CBD via Grand River - New express, as needed, started on existing routes at Southfield - East of Southfield buses follow existing routes	• Wyoming transfer station completed & phased into operation • Scotten ramp & SE terminus ramp completed & phased into operation (these ramps phased in when complete--can be Stage II) • New Center shuttle buses from Wyoming station begin operation • New Center distribution loop implemented - Kirby made one-way • Express service started on Eight Mile Road • Express buses, east of the Southfield Freeway, enter BRT system via Wyoming - All BRT buses go to CBD - New Center access via shuttle from Wyoming station - All BRT buses stop at Wyoming station

1.0 INTRODUCTION

The main objective of the Southfield/Greenfield Corridor Extension of the Jeffries Bus Lane project was to produce feasible preliminary engineering and operating plans for a Bus Rapid Transit (BRT) system in the corridor. Two alternative routes within the corridor were to be considered; the Southfield Freeway (M-39) and Greenfield Road. Alternative priority treatments were to be evaluated for each of the two routes. The most viable route and treatment were then to be selected and carried through preliminary engineering design. An additional objective of the program was to provide a plan for service between the Southfield area and the Dearborn area.

At the onset of the program, it was deemed desirable to first determine the BRT potential of the extended corridor to a level of detail consistent with those corridors analyzed in the Phase I effort (Michigan Bus Rapid Transit Demonstration Program, Phase I, May 1975). This approach would allow candidate corridors to be compared on an equal basis to determine the most promising corridor for a BRT demonstration project. The task was designated as Stage I.

This final report summarizes all major activities conducted during the course of the entire program. The report has been structured into Stage I and Stage II sections for clarity. An appendix is included which summarizes planning and design guidelines for efficient bus use of urban highway facilities. The summary was prepared as part of the contract effort to serve as an aid to evaluating alternative BRT implementations.

1.1 Stage I

Basically, Stage I included the development of demand data; alternative treatment and route selection; BRT route structuring including collection, stops, and distribution functions; a limited modal split analysis; system sizing; and preliminary cost estimates. Demand data was obtained from the TALUS 1965 base (updated by 1975 population estimates) and the Southfield Patronage Ridership Study. An O/D matrix was developed to accommodate major production and attraction zones within the designated corridor. Alternative bus treatments were postulated for Greenfield and Southfield routes. The most viable treatment for each route was determined, after which the most promising route of the two was selected.

The results of the Stage I effort indicated that the Southfield/Jeffries corridor was not the most promising from a ridership potential standpoint. However, there were significant reasons for continuing the Southfield/Jeffries BRT implementation effort. The Jeffries Freeway is not yet operating at maximum capacity; therefore, the designation of a traffic lane for high-occupancy vehicles would be more readily accepted by the driving public. The need for early implementation was also an important factor favoring the corridor since the Jeffries Freeway basically consists of four or more lanes in each direction obviating the need for major new construction. Another factor was a strong ridership on several existing express bus routes in the area (Imperial and Grand River express routes). Finally, a significant part of the planning was already accomplished through SEMTA's previous work. Therefore, the Stage II effort was directed toward further analysis of corridor characteristics in preparation for implementing the BRT system in the Southfield/Jeffries corridor.

1.2 Stage II

The Stage II work program was restructured, at the conclusion of Stage I, to include a more comprehensive analysis of alternative routes or combinations thereof including Greenfield Road as well as Southfield Road. The alternative route analysis was to be accomplished in the context of providing intermediate stops in conjunction with non-stop service. The following combinations of routes and service types were identified for study in Stage II:

1. Consider intermediate stops on Southfield in conjunction with BRT non-stop service on Southfield and some non-stop service on Greenfield.

2. Consider intermediate stops on Greenfield in conjunction with BRT non-stop service on Southfield and Greenfield.

3. Consider intermediate stops on Southfield and Greenfield in conjunction with BRT non-stop service on Southfield and Greenfield.

4. Consider intermediate stops on Southfield south of the Jeffries interchange.

5. Consider intermediate stops on Greenfield south of the Jeffries interchange.

Midway through Stage II work efforts, it was determined that alternative options two and five above were most promising. The remainder of the Stage II effort, therefore, was based upon that decision.

1.3 BRT as Part of Transportation System Management

It is believed that this preliminary design of Bus Rapid Transit service in the Southfield/Jeffries corridor is directly responsive to one of the pressing transportation needs of the area; namely, the need to assure that full use is being made of existing transportation facilities. The use of existing arterials and freeways for public transit, in efficient systems that are not capital-intensive, is not only a reasonable and prudent objective; it is also a specific requirement of the Urban Mass Transportation Administration (UMTA) for capital funding support. This total approach of maximizing the use of existing equipment and facilities is Transportation System Management (TSM); and this BRT effort is very much in the spirit of TSM.

1.4 BRT and the 1990 Plan

The southeastern Michigan area has developed an overall plan for regional transit services. This plan, based on a 1990 planning target, calls for an array of high, intermediate, and feeder level components. The BRT system reported herein is compatible with the SEMTA 1990 plan in that the Southfield/Jeffries BRT service from northwest Detroit and lower Oakland County to the CBD and New Center can be a precursor to the high level line ultimately to be implemented on the roughly parallel Grand River route. The delays inherent in the approval process, detailed engineering, and staged construction activities for a fixed guideway system such as is planned for the high level component of the 1990 plan suggest that interim service improvements must be considered. The BRT system discussed herein is a relatively low capital system which can provide substantially improved transit service prior to the ultimate implementation of the associated high level system.

The compatibility of this BRT effort with the SEMTA 1990 plan is further reinforced by the inclusion of an intermediate level line on Greenfield between the Northland complex in Oakland County and Dearborn's Fairlane Center. The 1990 plan provides for a north-south intermediate level route in this area.

1.5 Jurisdictional Assumption

In the conduct of this preliminary design effort the tacit assumption was made that all regional bus operations would be integrated, in effect or in fact, into one total system. That is, there would be no legal, administrative, or jurisdictional problems between SEMTA and the Detroit Department of Transportation which would constrain the BRT operational system.

STAGE I

GM Transportation Systems

SOUTHFIELD/GREENFIELD EXTENSION OF THE JEFFRIES BUS LANE STAGE I

GM Transportation Systems

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1.0 INTRODUCTION

The main objective of the Southfield/Greenfield Corridor Extension of the Jeffries Bus Lane project is to produce feasible preliminary engineering and operating plans for a Bus Rapid Transit (BRT) system in this corridor. However, it was deemed desirable at the onset of the program to first determine the BRT potential of the extended corridor to a level of detail consistent with those corridors analyzed in the Phase I effort (Michigan Bus Rapid Transit Demonstration Program, Phase I, May 1975). This approach would allow candidate corridors to be compared on an equal basis to determine the most promising corridor for a BRT demonstration project. The task has been designated as Stage I and is summarized in this report. Seven weeks were allocated for completion.

Basically, Stage I includes the development of demand data; alternative treatment and route selection; BRT route structuring including collection, stops, and distribution functions; a limited modal split analysis; system sizing; and preliminary cost estimates. Demand data was obtained from the TALUS 1965 base and the Southfield Patronage Ridership Study. An O/D matrix was then developed to accommodate major production and attraction zones within the designated corridor. Alternative bus treatments were postulated for Greenfield and Southfield routes. The most viable treatment for each route was determined, after which the most promising route of the two was selected.

To accommodate the objectives of Stage I, the priority lane treatment on the Jeffries Freeway was accepted as described in SEMTA's Feasibility Study of Reserved Bus-Car Pool Lanes for Jeffries Freeway. It was assumed, however, that the Jeffries Freeway would be completed west to the Southfield Freeway interchange in 1976, as scheduled. Distribution loops identified for the CBD and New Center area in Phase I are applicable for Stage I. Distribution in Southfield and Dearborn, however, have been re-evaluated and tailored to corridor demand. The limited modal split analysis applied to Phase I corridors was applied to the Stage I corridor, utilizing appropriate income and travel time inputs. The resulting potential BRT ridership figures provided the base for system sizing and first-order cost estimates.

The results of the Stage I analysis provide insight into the potential of the Southfield/Greenfield/Jeffries corridor for bus rapid transit. This report summarizes the activities leading to those results.

2.0 DEVELOPMENT OF DATA

2.1 Corridor Definition

The information utilized to define each variation of the Southfield/Jeffries corridor includes the following items:

- Origin Traffic Analysis Zone List - These zones constitute the only trip generators considered in evaluating corridor trip volumes. Origins are specified as districts (each containing several zones) where practical; otherwise, individual zones are specified.

- Destination Zone List - These zones define the only trip attractors to be evaluated.

- BRT Route Node List - A series of "nodes" (points in an X-Y coordinate system) define each BRT route to be analyzed.

Three basic variations of the Southfield/Jeffries corridor which are distinguishable in part by the destination areas associated with each have been defined. Six variations, listed below, result when the possibility of a future service extension along the planned Jeffries route west of the Southfield Freeway is considered for each of the three previous cases:

- Southfield/Jeffries to the Detroit CBD and New Center area

- Southfield/Jeffries to the Detroit CBD and New Center area with west Jeffries extension

- Southfield to the Dearborn area

- Southfield to the Dearborn area with west Jeffries extension

- Southfield/Jeffries northbound to the Southfield area

- Southfield/Jeffries northbound to the Southfield area with west Jeffries extension

Origin and destination districts and zones for each of these corridor variations are listed in Table 2-1, and the corridor boundaries are illustrated in Figures 2-1, 2-2, and 2-3.

2.2 Demand Analysis Time Interval

Phase I BRT analyses were based upon morning peak-period travel demand data, with that period defined as 7:00 to 10:00 a.m. The above interval was chosen by examining 1965 TALUS survey data and computing the number of trips originating in TALUS superdistricts

Table 2-1 Definition of Corridor Origins and Destinations

CORRIDOR	ORIGINS*	DESTINATIONS*
Southfield/Jeffries	070-074, 091-097, 210-214, 240, 242, 2032, 2034, 2040, 2041, 2043	0010-0072, 0132, 0133, 0500, 0501, 0521, 0600
Southfield/Jeffries with West Jeffries Extension	070-074, 091-097, 140-146, 210-214, 220-222, 240, 242, 2032, 2034, 2040, 2041, 2043	0010-0072, 0132, 0133, 0500, 0501, 0521, 0600
Southfield	070-074, 091-097, 210-214, 240, 242, 2032, 2034, 2040, 2041, 2043	1212, 1222, 1223, 1260
Southfield with West Jeffries Extension	070-074, 091-097, 140-146, 210-214, 220-222, 240, 242, 2032, 2034, 2040, 2041, 2043	1212, 1222, 1223, 1260
Southfield/Jeffries Northbound	011-014, 035, 051, 053-054, 070-073, 090-094, 097, 120-123, 125, 126, 133	2100, 2101, 2104, 2110, 2111, 2112
Southfield/Jeffries Northbound with West Jeffries Extension	011-014, 035, 051, 053-054, 070-073, 090-094, 097, 120-123, 125, 126, 133, 140, 142, 143, 145, 1410-1413, 1460-1465	2100, 2101, 2104, 2110, 2111, 2112

* Four-digit numbers designate TALUS zones; three-digit numbers identify TALUS districts

GM Transportation Systems

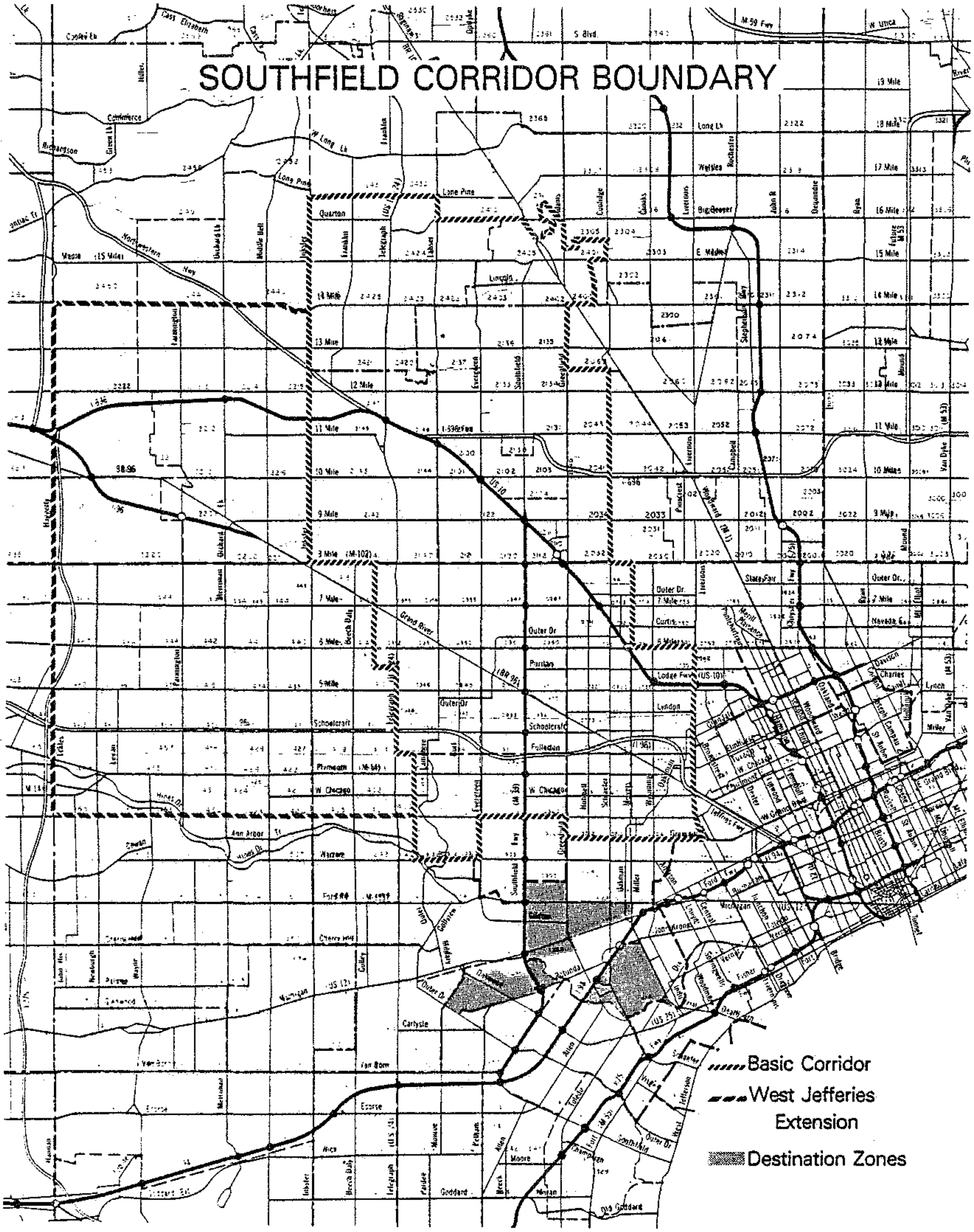

Figure 2-1 Southfield Corridor Boundary

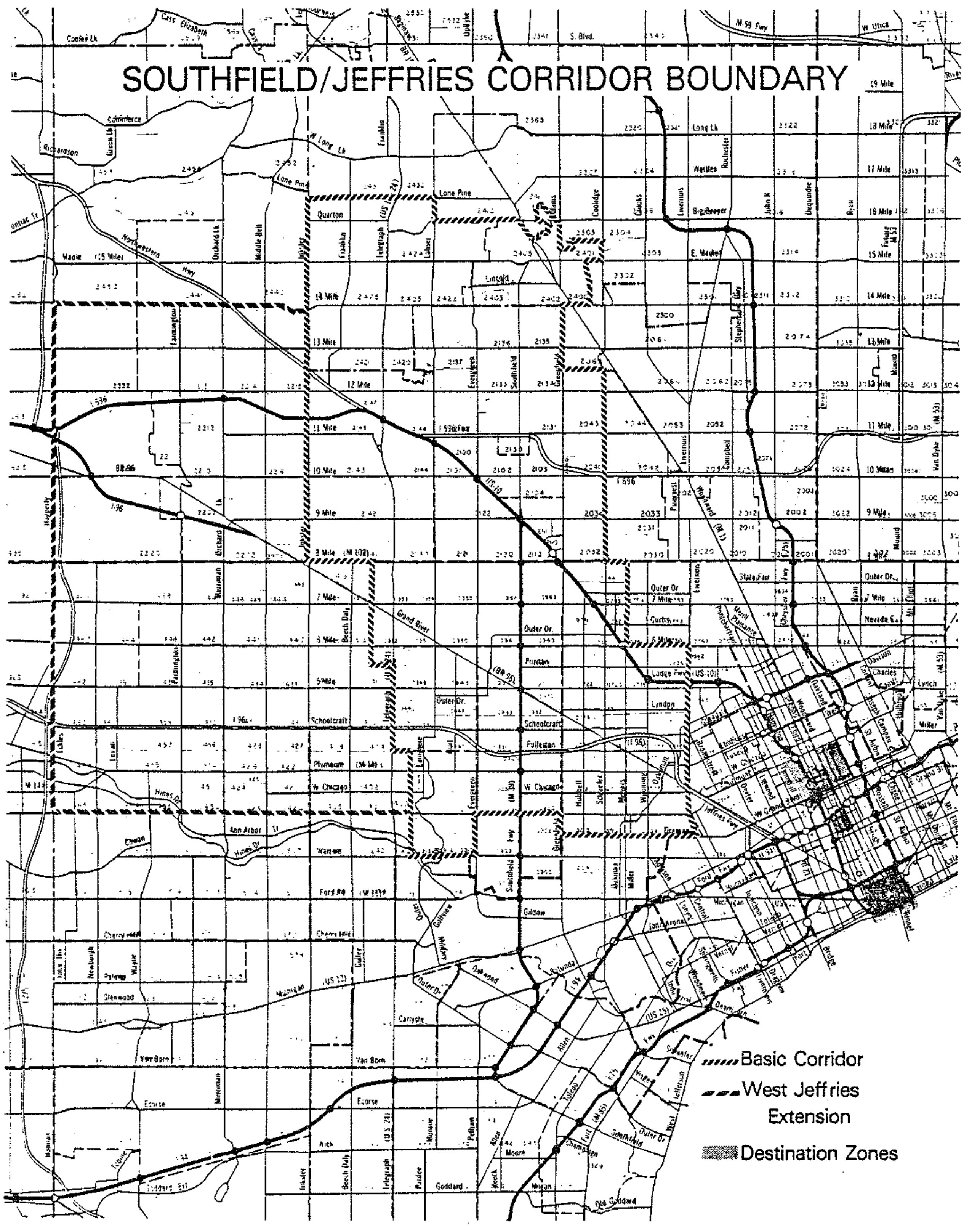

Figure 2-2 Southfield/Jeffries Corridor Boundary

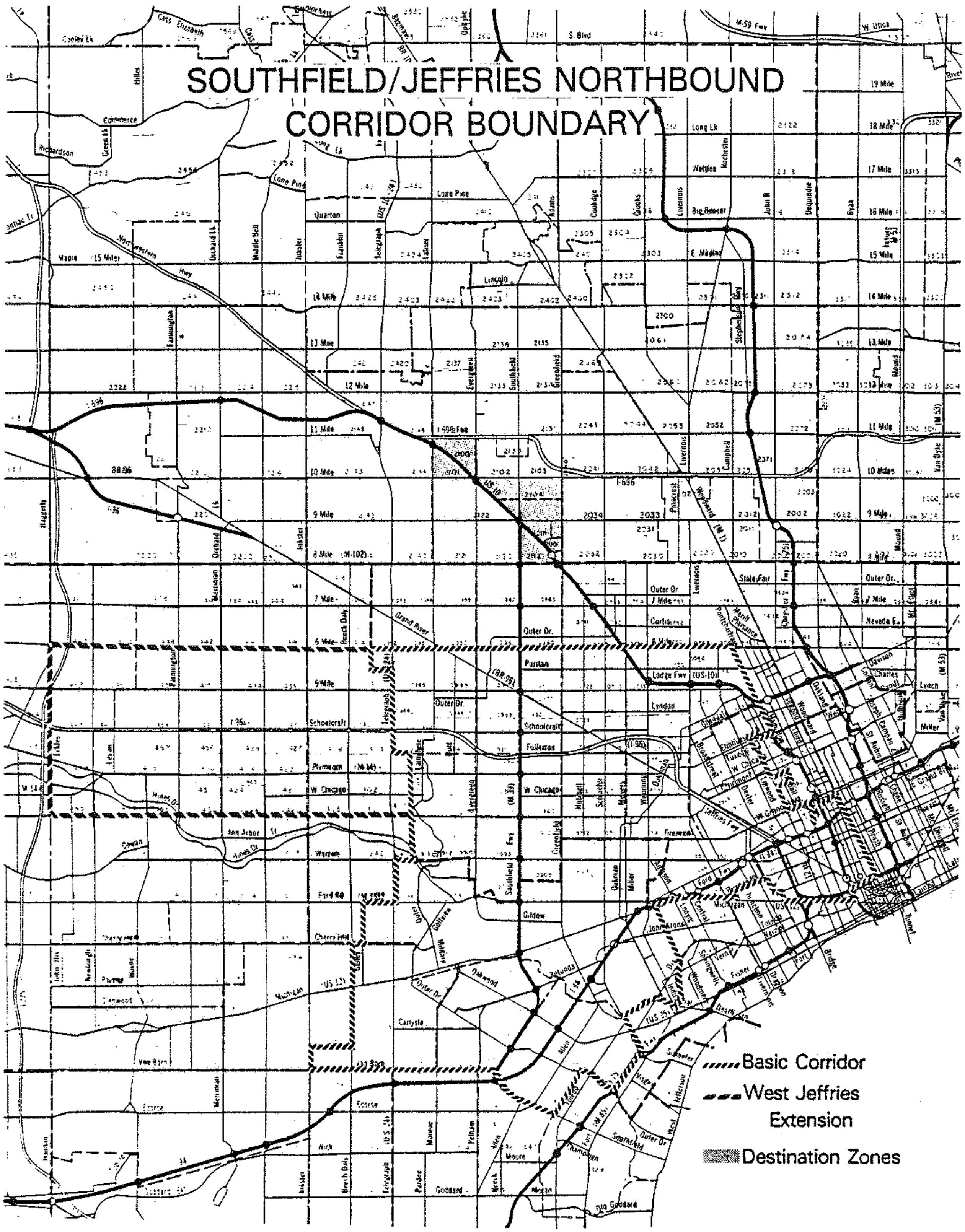

Figure 2-3 Southfield/Jeffries Northbound Corridor Boundary

0 through 35 and reported to terminate in the Detroit CBD (TALUS Superdistrict 0) during each of several 3-hour periods. In Phase IA, the peak-period choice was reviewed by considering only trips originating in the Southfield/Jeffries corridor and terminating in the Detroit CBD or New Center area, again using 1965 TALUS survey data. Trip totals for several 3-hour periods are listed in Table 2-2. Since the period from 7:00 to 10:00 a.m. included the greatest number of trips, it was again selected as the basis for demand analysis.

2.3 Travel Demand Data

Estimation of the total travel demand base from which BRT trips could potentially be drawn is a necessary task in the corridor analysis process. In Phase I of the BRT program, 1965 TALUS survey data (adjusted by 1975/1965 population ratios) were used in the development of a morning peak-period trip matrix for each corridor studied. Details of the trip matrix development may be found in the Phase I Final Report.*

Phase IA has been concerned with the Southfield area, creating the possibility that data generated in a recent Southfield Transit Alternatives Study** might be partially utilized in Phase IA trip matrix development. The Southfield Study (conducted by Goodell, Grivas, and Associates and by Barton-Aschman Associates) divided Southfield and Lathrup Village into 56 analysis zones and the remainder of the Detroit area into 38 additional zones. Then, using survey information, traffic counts, and demographic data, vehicular travel within Southfield/Lathrup Village and between Southfield/Lathrup Village zones and external zones was modeled. One significant output of that study is a 1975 daily vehicle trip matrix in production/attraction format for the 94-zone study area (trips having both termini external to Southfield/Lathrup Village, however, are not indicated). After an examination of this trip matrix, it was decided that its best use in the current BRT program would be to guide the planning of collection/distribution routes and feeder service in Southfield, rather than to estimate travel demand from Southfield to specific BRT destinations. The primary reason for that choice is the size of Southfield Study analysis zones relative to TALUS zones. Within Southfield these zones are generally much smaller than TALUS zones and permit a detailed examination of trip production patterns (56 Southfield Study zones cover an area equivalent to 24 TALUS zones). Outside of Southfield, TALUS zones are smaller than Southfield Study zones and are, therefore, superior for demand analysis purposes (the Detroit CBD and adjacent areas are subdivided into 94 TALUS zones and into only the single Southfield Study Zone 76).

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* "Michigan Bus Rapid Transit Demonstration Program, Phase I, Final Report," prepared for the Michigan State Highway Commission by GM Transportation Systems Division, EP-750012, May 1975.

** "A Study of Public Transit Alternatives for the City of Southfield, Michigan," a summary report of Phase I, prepared by Goodell, Grivas and Associates, Inc., Southfield, Michigan; and Barton-Aschman Associates, Inc., Evanston, Illinois, May, 1975.

Table 2-2 Trip Totals for Various Three-Hour Periods

Three-Hour Period	Total Trips*
4:00 a.m. - 7:00 a.m.	1,378
4:30 a.m. - 7:30 a.m.	3,914
5:00 a.m. - 8:00 a.m.	9,429
5:30 a.m. - 8:30 a.m.	15,427
6:00 a.m. - 9:00 a.m.	19,165
6:30 a.m. - 9:30 a.m.	21,620
7:00 a.m. - 10:00 a.m.	22,481
7:30 a.m. - 10:30 a.m.	21,310
8:00 a.m. - 11:00 a.m.	17,015
8:30 a.m. - 11:30 a.m.	12,154
9:00 a.m. - Noon	9,425
9:30 a.m. - 12:30 p.m.	7,542
10:00 a.m. - 1:00 p.m.	6,919
10:30 a.m. - 1:30 p.m.	7,015
11:00 a.m. - 2:00 p.m.	6,447
11:30 a.m. - 2:30 p.m.	6,401
Noon - 3:00 p.m.	5,953

* Number of trips reported to terminate in the combined Detroit CBD and New Center area and having origins within the Southfield/Jeffries corridor, based upon 1965 TALUS survey data.

Trip volumes for the two data sources were compared, and the results of that comparison are partially contained in Table 2-3. First, the daily production/attraction trip matrix generated as part of the Southfield Study was modified to approximate an origin/destination trip matrix. This transformation was accomplished by summing the trips between each zone pair and then dividing the trips equally in each flow direction. Next, TALUS zones contained within each Southfield Study zone in the Southfield/Jeffries corridor were identified (the 56 zones in Southfield/Lathrup Village were considered to be one zone for the comparison). Utilizing 1965 TALUS survey data, then, trip flows to and from Southfield/Lathrup Village and Southfield Study zones were tabulated for the morning peak period (7:00 to 10:00 a.m.). As peak-period trips were tabulated, daily trip totals were also noted, allowing peaking factors to be determined for the various origin/destination pairs. Furthermore, the 1975/1965 population ratio of each TALUS origin zone's district were applied to the reported trip quantities. Finally, the Southfield Study trip matrix (in origin/destination format) was adjusted by 1965 TALUS peaking factors, totaled for the zone groups being examined, and then compared to the population-adjusted 1965 TALUS data. For trips originating in Southfield/Lathrup Village and terminating in areas of major interest in Phase IA of the BRT program, numerical differences between trip volumes associated with the two data sources are generally not large. Peak-period trips from Southfield/Lathrup Village to Southfield Study Zone 76 (the Detroit CBD and nearby areas, or TALUS Superdistricts 0, 1, and 2) differ by only 322 trips, with the adjusted TALUS data indicating 2,242 trips and the Southfield Study resulting in 2,564 trips.

Table 2-4 presents a similar comparison of trips terminating in Southfield/Lathrup Village and originating in an area approximating the Southfield/Jeffries Northbound corridor as defined for the Phase IA BRT program. It may be seen that the use of TALUS data results in a lower estimate of Dearborn (Zone 69)-to-Southfield trips and a higher estimate of total trips.

Due to the above considerations, then, total travel demand estimates in Phase IA have been developed in the same manner as in Phase I of the BRT program. A summary of that demand by corridor is shown in Table 2-5.

Table 2-3 Comparison of Morning Peak-Period Trip Volumes Originating in Southfield

Data Source	Southfield Study Destination Zone			
	68 (1)	69 (2)	76 (3)	Total
1965 TALUS Survey (Adjusted to 1975 by Population Ratios)	1595	194	2242	4031
1975 Southfield Transit Alternatives Study (4)	708	550	2564	3822
Difference (Talus Relative to Southfield Study)	887	-356	-322	209

(1) Includes New Center destinations

(2) Includes Dearborn destinations

(3) Includes Detroit CBD

(4) Derived from production/attraction trip matrix supplied by Goodell, Grivas and Associates; peaking factors based upon 1965 TALUS survey.

Table 2-4 Comparison of Morning Peak-Period Trip Volumes Terminating in Southfield

Data Source	Southfield Study Origin Zone					
	59	60	68	69	77	Total
1965 TALUS Survey (Adjusted to 1975 by Population Ratios)	1908	3396	1699	499	297	7799
1975 Southfield Transit Alternatives Study(1)	955	2180	769	1526	78	5508
Difference (TALUS Relative to Southfield Study)	953	1216	930	-1027	219	2291

(1) Derived from production/attraction trip matrix supplied by Goodell, Grivas and Associates; peaking factors based upon 1965 TALUS survey.

Table 2-5 Total BRT Demand

Corridor	Total Trips
Southfield/Jeffries to CBD/NC	21,311
Southfield/Jeffries to CBD/NC with West Jeffries Extension	26,370
Southfield to Dearborn	3,484
Southfield to Dearborn with West Jeffries Extension	6,126
Southfield/Jeffries Northbound to Southfield	2,400
Southfield/Jeffries Northbound to Southfield with West Jeffries Extension	3,150

3.0 GREENFIELD/SOUTHFIELD ALTERNATIVE ROUTES

3.1 Alternative Treatment Matrix

For the purpose of the Stage I investigation, the reserved-lane implementation suggested by SEMTA for the Jeffries Freeway was accepted without critical review. Alternative implementations were considered for the extension of the Jeffries corridor to Southfield and for the extension of this Southfield/Greenfield corridor to Dearborn. Because of differences in the roadway characteristics, current vehicular volumes, and the estimated number of BRT vehicles involved, the two possible routes were considered in three separate sections. In general, the northern section is in Oakland County; the middle section is in Wayne County north of the Jeffries Freeway; and the southern section is south of the Jeffries-Southfield Freeway (or Greenfield) intersection.

3.2 Roadway and Traffic Characteristics

3.2.1 Greenfield

The northern section of Greenfield has five lanes from Thirteen Mile to Lincoln; seven lanes from Lincoln to Nine Mile; and six lanes with intermittent left-turn curb cuts in the median from Nine Mile to Eight Mile Roads. Parking is prohibited at all times, and the speed limit is currently 40 mi/h. The vehicular volume-to-capacity ratio generally exceeds unity and ranges from 0.97 to 2.53 according to the SEMCOG 1970 Highway Assignment Data File. This section of Greenfield is part of a rather extensive traffic signal progression network in Oakland County. The progression system includes Greenfield, Southfield, Coolidge, John R, Nine Mile, Ten Mile, Eleven Mile, Twelve Mile, and Fourteen Mile.

The middle section of Greenfield extends from Eight Mile to the Jeffries Freeway, but the road exhibits similar roadway and traffic characteristics from Eight Mile to Warren. In this section, Greenfield is approximately 60 feet wide and has two traffic lanes and a parking lane in each direction. Parking is prohibited during the peak period. Left turns are currently prohibited during the peak period at major intersections, except that left turn lanes are provided at Fenkell, Grand River, and Schoolcraft. The Wayne County Road Commission has scheduled the construction of left-turn lanes at Seven Mile and McNichols in 1976. The current vehicular volume on this section of Greenfield is less than capacity (the volume-to-capacity ratio ranges from 0.58 to 0.94). Hourly traffic counts reported by DDOT indicate that the traffic flows during the morning and afternoon peak periods are very nearly balanced. The traffic signal controllers on this section of Greenfield are not interconnected, but several signal progression systems intersect Greenfield including the ones on Eight Mile, the Lodge Service Drive, Seven Mile, McNichols, Grand River, and Plymouth.

The southern section of Greenfield Road--from Warren to Michigan Avenue--is 72 feet wide, and the three southbound lanes are separated from the three northbound lanes by a median. Parking is restricted at all times, and the speed limit is 40 mi/h. Traffic volume on this section is below capacity.

3.2.2 Southfield

The northern section of Southfield is similar to the northern section of Greenfield. Southfield is a 5-lane arterial from Fourteen Mile to Ten Mile and a 7-lane facility from Ten Mile to about Nine Mile where the Southfield Freeway begins. According to the 1970 Highway Assignment Data File, the road operates significantly above capacity (the volume-to-capacity ratio ranges from 1.04 to 2.61). The speed limit is 45 mi/h, and parking is prohibited at all times. The traffic signals on Southfield are part of a signal progression network which has been implemented in this area of Oakland County.

The middle and southern sections of Southfield are a 6-lane urban freeway which is currently operating near or above capacity in both directions during peak periods. The two sections are considered separately because the middle section is part of the Southfield/Jeffries route serving the CBD and would accommodate up to 70 BRT buses in the peak hour, while the southern section serves only Dearborn destinations and would accommodate only about 9 buses in the peak hour. Although the same alternative implementations can be considered for both sections, the disparity in the number of buses to be accommodated in the peak hour may suggest that different treatments be selected for the two sections.

3.3 Evaluation of Alternative Treatments

A total of 63 alternative implementations have been considered for the Southfield/Greenfield corridor. The alternatives include various combinations of free flow with or without traffic signal control (progression or pre-emption) and reserved lane operation with or without signal control. The alternatives have been evaluated on the basis of five factors. The factors include the effect on other traffic in the corridor, the estimated BRT speed, the dependability of the BRT speed, the ease or cost of implementation, and safety. Hard criteria for evaluating alternatives have not been developed in this Stage I effort. However, an in-depth analysis of the effects on other traffic for selected priority treatments and the resulting operating speeds will be performed as part of the Stage II effort.

Several of the 63 alternative implementations involve pre-emption of traffic signals by buses. This technique has been used with varying degrees of success in several areas including Dade County, Florida, and Louisville, Kentucky. At least one manufacturer of pre-emption equipment claims that his system minimizes any adverse effect on cross traffic and only temporarily interrupts progressive traffic signals. However, if the number of buses approaches one per cycle, even temporary disruption is likely to have a significant impact on traffic flow on cross streets. In the case of the Southfield/Greenfield corridor, up to 31 buses are expected to operate on the BRT route above Eight Mile in the peak hour. As many as 70 buses per peak hour are expected to use the middle section of the route. These volumes represent average headways of just under 2.0 minutes and 0.9 minutes, respectively.

The automobile and local bus volume on each of the major cross streets is at least as great as the volume on the alternative corridor routes. To improve the flow of this high crosstown volume, signal progression systems have been established on ten of these major cross streets, as well as on Greenfield and Southfield in Oakland County. Thus, it is unlikely that the time saved by BRT patrons as a result of pre-empting traffic signals will exceed (or even equal) the delay experienced by other commuters crossing the corridor. Therefore, signal pre-emption is not considered to be a viable alternative for BRT implementation in the Southfield/Greenfield corridor.

Another category of alternatives includes reserving the normal flow curb lane for buses. This is not considered to be a viable alternative for line-haul operation. Since the lane would have to be shared with local buses and right-turning vehicles, an improvement in average speed over mixed traffic operation is questionable. Even curb cuts at major intersections would not be particularly effective because of the many mid-block turns into businesses and residences and because of the low average velocity of local buses due to accelerations and decelerations. In addition, parking violations would be quite disruptive to the operation of the BRT system. For these reasons, reserving a curb lane for buses is not considered individually among the alternatives for each segment of the BRT route.

The remaining 35 alternatives which are considered individually for the various BRT routes are summarized in Tables 3-1 through 3-5, shown later. Each alternative implementation is evaluated on the basis of six factors. The evaluation factors include the effect on other traffic along the route, the estimated average velocity over the segment, the dependability of the BRT travel time, the relative ease and cost of implementation, BRT ridership implications, and relative safety of operation.

The alternatives for each potential BRT route were evaluated and the one or two most promising implementations for each route were selected. Then, these remaining alternatives were compared, and the final BRT route and implementation scheme was selected for the Stage I system sizing and costing effort.

3.3.1 Most Promising Greenfield Treatment

Four alternative implementations for the northern section of Greenfield are listed in Table 3-1. The alternatives include free flow under existing conditions, free flow after widening to seven lanes north of Lincoln, reserved center lane, and reserved inner lane (the normal flow lane next to the center lane). The free flow alternatives would have very little effect on other traffic on Greenfield. Reserving the center lane for buses and car pools would require the elimination of all left turns along Greenfield from Thirteen Mile to Eight Mile Roads. This is a severe disadvantage, since access to the many residences, commercial centers, office buildings, and major east-west arterials along Greenfield would be seriously impaired. No center lane exists between Eight Mile and

Table 3-1 BRT Implementation Alternatives, Greenfield Road – Thirteen Mile to Eight Mile

EVALUATION FACTORS / ALTERNATIVES	EFFECT ON OTHER TRAFFIC	SPEED OF BRT (TRAVEL TIME)	DEPENDABILITY OF SPEED & TRAVEL TIME	EASE & COST OF IMPLEMENTATION	RIDERSHIP IMPLICATIONS (MODAL SPLIT)	SAFETY
Free flow with signal progression	Essentially none	26.4 mph (11.4 mins)	BRT vehicles affected by incidents and delays	Existing condition Low cost	No advantage to BRT travel vs. car for this section	Relatively safe – no weaving required
Free flow with signal progression – widen road north of Lincoln	Improve speed by relieving congestion north of Lincoln	31.4 mph (9.6 mins)	BRT vehicles affected by incidents and delays	Quite costly – must move utility poles & hydrants; residential property must be acquired.	No advantage to BRT buses vs. cars for this section of Greenfield	Relatively safe – no weaving required
Reserve center lane for buses and car pools with signal progression	Very little effect on through traffic. Left turns would be eliminated.	35.8 mph (8.4 mins)	Incidents and delays do not affect exclusive land. Only delays in bus-weave area would affect BRT bus.	Low cost – special signing and lane striping required	Exclusive lane provides travel time advantage to BRT.	Bus weaving required to access/egress the BRT lane
Reserve inner lane with progression	One lane removed from general service. Left turn traffic must cross BRT lane.	35.8 mph (8.4 mins)	BRT lane unaffected by incidents in other lanes Delays possible as a result of weaving left-turn cars	Quite costly – must widen road north of Lincoln Special signs required Difficult to enforce	Exclusive lane provides travel time advantage to BRT	Weaving by buses and left turning autos

Nine Mile Roads. In order to build one, street lights and drains would have to be relocated. These disadvantages can be circumvented by the fourth alternative--reserving the inner, normal flow lane. In this case, left turns could be accommodated, but left-turning vehicles would have to cross the reserved lane to access the left-turn lane. This alternative has the disadvantage of removing a traffic lane from a heavily traveled arterial.

The estimates of average BRT speed are based on a number of automobile speed runs and several assumptions. The average of four automobile speed runs on this section of Greenfield (two southbound in the morning peak and two northbound in the evening peak) is 26.4 mi/h. Since the BRT vehicles are assumed to make no intermediate stops once they enter the main BRT route, this speed is taken as the estimated BRT speed for free flow on this section of Greenfield. Widening Greenfield to seven lanes would relieve some of the congestion, but the road would still operate near capacity. It is assumed that adding another lane would result in a 5 mi/h increase in the average speed of all traffic. The estimated BRT speed for this alternative is 31.4 mi/h. According to the actual experience of the "Orange Streaker," a reserved lane bus priority implementation using traffic signal pre-emption on Seventh Avenue in Dade County, Florida, a 14 percent increase in operating speed can be attributed to reserved lane operation. Therefore, the estimated average speed for the reserved lane alternatives on this section of Greenfield Road is 35.8 mi/h.

All four of the alternatives are expected to produce dependable BRT travel times. However, a reserved lane isolates the bus from the effects of traffic delays due to incidents.

The first alternative takes advantage of traffic engineering improvements already instituted by the Oakland County Road Commission, and it can be easily and inexpensively implemented. Widening Greenfield is a very costly alternative because right-of-way would have to be acquired, and utility poles and fire hydrants would have to be relocated. Widening is required not only for the second alternative, but also for the fourth alternative. Since Greenfield has only two traffic lanes in each direction north of Lincoln, another traffic lane would have to be added before one could be reserved for buses and car pools.

The two free flow alternatives provide no travel time advantage for BRT vehicles over the automobiles, while the reserved lane alternatives do provide an advantage for BRT vehicles. This advantage would tend to increase the proportion of commuters who choose BRT over competing modes of travel in the corridor.

All of the alternatives are relatively safe, although the reserved lane treatments do require the bus to weave across other traffic.

The first alternative--free flow with the existing signal progression system--is recommended for this section of Greenfield. Although the other alternatives result in higher average speeds, the expense of widening Greenfield is considered to be prohibitive, and the elimination of left turns from Greenfield is unreasonable.

Table 3-2 summarizes the implementation alternatives for the middle section of Greenfield Road from Eight Mile to Warren Avenue. The ten alternatives that are considered include the following:

- Free flow with and without signal progression
- Reserved center lane with and without signal progression
- Reserved fourth lane (reversible) with and without signal progression
- Free flow on a reversible fourth lane with and without signal progression

The first alternative listed in Table 3-2 is to operate the BRT vehicles in an express mode with no priority treatment. Although this alternative would probably result in consistent trip times and would have little effect on other traffic, the average BRT speed would be low. The average of four automobile speed runs on this section of Greenfield (two southbound in the morning peak and two northbound in the evening peak) is 22.7 mi/h. Since from 40 to 70 buses per hour are expected to operate in the peak hour on this section of the route, some form of priority to increase the average speed of the buses is warranted.

The delay experienced at traffic signals could be reduced by installing a signal progression system. This would benefit not only BRT travel but also local buses and automobile traffic in the peak direction as well. According to the Highway Capacity Manual, an average velocity of 25 mi/h can be maintained on a street having good signal progression which operates at a volume-to-capacity ratio of 0.8 and has a speed limit of 35 mi/h. Because maintenance responsibility for the traffic signals on Greenfield is split between Detroit DOT and the Wayne County Road Commission, and because Greenfield crosses several existing progression systems, close coordination between the two agencies would be required. The signals on Greenfield could be synchronized and coordinated with the systems on the east/west and radial streets using network analysis techniques.

Another alternative for this section of Greenfield is to restripe the road delineating five 12-foot lanes and to reserve the center lane for BRT vehicles and car pools. This is a rather easily implemented and inexpensive alternative which gives a clear priority and travel time advantage to high occupancy vehicles. However, it requires that all left turns be eliminated from Greenfield during peak periods except at major intersections where the road has been widened to provide a left-turn lane. In these areas, left-turning vehicles would be required to cross the reserved lane to access the left-turn lane. Possibly a more severe disadvantage of this alternative is that parking must be prohibited at all times. Some parking could be provided by paving the easement between the street and the sidewalk, as has already been done in some areas.

Another obvious effect of reserving a lane for high-occupancy vehicles is the reduction in the capacity of the road to accommodate low-occupancy vehicles. Since Greenfield currently operates below capacity, this is not a serious penalty. According to the SEMCOG 1970 Highway Assignment Data File, the capacity of this section of Greenfield is about 2250 vehicles per hour in each direction. Since the maximum hourly volume is

Table 3-2 BRT Implementation Alternatives, Greenfield Road - Eight Mile to Warren

EVALUATION FACTORS / ALTERNATIVES	EFFECT ON OTHER TRAFFIC	SPEED OF BRT (TRAVEL TIME TO JEFFRIES)	DEPENDABILITY OF SPEED & TRAVEL TIME	EASE & COST OF IMPLEMENTATION	RIDERSHIP IMPLICATIONS (MODAL SPLIT)	SAFETY
Free flow with no priority	None - road operates under capacity	22.7 mph (11.9 mins)	BRT affected by incidents in mixed traffic stream	Present usage Minimal cost	No time advantage for BRT over auto	No special safety problems or benefits
Free flow with traffic signal progression	Peak direction auto speed improved	25 mph (10.8 mins)	BRT affected by incidents in mixed traffic stream	Difficult to implement. Coordination with DDOT & Wayne County Road Commission required. Must be integrated with existing progression systems.	No time advantage for BRT over auto	No special safety problems or benefits
Reserve center lane (restripe for 5 12-foot lanes)	Prohibit left turns during peak periods except where left-turn lane is provided & eliminate parking at all times	26 mph (10.4 min)	BRT vehicles in exclusive lane not affected by incidents in mixed traffic	Not difficult. Restriping & signing required. Not too expensive.	Time savings to BRT patrons. BRT has advantages over auto.	Buses must weave to enter lane. No weaving required to exit onto Jeffries in a.m.
Reserve center lane with signal progression	Prohibit peak period left turns except where left-turn lane is provided & eliminate parking. Peak direction auto speeds slightly improved.	28.5 mph (9.5 mins)	BRT vehicles in exclusive lane not affected by incidents in mixed traffic. Progression aids dependability.	Exclusive lane not difficult to implement. Progression system difficult to implement because of crossing progression system.	Time savings to BRT patrons. BRT has advantages over auto.	Buses must weave to enter & exit lane. No weaving required to exit onto Jeffries in a.m.
Reserve inner lane (stripe for 6 lanes, 10 feet wide)	No left turns during peak periods except where center lane is provided. Parking allowed off-peak. Capacity decrease in peak direction.	26 mph (10.4 min)	BRT vehicles unaffected by incidents in mixed traffic	Not difficult to implement. May be difficult to enforce. Signing & striping required.	Time savings to BRT patrons	Autos must weave across bus lane to enter/exit center lane. No weaving by buses to exit onto Jeffries in a.m.
Reserve inner lane with signal progression	Peak direction auto speeds improved over previous alternative. No left turns during peak periods except where center lane is provided. Parking allowed off-peak. Capacity decrease in peak direc.	28.5 mph (9.5 mins)	BRT vehicles unaffected by incidents in mixed traffic. Progression aids dependability.	Difficult to enforce & to install progression due to cross progression system. Special signing & striping required.	Time savings to BRT patrons.	Autos must weave across bus lane to enter/exit center lane. No weaving by buses to exit onto Jeffries in a.m.

Table 3-2 BRT Implementation Alternatives, Greenfield Road - Eight Mile to Warren (Continued)

EVALUATION FACTORS	EFFECT ON OTHER TRAFFIC	SPEED OF BRT (TRAVEL TIME)	DEPENDABILITY OF SPEED & TRAVEL TIME	EASE & COST OF IMPLEMENTATION	RIDERSHIP IMPLICATIONS (MODAL SPLIT)	SAFETY
Reserve inner lane with 4 lanes in peak direction (strip for 6 10-foot lanes)	Prohibit left turns during peak periods. Parking allowed off-peak. Peak direction capacity maintained. Other direction capacity reduced.	26 mph (10.4 min)	BRT vehicles unaffected by incidents	Striping & signing required Easy to enforce	Should favor BRT. Time advantage over autos.	Weaving by buses to enter lane. No weaving by buses to exit on Jeffries in a.m. Head-on collision danger.
Reserve inner lane with 4 lanes in peak direction & signal progression	Prohibit left turns during peak periods. Parking allowed off-peak. Peak direction capacity maintained. Peak direction auto speed improved. Other direction capacity reduced.	28.5 mph (9.5 mins)	BRT vehicles unaffected by incidents. Progression aids dependability.	Striping & signing required. Easy to enforce. Progression system difficult to install.	Time advantage over autos	Weaving by buses to enter lane. No weaving by buses to exit on Jeffries in a.m. Head-on collision danger.
Free flow with 4 lanes in peak direction	Prohibit left turns during peak periods. Parking allowed off-peak. Peak direction capacity increased. Other direction capacity reduced.	25 mph (10.8 mins)	Diversion from other peak direction routes may cause congestion of 4 lanes & slow BRT vehicles	Striping & signing required Not difficult to implement	No time advantage over autos on same route	Inner lanes change direction. Danger of collision during transition.
Free flow with 4 lanes in peak direction with signal progression	Prohibit left turns during peak periods. Parking allowed off-peak. Peak direction capacity increased. Peak direction auto speed improved. Other direction capacity reduced.	27 mph (10 mins)	Diversion from other peak direction routes may cause congestion of 4 lanes & slow BRT vehicles	Striping & signing required Difficult to install progression system across other progression systems	No time advantage over autos on same route	Inner lanes change direction. Danger of collision during transition.

usually about 1200 to 1300 vehicles per hour in each direction, existing traffic could be adequately served on the remaining unreserved lanes even if the number of high occupancy automobiles which could use the reserved lane were quite low.

The average BRT speed estimated for this alternative as indicated in Table 3-2 is 26 mi/h (28.5 mi/h when the reserved lane concept is combined with signal progression). These speeds represent a 14 percent increase over the free flow estimate and reflect the Dade County experience with reserved bus lanes.

The next set of alternatives listed in Table 3-2 calls for striping this section of Greenfield for six 10-foot lanes and reserving the inner lane for buses and car pools. These alternatives (one with existing traffic signal control and the other with signal progression) result in similar effects on other traffic and similar advantages for BRT operation as the previous alternatives. Left turns--at least in the direction of BRT bus flow--must be prohibited except where left-turn lanes are provided at major intersections. As before, vehicles must cross the reserved lane to access the left-turn lane. Parking can be permitted during off-peak periods in this case, since two lanes would remain for traffic flow in each direction. These alternatives also provide a travel speed advantage to BRT buses and can be implemented relatively inexpensively.

The remaining four alternatives all involve striping Greenfield for six 10-foot lanes and using four lanes for traffic flow in the BRT flow direction. These alternatives share the same critical disadvantage. They require that all left turns from Greenfield be prohibited during peak hours. Since this is contrary to the current policy of the Wayne County Road Commission to facilitate left turns by providing left turn lanes at mile-road intersections, these alternatives are not considered to be acceptable.

Based primarily on the adverse effects on other traffic in the corridor, the ten alternatives for this section of Greenfield have been reduced to two promising implementations--free flow with traffic signal progression and reserved inner lane operation with signal progression. The reserved lane alternative would more adversely affect the level of service provided to other traffic on Greenfield, but it would result in more dependable and faster BRT service. The estimated BRT speed for the reserved lane alternative is 28.5 mi/h while that for free flow is 25 mi/h. These estimated speeds represent a difference in travel time for a BRT trip from Eight Mile to the Jeffries Freeway of 1.3 minutes (10.8 minutes for free flow versus 9.5 minutes for reserved lane).

Greenfield, between Warren and Michigan, is a wider road (72 feet) with a median. Therefore, in addition to the free flow and reserved inner lane alternatives, a new median lane exclusively for buses and carpools can be considered. A summary of the six alternatives that were considered for this section is included in Table 3-3. Since this section of Greenfield currently operates below capacity, any of the alternatives can be implemented without seriously affecting other traffic. However, the expense of constructing a new lane in the median cannot be justified in view of the excess capacity of the road and the limited number of buses expected to use the facility--about nine in the peak hour. If an existing lane were reserved, curb cuts in the median would be required so that left turns could be accommodated without blocking the reserved lane. Left-turning vehicles would

Table 3-3 BRT Implementation Alternatives, Greenfield Road - Warren to Michigan Avenue

ALTERNATIVES \ EVALUATION FACTORS	EFFECT ON OTHER TRAFFIC	SPEED OF BRT (TRAVEL TIME)	DEPENDABILITY OF SPEED & TRAVEL TIME	EASE & COST OF IMPLEMENTATION	RIDERSHIP IMPLICATIONS (MODAL SPLIT)	SAFETY
Free flow	None - road operates under capacity	26.7 mph (4.5 mins)	BRT buses subject to all delays of normal traffic	Existing condition Low cost	No distinct time advantage to BRT	No distinct safety advantage or disadvantage
Free flow with progression	Auto speed increased with bus speed	31.4 mph (3.8 mins)	BRT buses subject to delays of mixed traffic	Few signals involved Coordination with Michigan Avenue system required	No distinct time advantage to BRT	No distinct safety advantage or disadvantage
Reserve inner lane	Removes capacity from peak direction. Curb cuts & shared status of lane required to permit left turns.	30.4 mph (4.0 mins)	Exclusive lane isolates BRT bus from mixed traffic problems	Requires signing & striping Enforcement difficult	Travel time advantage over autos	No particular safety problem. Not difficult to enter lane. May be difficult to exit.
Reserve inner lane with progression	Removes capacity from peak direction. Curb cuts & shared status of lane required to permit left turns.	35.8 mph (3.4 min)	Exclusive lane isolates BRT buses from mixed traffic problems	Requires signing & striping. Progression must be coordinated with Michigan Avenue progression system Enforcement difficult	Travel time advantage over autos	No particular safety problem. Not difficult to enter lane. May be difficult to exit.
Reserve new median lane for buses and car pools	None	31.7 mph (3.8 min)	BRT vehicles isolated from remaining traffic.	Very costly; requires construction of new lane. Must relocate lights.	BRT less travel time than auto	Weaving necessary by buses
Reserve new median lane with progression	Auto speed increased by signal progression	37.3 mph (3.2 min)	BRT vehicles isolated from remaining traffic	Costly, required construction of new lane. Must relocate lights & coordinate with Michigan Avenue progression system.	BRT less travel time than auto	Buses must weave to enter lane

cross the bus lane to access the curb cuts. Enforcement of the priority status of the lane would be difficult because of the small number of buses which are expected to use the exclusive lane. Since this section of Greenfield is currently below capacity and few BRT vehicles would be involved, free flow in mixed traffic with signal progression is the recommended treatment for this southern-most section of Greenfield.

3.3.2 Most Promising Southfield Treatment

The alternative BRT implementation schemes for Southfield were considered in two sections. The first section is Southfield from Fourteen Mile to about Nine Mile, where the freeway begins. The other section of the route is the freeway portion from about Nine Mile to Rotunda. The four alternatives which were considered for the northern section of Southfield are listed in Table 3-4. The alternatives include free flow under existing conditions, free flow after widening to seven lanes north of Ten Mile, reserved center lane, and reserved inner lane. The first alternative--mixed traffic operation utilizing the existing traffic signal progression system--is a viable treatment which would result in a reasonable average speed and relatively consistent BRT travel times. The average of six southbound speed runs made in an automobile during the morning peak hour is 30.6 mi/h. Since Southfield currently operates above capacity, the average BRT speed, as well as the speed of other traffic on Southfield could be increased by widening the road to seven lanes north of Ten Mile. Right-of-way is available to accomplish this widening, and the project is part of the long-term plans of the Oakland County Road Commission. According to Oakland County Road Commission estimates, the cost of widening Southfield would average about $500,000 per mile from Ten Mile to Thirteen Mile and about $700,000 for the section between Thirteen Mile and Fourteen Mile. It is estimated that a 5-mile per hour increase in average velocity could be achieved by widening the road. Thus, the estimated average BRT speed for this alternative is 35.6 mi/h.

Reserving the center lane for buses and car pools would result in an estimated 14 percent increase in average BRT speed over the previous alternative and would isolate the buses from delays caused by incidents in unreserved lanes. However, in order to implement this alternative, all left turns from Southfield would have to be prohibited during the peak periods. According to recent peak period Turning Movement Reports compiled by the Oakland County Road Commission, 3 to 4 percent of the vehicles on Southfield at Ten Mile and 5.5 to 5.8 percent of the vehicles on Southfield at Twelve Mile turn left. In addition, there are many mid-block left turns from Southfield to access businesses and apartment buildings. Considering the volume of these turning movements, the elimination of left turns from Southfield seems unacceptable. Therefore, reserving the center lane for buses and car pools is not a viable alternative.

The fourth alternative listed in Table 3-4--reserving the inner lane for buses and car pools--retains the BRT speed advantage of the center lane alternative and accommodates left turns. Vehicles must, however, weave across the reserved lane to access the center left-turn lane. Since only two traffic lanes exist in each direction north of Ten Mile, Southfield would have to be widened to seven lanes in this area. Near Nine Mile, traffic in the left lane must exit to the Lodge Freeway, while the other lanes continue to the

Table 3-4 BRT Implementation Alternatives, Southfield Road - Fourteen Mile to Nine Mile

ALTERNATIVES \ EVALUATION FACTORS	EFFECT ON OTHER TRAFFIC	SPEED OF BRT (TRAVEL TIME)	DEPENDABILITY OF SPEED & TRAVEL TIME	EASE & COST OF IMPLEMENTATION	RIDERSHIP IMPLICATIONS (MODAL SPLIT)	SAFETY
Free flow with signal progression	Essentially none	30.6 mph (20.6 min)	Buses affected by mixed traffic delays & incidents	Existing condition Low cost	No distinct advantage to BRT over auto	No particular safety hazards or benefits
Free flow with progression & widen Southfield north of Ten Mile	Congestion would be reduced above Ten Mile	35.6 mph (17.7 min)	Buses affected by delay & incidents in mixed traffic	Widening cost is about $500,000/mile to 13 Mile, $700,000 for last mile	Speeds of both auto & BRT increased. No distinct BRT advantage.	No particular benefits or hazards
Reserve center lane with progression	Through traffic affected very little except all left turns would be eliminated from Southfield during peak periods	40.5 mph (15.6 min)	Buses isolated from other traffic	Signing & striping necessary; not expensive	Distinct advantage to BRT	Buses must weave to enter/exit lane. Increased probability of sideswipe accidents.
Reserve inner lane with signal progression	Can accommodate peak hour left turns but peak direction vehicles must cross reserved lane to access center left-turn lane.	40.5 mph (15.6 min)	Buses isolated from mixed traffic. However, left turn autos must cross lane	Signing & striping required Road must be widened north of Ten Mile	Advantage to BRT	Weaving by autos across BRT lane to make left turns

Southfield Freeway. Therefore, the exclusive lane would have to be discontinued near Ten Mile to allow buses to weave over to the right lanes and to allow automobiles to access the Lodge Freeway.

Enforcing the priority use of the lane by high-occupancy vehicles would be difficult because low-occupancy vehicles would be allowed to cross the lane to make left turns and only about 31 buses are expected to operate on this section of the route during the peak hour.

Table 3-5 lists the alternatives for the southern portion of the Southfield route from Nine Mile to Rotunda. The eleven alternatives include free flow and reserved lane operation on the freeway, widening the freeway, and various service drive implementations. The four alternatives which utilize the Southfield service drive were all found to be unsatisfactory for several reasons. The service drive is not a through street, but it is primarily an access road on which many weaving and turning movements occur. In many locations, the freeway exit ramps have the right-of-way, and the northbound service drive is discontinuous at Chicago Road. The average BRT speed on the service drive is likely to be quite low. The average of three automobile speed runs on the southbound Southfield service drive in the morning peak hour was 18.7 mi/h. Even if BRT vehicles were given the right-of-way over the freeway exit ramps in an exclusive lane on the service drive and the traffic signals were made progressive, the average speed is estimated to be only 31 mi/h.

Another alternative, which is included for completeness, involves construction of an exclusive bus lane elevated above the freeway median. Although this alternative would result in very high BRT speeds and dependable travel times, it would be prohibitively expensive. Right-of-way would probably be required for access/egress ramps, and the interchange with the Jeffries would be particularly difficult and expensive to construct. This alternative obviously could not be implemented quickly.

Three alternatives which require the Southfield Freeway to be widened to eight lanes are also included in Table 3-5 for completeness. Although right-of-way appears to be available between major intersections, the bridges over the freeway would have to be reconstructed. These alternatives are also prohibitively expensive and are not easily or quickly implemented.

The remaining alternatives for the freeway portion of the Southfield route include free flow in mixed traffic and reservation of an existing lane on the freeway for buses and car pools. The free flow alternative is a low-cost, easily implemented alternative which provides a reasonably short BRT travel time over this section of the route. The average of six automobile speed runs on the southbound Southfield Freeway during the morning peak hour is 36.7 mi/h. However, the variation in the average velocity due to changing traffic conditions is relatively great. The average velocities recorded during the six speed runs vary from 30 mi/h to 49 mi/h. This variation represents a difference of 4.2 minutes in the travel time from Nine Mile to the Jeffries Freeway (10.8 minutes for 30 mi/h versus 6.6 minutes for 49 mi/h). This variation is about 9 percent of the total travel time for a representative BRT trip from northwest Detroit to the CBD.

Table 3-5 BRT Implementation Alternatives, Southfield Road - Nine Mile to Rotunda

ALTERNATIVES \ EVALUATION FACTORS	EFFECT ON OTHER TRAFFIC	SPEED OF BRT (TRAVEL TIME TO JEFFRIES)	DEPENDABILITY OF SPEED & TRAVEL TIME	EASE & COST OF IMPLEMENTATION	RIDERSHIP IMPLICATIONS (MODAL SPLIT)	SAFETY
Free flow on Southfield Freeway	Other traffic would be delayed somewhat due to presence of buses	36.7 mph (8.8 mins)	Large variance in average speed; range: 30 to 49 mph	Low cost Existing condition. Exclusive bus ramps could be constructed.	No distinct advantage to BRT	No distinct safety problems or advantages
Reserve left lane on freeway	Freeway now over capacity using all lanes. Severe congestion when lane for BRT removed from mixed traffic.	48 mph (6.7 mins)	BRT lane isolated from mixed traffic & oncoming traffic-median barrier	Relatively low cost. Signing & striping required.	Definite transit identity to BRT	Buses must weave across traffic to enter & exit reserved lane except at Southfield Road
Free flow on widened freeway	Initially all traffic would move more freely. However, volume would probably increase to capacity of 8 lanes	42 mph (7.7 mins)	BRT vehicles affected by delays due to incidents on freeway	Very expensive & difficult to implement. Right-of-way not available in some areas. Bridges would have to be rebuilt.	No specific benefit to BRT vehicles over other vehicles on same route	No distinct problems or advantages relative to other traffic
Reserve left lane on widened freeway	Capacity & speed increased in off-peak direction. Speed & capacity in peak direction remains the same	48 mph (6.7 mins)	BRT lane unaffected by mixed traffic conditions	Very expensive, difficult to implement. Bridges would have to be rebuilt. Right-of-way required in some areas.	Would speed BRT vehicles relative to autos	Buses must weave across 3 lanes of traffic to enter & exit exclusive lane.
Reserve right lane	More difficult for non-BRT traffic to enter & exit. Must cross exclusive lane. Traffic slowed due to removal of mixed traffic lane.	42 mph (7.7 min)	BRT vehicles affected by merging & demerging traffic	Low cost; striping & signing necessary. Enforcement very difficult.	BRT vehicles somewhat faster than mixed traffic	Not safe. All entering & exiting traffic required to cross exclusive BRT lane.
Reserve right lane on widened freeway	Should not affect traffic on freeway. However, weaving required to cross BRT lane. No mixed traffic capacity decrease.	45 mph (7.1 min)	BRT vehicles affected by entering & exiting traffic	Very expensive & difficult to implement. Bridges would have to be rebuilt. Right-of-way required in some areas. Difficult to enforce.	BRT vehicles somewhat faster than mixed traffic	Not safe. All entering & exiting traffic required to cross exclusive BRT lane.

Table 3-5 BRT Implementation Alternatives, Southfield Road – Nine Mile to Rotunda (Continued)

ALTERNATIVES \ EVALUATION FACTORS	EFFECT ON OTHER TRAFFIC	SPEED OF BRT (TRAVEL TIME TO JEFFRIES)	DEPENDABILITY OF SPEED & TRAVEL TIME	EASE & COST OF IMPLEMENTATION	RIDERSHIP IMPLICATIONS (MODAL SPLIT)	SAFETY
Elevated median bus lane	None	55 mph (5.6 mins)	BRT traffic completely isolated	Very expensive, difficult to implement. Ramps to lane must be constructed. Tow vehicles must always be available.	Strongly favor BRT modal split. Very efficient, dependable service.	Very safe. Vehicles in elevated lane completely isolated.
Free flow on Southfield Service Drive	Buses would somewhat delay auto traffic	18.7 mph (17.2 mins)	Service drive slow; many weaving & turning movements potential delays	Discontinuity at Chicago Rd. (northbound), bridge required over RR tracks. Freeway exit ramps have right-of-way in some locations.	Time disadvantage to BRT. Auto on Southfield much faster.	Unsafe. Too many weaving & turning movements on service drive.
Free flow on Southfield Service Drive with signal progression	Buses would somewhat delay auto traffic. However, progression would help autos, too.	22 mph (14.6 mins)	Many weaving & turning movements, potential delays	Discontinuity at Chicago Rd. (nbound); bridge required over RR tracks. Freeway exit ramps have right-of-way in some locations. Coordination with existing progression systems required.	Auto travel on Southfield faster than BRT. Modal split would favor autos.	Not safe. Too many weaving & turning movements on service drive.
Reserved right lane on Southfield Service Drive	Very detrimental to other traffic which would be forced into only one lane.	27 mph (11.9 mins)	Interference from right turning vehicles & local buses will limit average speed & cause delays.	Not advisable - service drive has only 2 lanes; poor practice to reserve 1 of 2 lanes for transit. Freeway ramps have right-of-way in some locations.	Auto travel on Southfield faster than BRT. Modal split would favor autos.	Not very safe. Too many weaving & turning movements on service drive.
Reserve right lane on Service Drive with signal progression	Very detrimental to other traffic which would be forced into one lane	31 mph (10.4 mins)	Interference from right turning vehicles & local buses will limit average speed & cause delays.	Service drive 2 lanes; poor practice to reserve 1 of 2 lanes for transit. Freeway ramps have right-of-way in some locations.	Auto travel on Southfield faster than BRT. Modal split would favor autos.	Not very safe. Too many weaving & turning movements on service drive.

The variation in travel time as well as the travel time itself could be reduced by reserving an existing lane on the Southfield Freeway for buses and car pools. This alternative could be implemented quickly and relatively inexpensively. Signing and possibly some pavement markings would be required to identify the reserved lane.

In order to acknowledge consideration of all possible alternatives, Table 3-5 includes the alternative of reserving the right lane for priority use by buses and car pools. This possibility exhibits several critical disadvantages. All traffic entering or exiting the freeway would have to weave across the reserved lane. This would result in a potentially unsafe condition for buses, limited speed advantage, and very serious enforcement problems. For these reasons, reserving the right lane for buses and car pools is not an acceptable alternative.

A definite speed advantage and isolation from the effects of other traffic would result from reserving the left lane for buses and car pools. This alternative, however, is not without serious disadvantages. It would be necessary for buses to weave across two lanes of traffic to enter and exit the reserved lane. Since the freeway currently operates above capacity, this weaving maneuver is likely to be quite difficult for car pools as well as for buses, especially when one traffic lane is removed from general service.

Weaving to and from a reserved lane on Southfield may be particularly objectionable and hazardous because this segment of the route is relatively short. Only about 36 percent of the buses which use this portion of the route to access the Jeffries travel the maximum 5.5 miles. Approximately 35 percent of the buses which enter the Jeffries from Southfield travel 2.5 miles or less on the Southfield Freeway. If a half-mile is required for a bus to weave across two lanes of congested freeway traffic, then buses entering the Southfield Freeway at McNichols will travel on the reserved lane for only 1.5 miles.

Another criticism of reserving a lane on Southfield involves the equity of removing a lane from a heavily traveled cross-town freeway to benefit primarily CBD oriented traffic. Many current users of the Southfield Freeway who would be inconvenienced or displaced from that facility if a lane were reserved are not destined for the CBD or New Center and could not benefit from BRT service.

One possible justification for reserving a normal flow lane on an already congested freeway might be that an increase in the number of people moved by the facility results from reserving a lane for the exclusive use of high-occupancy vehicles. In order to estimate the increase in utilization and the number of people displaced from the freeway, current volume and the vehicle occupancy distribution must be determined. Figure 3-1 shows the average week-day volume on the Southfield Freeway in the spring of 1973. The figure indicates that the southbound volume on the segment from Schoolcraft to the Jeffries Freeway, for example, is 6210 vehicles in the morning peak hour (7:00 to 8:00 a.m.). The occupancy distribution for Southfield is not available. However, the average distribution for the Ford, John Lodge, and Jeffries Freeways is available.* This occupancy

* "Feasibility Study of Reserved Bus-Car Pool Lanes for Jeffries Freeway (I-96)," SEMTA, June 1975.

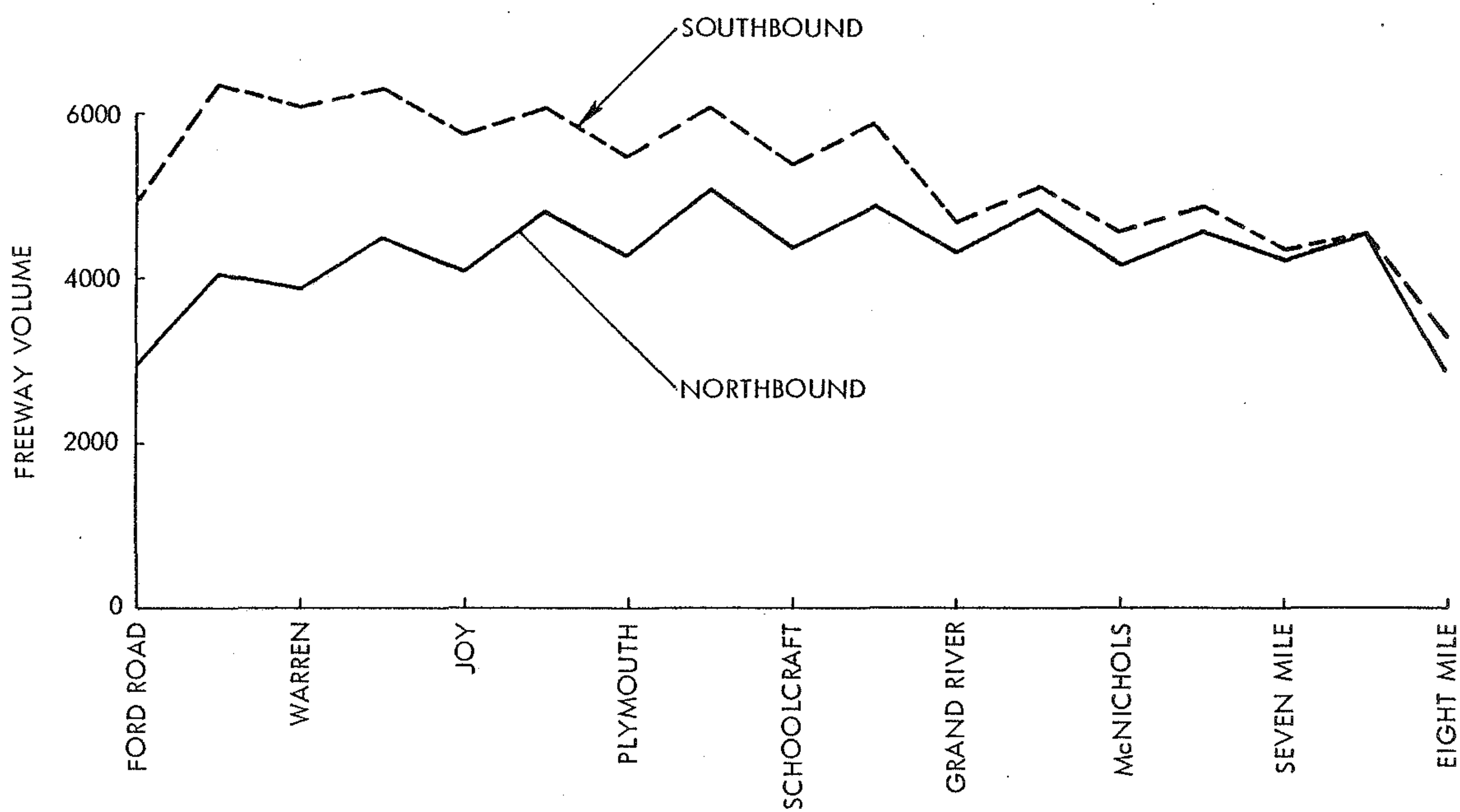

Figure 3-1 Southfield Expressway Traffic Volumes - Morning Rush Hour

distribution and the results of applying it to the Southfield Freeway volume are summarized in Table 3-6.

These 6210 vehicles are not distributed evenly over the three southbound lanes. The Highway Capacity Manual gives an average volume distribution by lane upstream of on-ramp junctions. This distribution for Southfield is shown in Table 3-7. The Highway Capacity Manual figures result in an unreasonably high volume for Lane 3. Therefore, the distribution was modified as shown in the last column of Table 3-7.

Based on these data, the effect of reserving a lane for buses and car pools on the utilization of the freeway in terms of the number of vehicles and persons accommodated in the peak hour can be determined. Table 3-8 summarizes the estimated change in freeway utilization if one lane is reserved for the exclusive use of buses and automobiles with three or more occupants. The table indicates that even though the reserved lane is extremely under-utilized, this reserved lane concept results in a 10.4 percent increase in the number of persons moved in the peak hour.

The table shows that although more persons are moved on the freeway, fewer vehicles are accommodated. The number of vehicles and persons displaced from the freeway must be estimated to assess the effect of the reserved lane on alternate routes in the corridor. The difference between the number of automobiles accommodated by the freeway at this check point with and without the reserved lane is 2013. Although Southfield is primarily a cross-town route, a number of vehicles on the freeway are destined to the Detroit CBD via Grand River and the Jeffries Freeway. Some of these automobile occupants will divert to BRT thus reducing the number of vehicles which must use alternate routes after being displaced from Southfield. In order to estimate this number of vehicles, it was estimated that 300 autos turn left on Grand River after exiting from the southbound Southfield Freeway. It was further estimated that 200 of these autos are destined for the Detroit CBD. Since the BRT modal split for CBD trips is about 50 percent, it is assumed that the occupants of 100 of these automobiles will be diverted to the BRT system. Therefore, a total of 1913 vehicles or 2257 persons* are displaced from the freeway (at this checkpoint) and must either form car pools or be accommodated by surface streets in the corridor. Although the alternate routes, Evergreen and Greenfield, are currently operating less than capacity, severe congestion would probably result if this additional volume were to be accommodated.

According to Table 3-6, the total number of vehicles having two or more occupants which pass this checkpoint is 1243. Since the maximum number of BRT vehicles expected to use Southfield in the peak hour is 70, a reserved lane could easily accommodate buses and automobiles having two or more occupants. Table 3-9 shows the estimated freeway utilization if two-occupant car pools are permitted to use the reserved lane. The data indicate that this condition results in a 28.4 percent increase in the number of persons moved past the checkpoint on the freeway.

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* Assuming 82 percent of the vehicles have one occupant and 18 percent have two occupants.

Table 3-6 Auto Occupancy Distribution on Southfield Based on Ford, John Lodge, and Jeffries Freeways

Auto Occupancy	Distribution (%)	Number of Vehicles		Number of People
1	80	4967		4967
2	17	1056		2112
3	1.9	118	187	354
4	.8	50		200
5+	.3	19		95
Total	100	6210		7728

Table 3-7 Average Volume Distribution by Lane for Southfield

Lane	Per Highway Capacity Manual (%)	Per Highway Capacity Manual (Vehicles)	Modified for Southfield (Vehicles)
1 (Curb Lane)	80	1739	1910
2	34	2111	2100
3	38	2360	2200
Total		6210	6210

Table 3-8 Freeway Utilization with Lane Reserved for Buses and Car Pools with Three or More Occupants

Lane	Existing Conditions		Reserved Lane (3 + occupant car pools)	
	Vehicles	Persons	Vehicles	Persons
1	1910	2377	1910	2254
2	2100	2613	2100	2478
3 (autos)	2200	2738	187	649
3 (bus)			70	3150
Total	6210	7728	4197 auto + 70 bus	8531

Table 3-9 Freeway Utilization with Lane Reserved for Buses and Car Pools with Two or More Occupants

Lane	Existing Conditions		Reserved Lane (2 + occupant car pools)	
	Vehicles	Persons	Vehicles	Persons
1	1910	2377	1910	1910
2	2100	2613	2100	2100
3 (autos)	2200	2738	1243	2761
3 (bus)			70	3150
Total	6210	7728	5253 auto + 70 bus	9921

The number of single-occupant vehicles displaced from the freeway (less the 100 vehicles which are assumed to divert to the BRT system) is 857. If a reasonable number of these persons formed new car pools, the surface streets in the corridor may be able to accommodate the increased volume without experiencing severe congestion.

The effect of reserving a lane for high-occupancy vehicles must be evaluated for each segment along Southfield. Although BRT vehicles may not operate on Southfield south of the Jeffries, it may be necessary to extend the reserved car pool lane to Michigan Avenue. An exclusive lane which terminates at the Jeffries would provide little incentive for motorists on Southfield to form car pools since the freeway is actually more congested south of the Jeffries during the morning peak. In addition, serious enforcement problems may result from trying to convert a northbound lane from general use to a priority status at an intermediate point such as the Jeffries Freeway. On the other hand, in the absence of high-occupancy transit vehicles, the utilization of the freeway in terms of the number of persons moved per hour is reduced as a result of reserving a lane for car pools. The data in Table 3-9 indicate that a 12 percent reduction in the number of persons moved on the freeway would result from reserving a lane for car pools in the absence of BRT patronage.

An increase in the number of persons moved in the peak hour may not, by itself, be sufficient justification for reserving a lane for multi-occupancy vehicles. Total travel time in the corridor is another important consideration which may have to be addressed. The calculation of total travel time and relative delay resulting from various priority treatments is a complex problem involving many factors. The net decrease in travel time achieved by high-occupancy vehicles must be determined by considering the cruise speed of vehicles in the reserved lane and delays associated with accessing the freeway and weaving to and from the reserved lane. Several factors must be considered in determining the net increase in travel time experienced by the occupants of non-priority vehicles. The cruise speed on the unreserved lanes will be reduced due to the increased volume and the weaving movements of high-occupancy vehicles. The increased volume on the unreserved lanes will also cause increased delays at freeway entrance and exit ramps. In addition, some vehicles will be displaced entirely from the freeway and forced to use surface streets. Finally, the current users of surface streets will be delayed due to the increased volume on these streets.

In conclusion, all but two of the eleven BRT implementation alternatives for the freeway portion of Southfield listed in Table 3-5 have been eliminated from further consideration. The two alternatives that remain are running free flow in mixed traffic on the freeway and reserving a lane on the freeway for buses and automobiles with two or more occupants.

4.0 SKETCH PLANNING

4.1 Route Selection

A large number of BRT implementation alternatives has been considered. The result of the analysis reported in Section 3.0 has been to eliminate all but one or two of the most promising alternatives for the two potential BRT routes. Those remaining alternatives will be reviewed and further evaluated. Finally, the BRT route and implementation which has been selected for the purposes of preliminary sizing and costing will be described.

A summary of the most promising BRT implementation alternatives for the Southfield/ Greenfield corridor is presented in Table 4-1. The recommended alternative for the northern section of Southfield is free flow with mixed traffic after widening Southfield to seven lanes north of Ten Mile. The best alternative for the freeway portions of the Southfield route appears to be free flow, although reserving the median lane for the exclusive use of buses and automobiles with two or more occupants may also be a viable alternative.

For the northern section of the route, the Southfield implementation (free flow after widening to seven lanes) is superior to any of the alternatives for Greenfield because it provides a relatively high average speed at reasonable cost and with only minor impact on existing traffic. Therefore, the Southfield implementation is recommended for the northern segment of the BRT route even if Greenfield is selected for the lower portion of the route. The Lodge Freeway and service drive can be used as a connector between Southfield and Greenfield roads. Free flow with signal progression may be the best alternative for the middle section of Greenfield from Eight Mile to Warren. Reserving the inner normal flow lane for buses and car pools from Eight Mile to the Jeffries in addition to signal progression is also a viable alternative for this section of Greenfield. Free flow with signal progression is recommended for the southern portion of the Greenfield route from Warren to Michigan Avenue.

There are several advantages associated with the Southfield route. First, the estimated average speed on the freeway is greater than that on Greenfield Road even if a lane were reserved for buses. It is estimated that the average BRT speed on the freeway is 36.7 mi/h assuming free flow. The average speed on the central section of Greenfield is estimated to be only 25 mi/h with signal progression and 28.5 mi/h with a reserved lane in addition to progression. Although the freeway route provides a higher average speed than the arterial, the variation in speed is great, resulting in unreliable travel times. However, even the lowest expected speed on the freeway is greater than the speed achievable on Greenfield with a reserved lane.

A second advantage of the Southfield route is the phased implementation potential that SCANDI offers. When the Surveillance, Control, and Driver Information System is installed on the Southfield Freeway, exclusive bus entrance ramps can be constructed relatively inexpensively to allow buses to bypass the auto queues at the metered entrance ramps. Integrating the BRT system with SCANDI will result in improved trip time reliability as well as increased average speed. If the BRT system is initially implemented on

Table 4-1 BRT Implementation Alternatives for the Southfield/Greenfield Corridor

Segment	Route	
	Southfield	Greenfield
North	Free flow on widened Southfield Road.	Free flow on widened Southfield Road. Free flow on Lodge from Southfield to Greenfield.
Central	Free flow on freeway. Reserved lane on freeway (buses and autos with 2+ occupants).	Free flow with signal progression on Greenfield. Reserved lane with signal progression on Greenfield.
South	Free flow on freeway. Reserved lane on freeway (buses and autos with 2+ occupants).	Free flow with signal progression on Greenfield.

the Southfield Freeway, then integration with SCANDI can be accomplished without modifying BRT routes or inconveniencing any existing BRT patrons.

Finally, by utilizing the Southfield route, it may be possible to temporarily avoid weaving on the Jeffries Freeway at the northwestern terminus of the reserved lane by using a portion of the unopened freeway. The plan would require extending the pavement of the Jeffries (but not the median barriers) about 500 yards west of the Southfield Freeway and completing the interchange from the eastbound Jeffries to the Southfield Freeway. As illustrated in Figure 4-1, westbound buses would continue in the reserved lane past the exit ramp of the Southfield Freeway to the unopened section of the Jeffries. The buses would make a U-turn on the wide pavement and have exclusive use of the new ramp from the eastbound Jeffries to the Southfield Freeway. Buses would ultimately have to merge with other traffic on the entrance ramps to the Southfield Freeway, but they would be able to bypass the long queue of vehicles exiting the Jeffries, and they would avoid a potentially hazardous weaving maneuver. Of course, this would be a temporary arrangement, but it would provide a very conspicuous advantage for BRT vehicles at the very beginning of the program when BRT ridership is being established. After the Jeffries Freeway is extended west of Southfield, the volume of traffic exiting at Southfield will be reduced, and the hazard associated with buses weaving over from the median lane at this location may also be reduced.

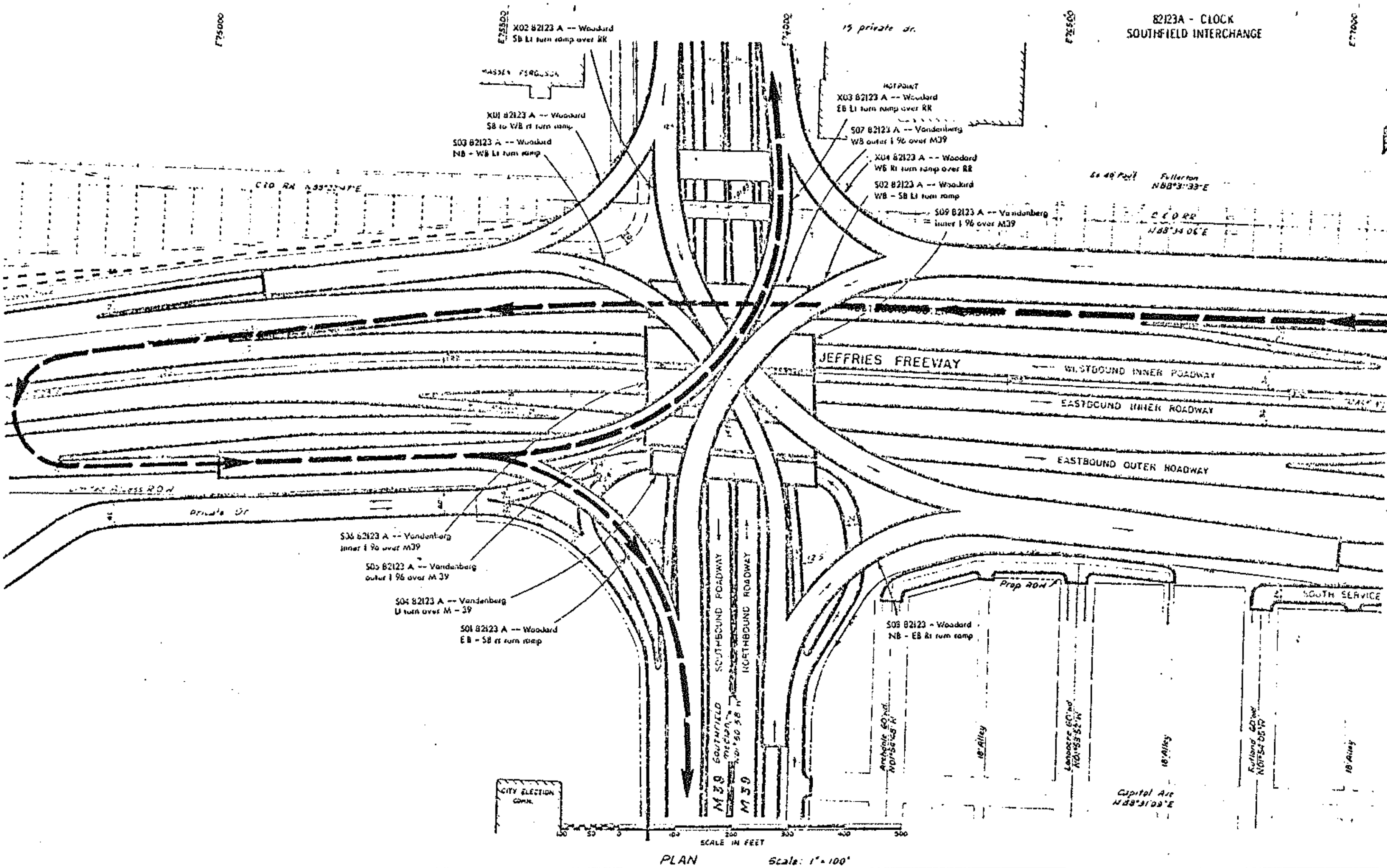

Figure 4-1 Temporary Terminus of Jeffries Bus/Car Pool Lane at Southfield

In addition to these advantages, the Southfield route has some obvious disadvantages. Because of serious congestion in the vicinity of Eight Mile, the Southfield route does not provide convenient access to Northland--a major park-and-ride facility and transit terminal. Significant delay is often experienced by vehicles attempting to enter the Southfield Freeway from westbound Eight Mile. This delay could be minimized for buses by either widening the access road from Eight Mile to provide an exclusive lane for buses to bypass the auto queue or by allowing buses only to turn left from Eight Mile directly onto the southbound Southfield service drive. A similar queuing problem and significant delays occur during the evening peak period when vehicles attempt to exit the Southfield Freeway at Eight Mile. In order to minimize the delay to the buses which exit at Eight Mile Road, an exclusive exit ramp just north of Eight Mile may be required. This would be relatively costly and possibly unpopular with local residents.

The Greenfield route provides much more direct access to Northland Center, but the average speed on this route is much lower than that on Southfield. In addition, since Southfield is the recommended route north of Eight Mile, northbound buses would have to turn left from Greenfield onto the Lodge service drive in the evening peak period.

In view of these advantages and disadvantages, free flow on the Southfield route was selected for the Stage I BRT sizing and costing efforts. Construction of an exclusive exit ramp for buses north of Eight Mile is assumed. If this ramp construction is found to be unacceptable, an alternate implementation which combines the advantages of both routes may be considered.

In this alternative, Southfield would be designated as the main BRT route. However, buses destined to Northland Center in the evening peak period would use Greenfield, while those continuing north would use the Southfield Freeway. Since approximately 14 buses in the peak hour could conveniently use Greenfield between the Jeffries and Northland Center, the expense of installing signal progression to improve bus speeds may be justified. Progression would also improve auto travel on Greenfield--at least in the direction of BRT travel.

4.2 Basic BRT Route Structure

The BRT route is comprised of three segments: collection, line-haul, and distribution. The operational scenario for the Southfield/Jeffries BRT system is identical in concept to that proposed for Phase I corridors. The major trip production zones are shown in Figure 4-2. The map also indicates the designation of access nodes along the main line route.

The collection of BRT passengers has been approached in two ways. Within the Detroit DOT service area, it has been assumed that a collector service by BRT buses for park-and-ride lots and the existing DOT bus service will be sufficient. The adequacy of this Stage I assumption will be further analyzed during Stage II activities. Elsewhere in the corridor, a Dial-a-Bus feeder service is envisioned to supplement the BRT collection service at park-and-ride lots. So that feeder transfer points and park-and-ride lots may be

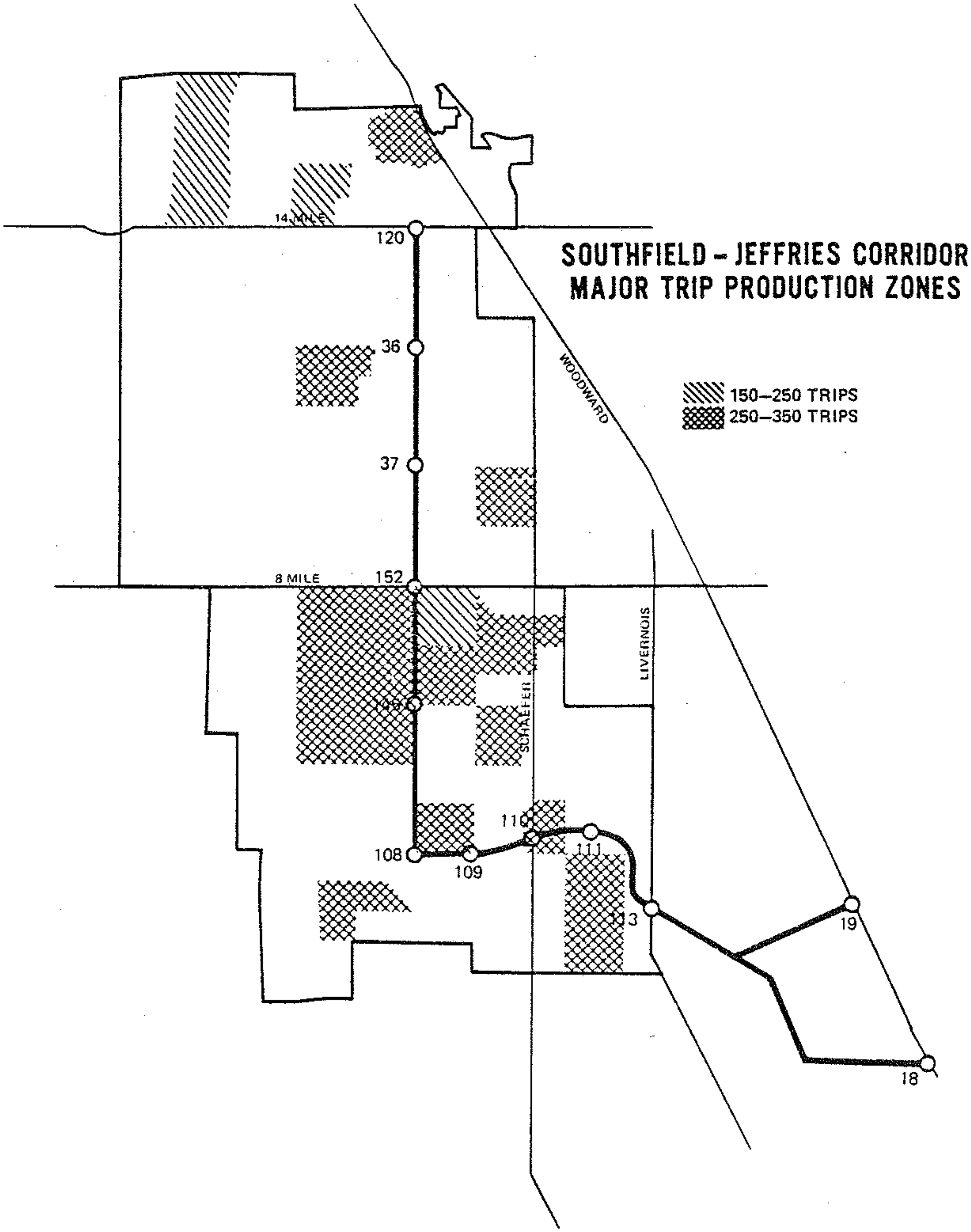

Figure 4-2 Southfield/Jeffries Corridor Major Trip Production Zones

dispersed in the vicinity of a BRT mainline route access node, each BRT bus will complete a short collection route, stopping at such locations, prior to entering the mainline route.

BRT buses providing the collection function will be destined for only a single major destination such as the CBD or New Center area. After collecting passengers in the vicinity of the access node, the BRT bus enters the mainline route at the access node and proceeds on a non-stop basis to its major destination and ultimate passenger distribution. This concept allows buses to provide the collection function at each access node area, enter the mainline route, and proceed to the destination area without the apparent time loss penalties associated with intermediate stops. The effects of an intermediate stopping policy on ridership and travel times, however, will be analyzed during Stage II activities.

Due to the special problems associated with the distribution of passengers to their destinations (e.g., traffic congestion, travel time constraints, and walking distance limitations), the distribution function is of prime importance. During Phase I of the Michigan Bus Rapid Transit Demonstration Program, BRT distribution routes were designed for the Detroit CBD, the New Center, the Dearborn Ford Complex, and the Southfield/Northland area. These routes were presented in the Phase I Final Report. The discussion and routes for the CBD and New Center presented below are taken from that report. The Dearborn and Southfield routes, however, have been expanded and refined to more closely accommodate Southfield/Jeffries corridor characteristics at these destination areas.

A common set of objectives was formulated and employed, where applicable, when establishing the distribution routes for the major destinations in the Detroit area, i.e., the CBD, New Center, Dearborn Ford Complex, and the Southfield/Northland area. Each route was structured to come within 1000 feet of major trip attractors in the distribution area. An attempt was made to optimize route length and trip time, consistent with the 1000-foot service criterion. For each distribution area, the major attractors were identified, trial routes were defined and inspected, and a proposed final route, based on trial routes, was structured.

The major trip attractors were identified using 1975 origin/destination predictions based on the 1965 TALUS data. In addition to this data, an inspection of each major destination was made to locate any new trip attractors which were constructed since the TALUS survey was made.

Trial routes, based on the attraction data, were laid out for the major destinations. These routes were designed such that buildings which are major attractors are within 1000 feet of the proposed BRT distribution routes. The routes were purposely structured to be short with relatively few turns. In addition, roads wide enough to allow an exclusive bus lane, where desirable, were selected. Routes satisfying these criteria provide an acceptable compromise between travel time for the route and ease of access for BRT patrons.

The trial routes were inspected, route distances were measured, and travel times by car were noted. By observing potential points of congestion and delay, some route segments were deemed not viable and were, therefore, eliminated.

For the areas of dense employment concentration (the CBD and New Center where traffic is relatively congested and slow moving) an attempt was made to utilize contra-flow implementation. Contra-flow lanes are self-enforcing (assuming headways are reasonably short). Traffic congestion and resulting delays do not affect travel in the exclusive contra-flow lane. Finally, when contra-flow lanes on perpendicular streets are arranged such that buses make left turns, the bus could, if provided with a priority left-turn signal, complete the turn without delay.

To negotiate a left turn from a contra-flow lane, the bus would have to cross the lane of oncoming, one-way traffic, assuming the bus entry/exit doors were adjacent to the curb. Traffic signaling would be required to stop all traffic at the intersection except in the exclusive bus lane. The buses would be provided with a left-turn arrow which would be illuminated only long enough to allow the bus to complete the turn. The left-turn arrow would be illuminated once during every cycle of the traffic signals. If preferred, the buses could be equipped with signaling devices such that the left-turn arrow is illuminated only when a BRT vehicle is waiting to negotiate the turn. Special traffic signaling would be necessary only for the intersections where buses are required to turn, not at the intersections where the buses merely go straight. However, standard signal heads facing the reverse flow direction on the contra-flow lanes would have to be added.

The distribution routes for the Southfield/Northland area and Dearborn Ford complex provide service to rather widely dispersed areas of employment. This wide dispersion coupled with the relatively low peak-hour destination trip volumes in the areas would not warrant exclusive use of lanes by the BRT buses providing the distribution function. Therefore, no exclusive bus lanes were planned for these two areas.

The proposed distribution routes for the major destinations in the Detroit metropolitan area represent implementations providing service to the majority of transit trip attractors in each area, via the shortest route, as quickly as possible, while minimizing the likelihood of delay. The distribution routes and discussions for the Detroit CBD and New Center areas are taken from the Michigan Bus Rapid Transit Demonstration Program Phase I Final Report. It was not deemed necessary to alter these distribution routes for the Stage I analysis effort. However, coverage has been expanded for the Dearborn and Southfield areas. Detailed discussions of the distribution routes follow.

4.2.1 Detroit CBD Distribution

The proposed CBD distribution loop is shown in Figure 4-3. The route, as shown, is two miles long. Buses travel counter-clockwise around the loop, and for most of the route, the implementation is contra-flow on one-way streets. The proposed route is felt to be the best implementation at present. However, as major trip attractors in the CBD shift, for example, when the Renaissance Center opens, the route can easily be shifted to accommodate the changes in demand concentrations. The circles drawn in Figure 4-4 represent 1000-foot radius circles about each stop showing the coverage area in the CBD.

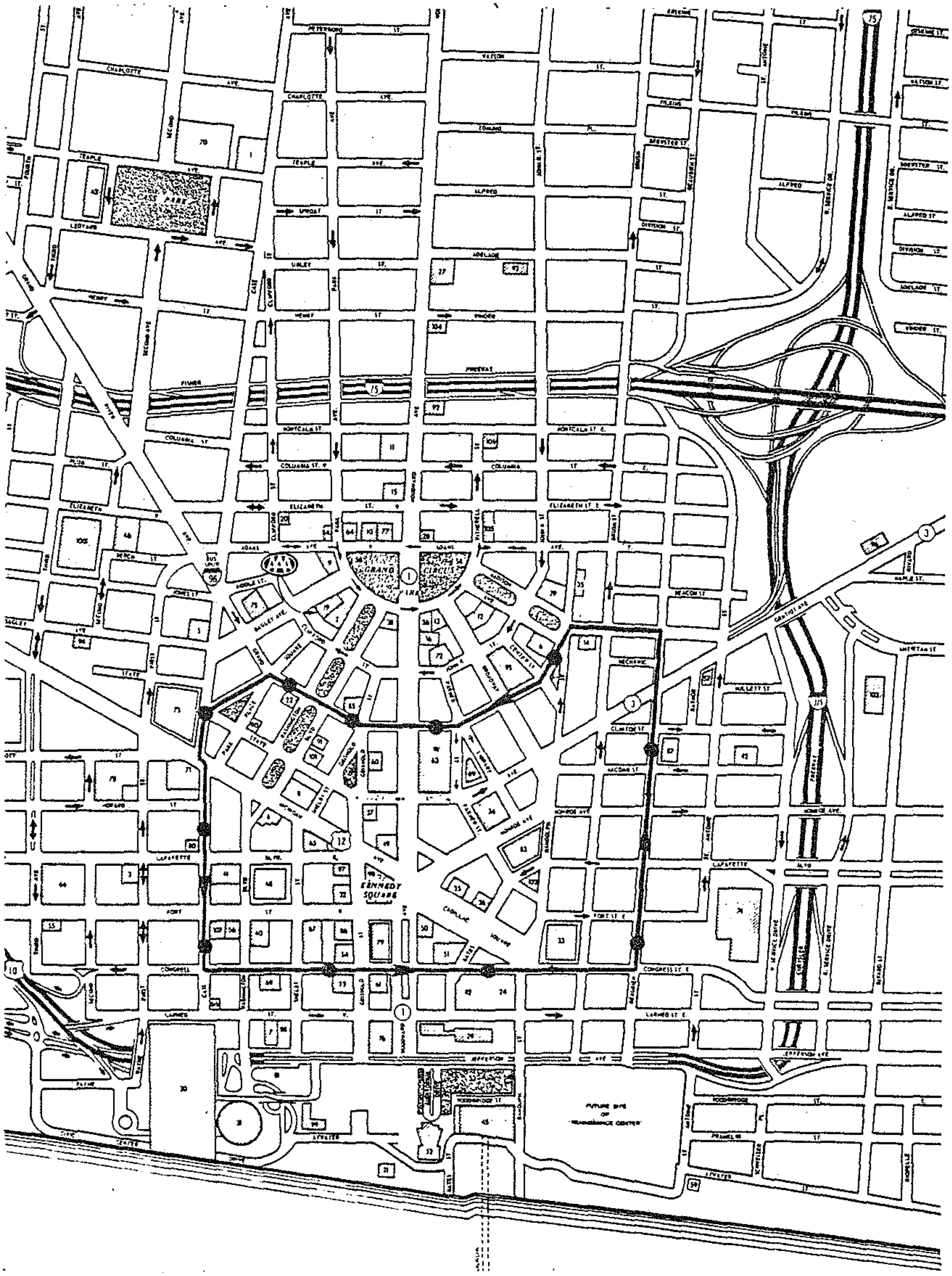

Figure 4-3 CBD Distribution Loop

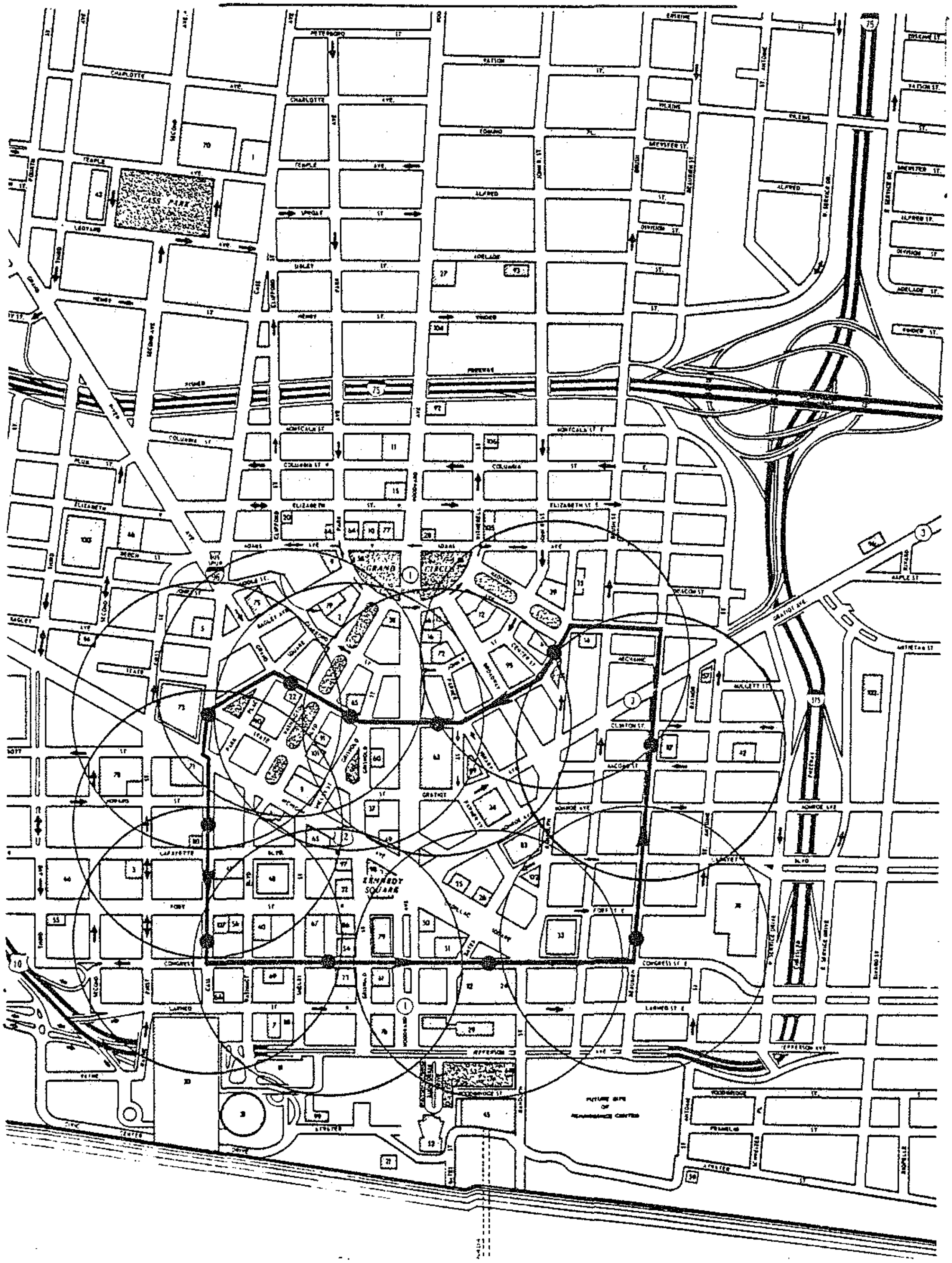

Figure 4-4 Area Coverage of CBD Distribution Loop

Starting in the southwest corner, the BRT route goes east on Congress, contra-flow on the south side of the street from Cass to Beaubien, then north on Beaubien, contra-flow in the east lane to Madison. The route then proceeds west on Madison for two blocks. Madison in this area is six lanes wide, two-way, with parking on both sides. The curb lane on the north side of the street could be reserved for BRT buses, if necessary. The route then proceeds contra-flow along Grand River to Times Square, along Times Square free flow to Cass, then south on Cass. Cass is adequately wide to run free flow to the Fort Street intersection. South of Fort, Cass is four lanes wide, with parking on both sides, leaving one traffic lane in each direction. Therefore, to minimize delays and to help assure rapid flow of BRT traffic, parking must be eliminated on the west lane, and that lane would then be reserved for buses. Two blocks south of Fort, Cass merges with Congress to complete the CBD loop.

To access the CBD loop, the BRT buses would exit the Jeffries at the Myrtle Street ramp onto the Jeffries service drive. They would then proceed south on the service drive to Michigan Avenue, turn east on Michigan to the CBD. At the intersection of Michigan and Cass, the buses turn south onto Cass, entering the CBD distribution loop.

The time required to complete one complete circuit of the CBD distribution loop is estimated to be 15 minutes, assuming a distribution speed of 8 mi/h.

4.2.2 New Center Midtown Distribution

The proposed distribution loop for the New Center midtown area is shown in Figure 4-5. The route shown is 4.7 miles long. Buses travel counter-clockwise around the loop. On Second Street and John R, the BRT buses run contra-flow, south on Second and north on John R. The distribution loop serves the New Center, Wayne State University, the Medical Center, the Cultural Center, and Ford Hospital.

Starting at the southeast corner, the Medical Center at the intersection of Alexandrine and John R, the New Center distribution loop follows John R north to Grand Boulevard. The buses proceed west on Grand Boulevard to the southbound service drive of the Lodge Expressway at Ford Hospital. The service drive is followed one block south to Milwaukee Avenue. The buses turn east onto Milwaukee and then south on Second to Alexandrine and east on Alexandrine to John R, completing the loop.

Access to the New Center distribution loop is accomplished from the Jeffries Freeway via West Grand Boulevard. Buses would proceed east on Grand Boulevard to the southbound Lodge service drive. Turning onto the service drive, the buses would enter the New Center distribution loop.

The route, as shown, has six proposed stops serving the major trip attractors in the area. These stops are tentative; changes in demand may dictate adding, deleting, or moving stops. The estimated time necessary to complete one circuit of the loop is 28 minutes, assuming a distribution speed of 10 mi/h.

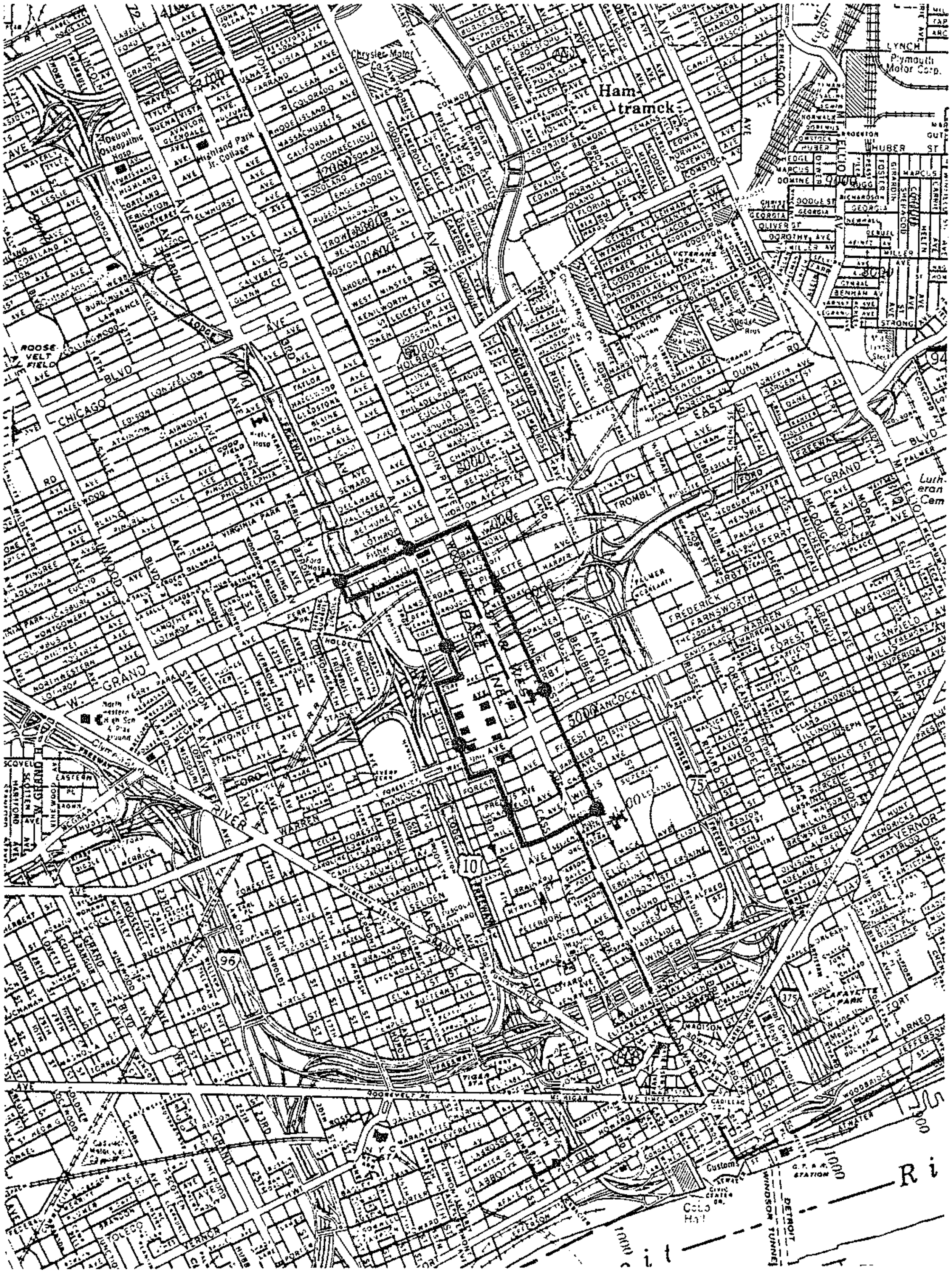

Figure 4-5 New Center Distribution Loop

4.2.3 Dearborn Ford Complex Distribution

Two separate distribution routes are proposed to provide BRT distribution service to the Dearborn Ford Complex. One route would serve only the Ford Rouge Plant. The other route would service the Michigan American Automobile Association (AAA) Building, the Parklane Towers, the Ford Central Staff Building, the Ford Division Building, and the Ford Research and Engineering Center. Both routes are illustrated in Figure 4-6.

The Rouge Plant is served from Miller Road. The BRT buses would exit Southfield at Rotunda, proceed west on Rotunda, and turn south onto Miller Road to the Rouge Plant. Peak demand for this route would occur at an earlier hour than the other Dearborn distribution route as a result of the different starting times for the workers at the manufacturing plant versus the office buildings.

The remaining Dearborn route would serve six office complexes. Beginning at the southbound Southfield Freeway service drive at Ford Road, the BRT buses would stop at the large AAA facility to off-load passengers. From AAA the buses would proceed south on the service drive to Hubbard, west on Hubbard to Parklane Boulevard, and north on Parklane to the Parklane Towers. After stopping at the Towers, the buses would proceed south on Parkland to Hubbard, turn east on Hubbard to Mercury Drive, turn south on Mercury Drive to Michigan, and west on Michigan to the Ford Central Staff Building. From the Central Staff Building, the route proceeds west on Michigan to Southfield, south on the Southfield service drive to the Ford Division Building at Rotunda. From the Ford Division Building, the buses proceed west on Rotunda to the Ford Research and Engineering Center. From there, the buses would go to the Ford Engineering Buildings on Oakwood Boulevard. There are two alternative routes between the Ford Engineering Buildings. For one, the buses would go east on Rotunda and then turn west on Oakwood to the Engineering Buildings. The other route would use private roads internal to the Ford Complex. The internal route is the more desirable, but would require approval for use.

The Rouge route from Southfield Road to the plant is approximately 3.6 miles long. Assuming a bus speed of 20 mi/h, the trip would take approximately eleven minutes. The "office" route is approximately 6.5 miles long, assuming the internal Ford roads are not used. For this route, assuming a distribution speed of 15 mi/h, 26 minutes would be required to traverse the entire length. A slower distribution speed is assumed for the office route to account for the time necessary to make the various stops.

4.2.4 Northland/Southfield Distribution

The Northland/Southfield distribution function would be provided by BRT buses and shuttle buses. The BRT buses would serve the Northland area, and a transfer point would be provided at Northland such that BRT patrons could board a shuttle bus serving the businesses to the northwest along Northwestern Highway.

Figure 4-6 Proposed Distribution Routes for Dearborn Ford Complex

A shuttle bus is considered advantageous because it would reduce the total trip time for BRT patrons who would otherwise be on the end of a long circuitous distribution route served by BRT buses only. If necessary, several shuttle buses could be operated on diverse routes to further speed travel. The use of shuttle buses would also allow the BRT buses to return to line-haul service sooner.

The Northland distribution route, served by BRT buses, is approximately 2 miles long and is illustrated in Figure 4-7. Assuming a 10 mi/h distribution speed, approximately 12 minutes would be required to complete the route. The route begins at Greenfield and Eight Mile. The first stop is made along the service drive to Northwestern Highway at Eight Mile, where the large office buildings south of Northland are served. The buses then proceed along the service drive to the bus station at Northland where BRT patrons may board the shuttle bus accessing the businesses along Northwestern Highway. After the Northland stop, the buses proceed along the service drive to J. L. Hudson Drive, northeast on J. L. Hudson to Providence Drive, then north on Providence to Providence Hospital. After the hospital stop, the buses turn west onto Nine Mile Road and stop at the Honeywell Office Building, completing the route.

The shuttle route is approximately seven miles long and is shown in Figure 4-7. Assuming a 15 mi/h distribution speed, the route would take approximately 28 minutes to complete. Beginning at the bus station at Northland, the shuttle bus would travel along the Northwestern Highway service drive to Southfield Road. The buses turn from Southfield into the Bell Telephone facility south from Mt. Vernon. From Bell, the buses return to the service drive of Northwestern Highway and proceed to the Prudential Towers. From the Towers the buses turn west on Civic Center Drive, stop at Bendix, turn north on Central Park Boulevard, stop at the Traveler's Building, return south on Central Park, and return to the service drive via Civic Center Drive. At Lahser the bus crosses over the highway and stops at Federal Mogul. From there it travels southeast on the service drive and stops at IBM west of Evergreen, completing the route.

4.3 Travel Time Analysis

4.3.1 Travel Time Comparisons

Bus rapid transit is intended to compete effectively with other transportation modes currently available in Metropolitan Detroit. One of the most important attributes of any transportation mode is the portal-to-portal travel time for a particular trip. Therefore, portal-to-portal travel time was chosen as the basis for comparison of alternative transportation modes for the Southfield/Jeffries corridor.

The following transportation modes were compared for a particular trip:

- Automobile
- Local Bus
- "Conventional" Express Bus
- Bus Rapid Transit

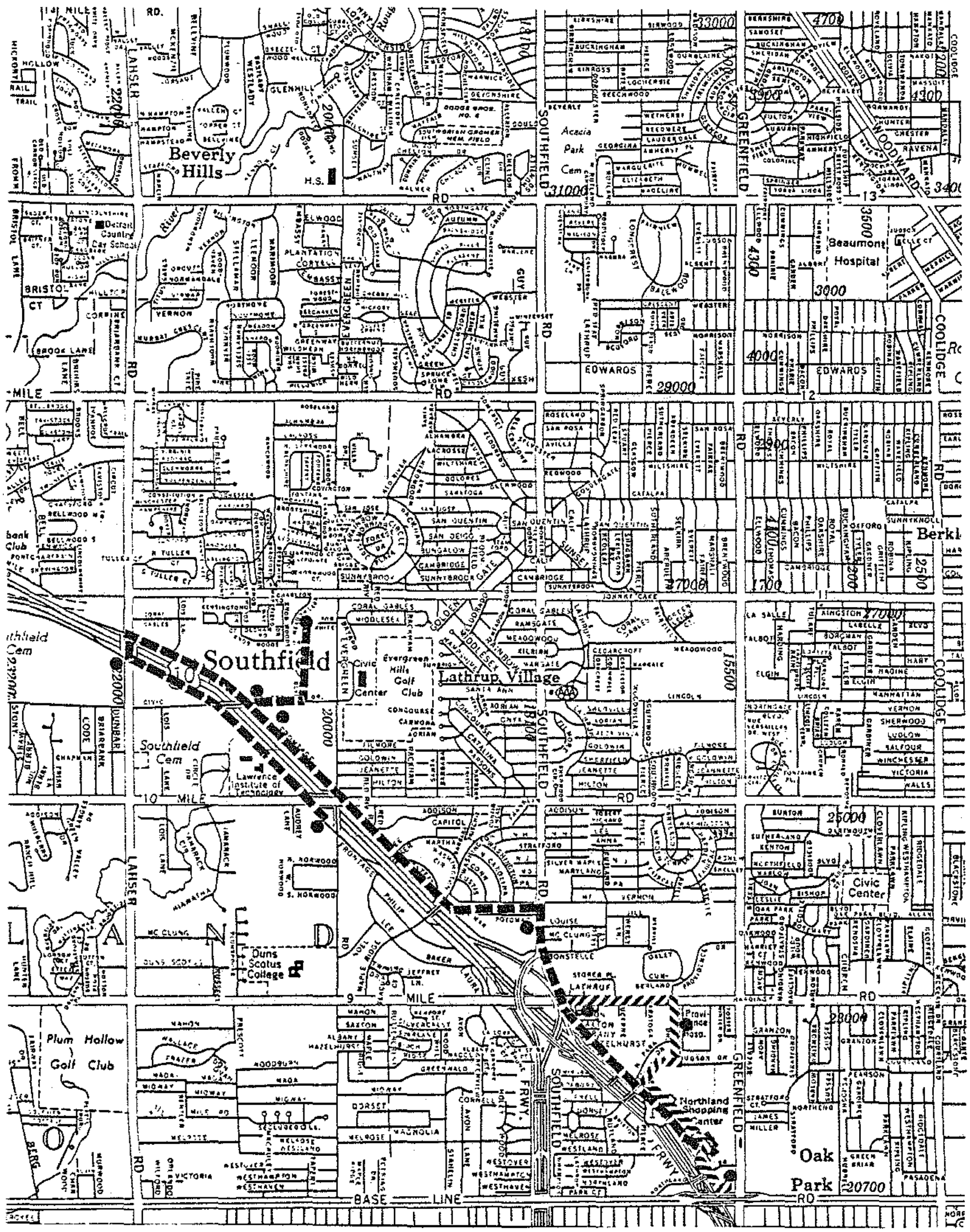

Figure 4-7 Southfield/Northland Distribution Route

4.3.2 Travel Time Elements

A "typical" trip in the corridor was selected for the travel time comparison. This trip is merely a representative example and does not depict a minimum, maximum, or average trip in the corridor.

The following three explicit distance elements comprise the example trip (it is assumed that an identical path is followed, regardless of travel mode, for the particular origin/destination zone pair):

- Travel from the origin zone centroid to the nearest corridor mainline access point
- Travel along the mainline BRT route
- Travel to the destination zone centroid from the mainline egress point nearest that location

For the "typical" trip chosen, i.e., an origin in northwestern Detroit to a destination in the Detroit CBD, the travel distance along the mainline BRT route was divided into three segments, each with a different travel speed. The three segments comprising the mainline distance for this trip are: 3.52 miles on the Southfield Freeway; 8.72 miles on the Jeffries Freeway; and 1.96 miles on Michigan Avenue.

Distances are implied, but not specifically stated in two additional elements of the bus trips considered. First, time is allowed for a walk from the traveler's residence to a nearby bus stop. Also, a time is identified for a walk from the drop-off bus stop to the traveler's ultimate destination. Auto trips include an implied travel distance in the time allowed for the traveler to locate a parking space, park the car, then complete the trip.

Other travel time elements are not related to trip distances. For bus trips, these elements include a waiting time at the initial bus stop and, for all bus modes except BRT, a bus transfer time (at the intersection of two local bus routes or at the interface between a local bus and an express bus). For auto trips, time is allowed to start the car.

4.3.3 Travel Time Program

A computer program was developed to perform the task of calculating portal-to-portal travel times associated with various transportation modes in the corridor. The program also computes the bus-to-automobile travel time ratio for each type of bus transit being examined.

The program includes several assumptions regarding travel by each mode. For automobile trips, the following assumptions were applied:

• Start car (minutes)	1.0
• Travel to mainline entry point (mi/h)	25.0
• Travel to parking lot from mainline exit point (mi/h)	15.0
• Park and walk to CBD destination (minutes)	7.0

Local bus, express bus, and BRT trip assumptions are listed below:

• Walk to bus stop (minutes)	5.0
• Wait for bus (minutes)	5.0
• Travel to mainline entry point (mi/h)	15.0
• Transfer to second bus, except BRT (minutes)	5.0
• Travel to drop-off bus stop from mainline exit point (mi/h)	8.0

The mainline travel speeds (in mi/h) assumed for each travel mode are listed below:

• Automobile	
- Southfield Freeway	36.7
- Jeffries Freeway	50.0
- Michigan Avenue	15.0
• Local Bus	13.5
• Express Bus	17.7
• Bus Rapid Transit	
- Southfield Freeway	36.7
- Jeffries Freeway	50.0
- Michigan Avenue	15.0

The automobile travel speeds on the Southfield Freeway and on Michigan Avenue are based on a limited number of peak-hour speed runs by GM TSD personnel. The automobile speed for the Jeffries Freeway is an estimate based on present traffic volume and the capacity of the freeway when completed. In all cases, it is assumed that BRT speeds equal those of automobile traffic. The local bus speed is based on existing local bus service along Michigan Avenue. The express bus speed is based on existing express bus service on Grand River.

The results of the travel time comparison run for the Southfield/Jeffries Corridor, in addition to the trip-specific input data, are shown in Table 4-2.

4.4 Limited Modal Split Analysis

An estimate of anticipated BRT ridership is a major input to the corridor sketch planning process. The modal split analysis technique utilized in Phase IA, Stage I of the BRT program is essentially that employed in Phase I and fully described in the Phase I Final Report. This section briefly discusses the modal split process and presents the results obtained.

Enter Corridor Access Distance	1.69	
Enter Corridor Egress Distance	.14	
Enter Mainline Segments Distance & Auto BRT Speed:	Dist.	Speed
Southfield Fway	3.52	36.7
Jeffries Fway	8.76	50.0
Michigan Ave.	1.96	15.0
Enter Local Bus Speed	13.1	
Enter Express Bus Speed	17.7	

Auto Travel Time	
Start Car	1.00
Mainline Access	4.06
Mainline Travel	24.11
Mainline Egress	0.56
Park & Walk to Destination	7.0
Total Auto Travel Time	36.72

Express Bus Travel Time	
Walk to Bus Stop	5.00
Wait for Bus	5.00
Mainline Access	6.76
Transfer to 2nd Bus	5.00
Mainline Travel	48.27
Mainline Egress	1.05
Walk to Destination	5.00
Total Express Bus Travel Time	76.03

Walk to Bus Stop	5.0
Wait for Bus	5.00
Mainline Access	6.76
Transfer to 2nd Bus	5.00
Mainline Travel	65.22
Mainline Egress	1.05
Walk to Destination	5.00
Total Local Bus Travel Time	93.03

Walk to Bus Stop	5.0
Wait for Bus	5.00
Mainline Access	6.76
Mainline Travel	24.11
Mainline Egress	1.05
Walk to Destination	5.00
Total BRT Travel Time	46.92

Local Bus/Auto Travel Time Ratio	2.53
Express Bus/Auto Travel Time Ratio	2.07
BRT/Auto Travel Time Ratio	1.28

Table 4-2 Southfield/Jeffries Travel Time Comparison

4.4.1 Modal Split Process

The first step of the modal split process for each corridor variation was to employ a computer program to read the corridor's 1965 peak-period trip file, adjust the numbers of trips according to origin district 1975/1965 population ratios, assign trips to BRT route access/egress points, and produce a file containing the following information for each origin/destination zone pair:

- Origin zone number
- Destination zone number
- Total number of trips (all modes)
- BRT route access distance by transit
- BRT route travel distance by transit
- BRT route egress distance by transit
- BRT route access distance by automobile
- BRT route travel distance by automobile
- BRT route egress distance by automobile

The next step was to estimate the fraction of the trips between each zone pair likely to be taken by BRT (that is, the BRT modal split). As in Phase I of the BRT program, the Peat, Marwick, Mitchell (PMM) and Company aggregate modal split model was utilized. (The same model, with different system operating characteristics was used by SEMCOG to predict ridership for the proposed SEMTA 1990 transit system.) The model is based upon the assumption that the selection of a travel mode by a person who has decided to make a particular trip depends upon the following factors:

- Economic status of the trip maker
- Trip purpose (not used in Detroit)
- Relative level of service provided by priate auto and public transit, expressed in terms of door-to-door travel time
- Relative convenience provided by the private auto
- Relative perceived cost of making the trip by private auto and public transit, expressed in terms of out-of-pocket expenditures

The PMM and Company modal split model consists of 80 diversion curves relating the above factors to the propensity to use transit. The first factor (economic status of the trip maker) is accounted for by tabulating the household income classification of each origin zone. Relative level of service is specified as the door-to-door travel time ratio of BRT and auto travel between each zone pair. Table 4-3 lists the time and speed assumptions used in computing travel times for each of the three basic corridor variations. Convenience of the private auto relative to transit is measured as an excess time ratio (that is, the ratio of the out-of-vehicle travel time components for the two modes). Finally, perceived travel costs consist of fare for transit and parking and out-of-pocket expenses (rather than total operating and ownership cost) for auto.

Table 4-3 Modal Split Analysis Parameter Values

Modal Split Parameter	Southfield/Jeffries Corridor	Southfield Corridor	Southfield/Jeffries Corridor (Northbound)
BRT Collection Speed (mi/h)	10.0	10.0	10.0
BRT Line-Haul Speed (mi/h)	42.3	36.7	42.3
BRT Distribution Speed (mi/h)	8.0	8.0	8.0
Walking Time to Bus Stop (min)	5.0	5.0	5.0
Bus Stop Waiting Time (min)	5.0	5.0	5.0
Walking Time from Bus Stop to Destination (min)	5.0	5.0	5.0
Auto Collection Speed (mi/h)	25.0	25.0	25.0
Auto Line-Haul Speed (mi/h)	42.3	36.7	42.3
Auto Distribution Speed (mi/h)	15.0	15.0	15.0
Time to Start Auto (min)	1.0	1.0	1.0
Time to Park & Walk to CBD Destination (min)	7.0	7.0	7.0
Time to Park & Walk to Activity Center Destination (min)	3.0	3.0	3.0
Time to Park & Walk to Local Destination (min)	2.0	2.0	2.0
Parking Cost (dollars)	0.50	0.50	0.50
Average One-Way BRT Fare (dollars)	0.45	0.45	0.45

4.4.2 Modal Split Results

A modal split computer program (incorporating the PMM and Company diversion curves) was run to produce a transit trip matrix for each corridor variation. These trips were then screened to eliminate those not having at least two miles of travel on the BRT route. Modal split analysis results are summarized in Table 4-4. A map of major BRT trip production zones relative to the Southfield/Jeffries BRT route is presented in Figure 4-8. Figures 4-9 and 4-10 illustrate the number of trips entering the Southfield/Jeffries BRT route at each node with destinations in the Detroit CBD and New Center area, respectively. Figure 4-11 indicates the number of trips to the Dearborn area entering the Southfield BRT route at each node, while Figure 4-12 shows trips to Southfield entering the Southfield/Jeffries northbound BRT route.

Table 4-4 BRT Modal Split Summary

Corridor	Total Trip	BRT Trips	Modal Split (%)
Southfield/Jeffries	21,311	9,842	46.2
Southfield/Jeffries with West Jeffries Extension	26,370	12,219	46.3
Southfield Dearborn	3,484	811	23.3
Southfield/Dearborn with West Jeffries Extension	6,126	1,629	26.6
Southfield/Jeffries Northbound	2,400	473	19.7
Southfield/Jeffries Northbound with West Jeffries Extension	3,150	715	22.7

4.5 BRT System Sizing

In this section, the rationale and assumptions associated with determining the number of buses and other facilities are described. First, the process used to calculate the number of line-haul buses is described, then the sizing of the Dial-a-Bus feeder system is discussed. Total vehicle operating hours per year are estimated as a first step toward determining labor requirements. Finally, the number of park-and-ride spaces and bus shelters are determined.

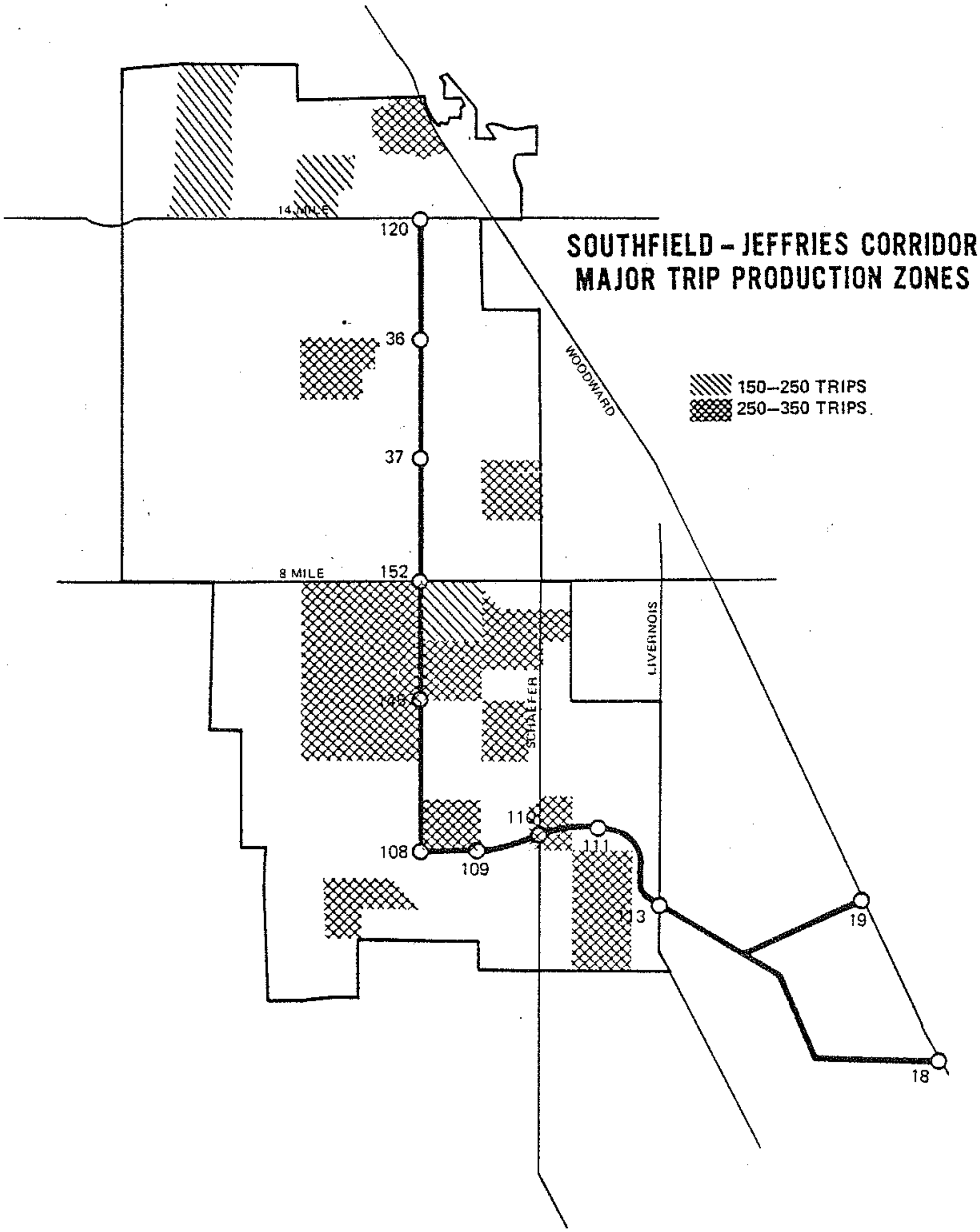

Figure 4-8 Southfield/Jeffries Corridor
Major Trip Production Zones

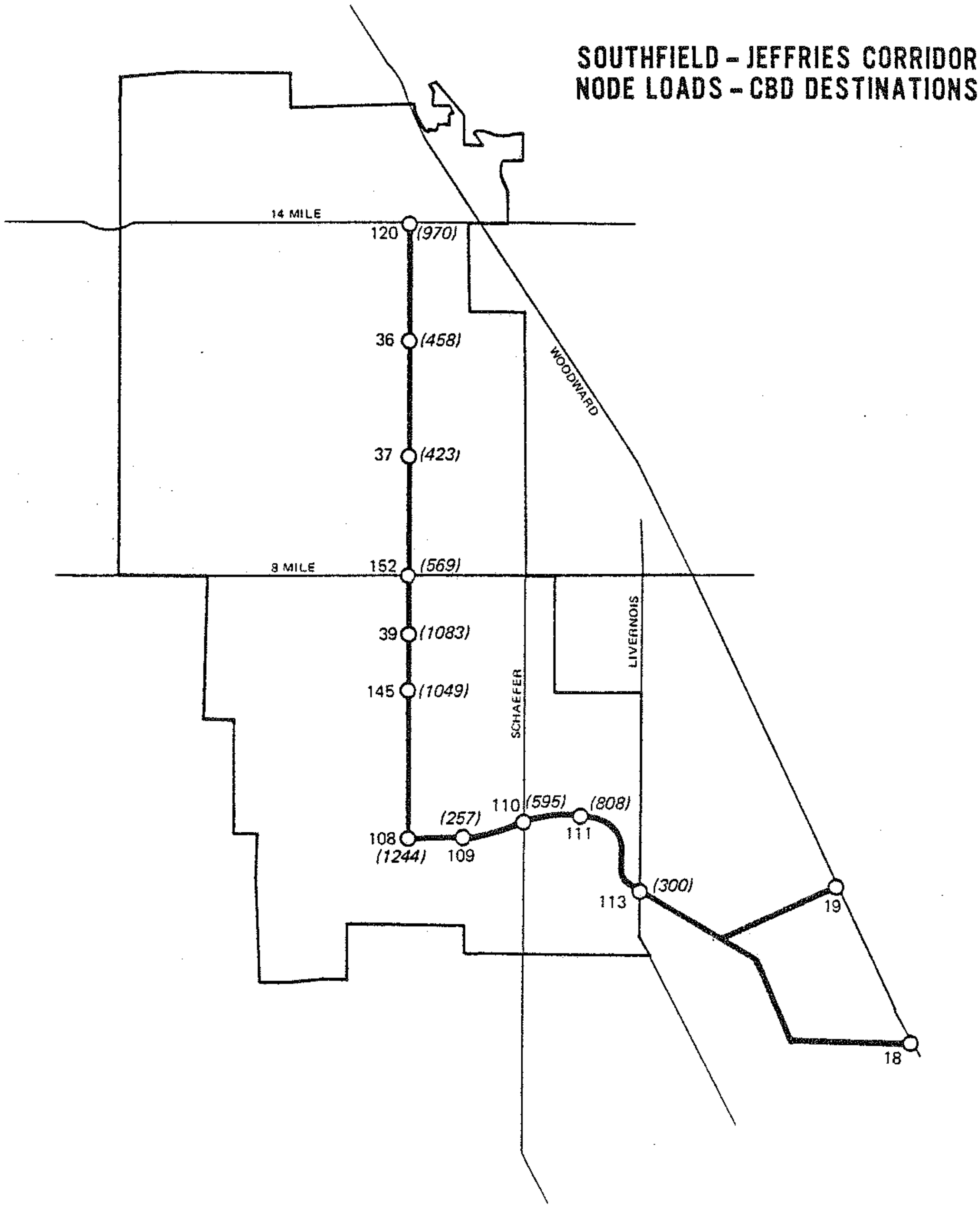

Figure 4-9 Southfield/Jeffries Corridor
Node Loads - CBD Destinations

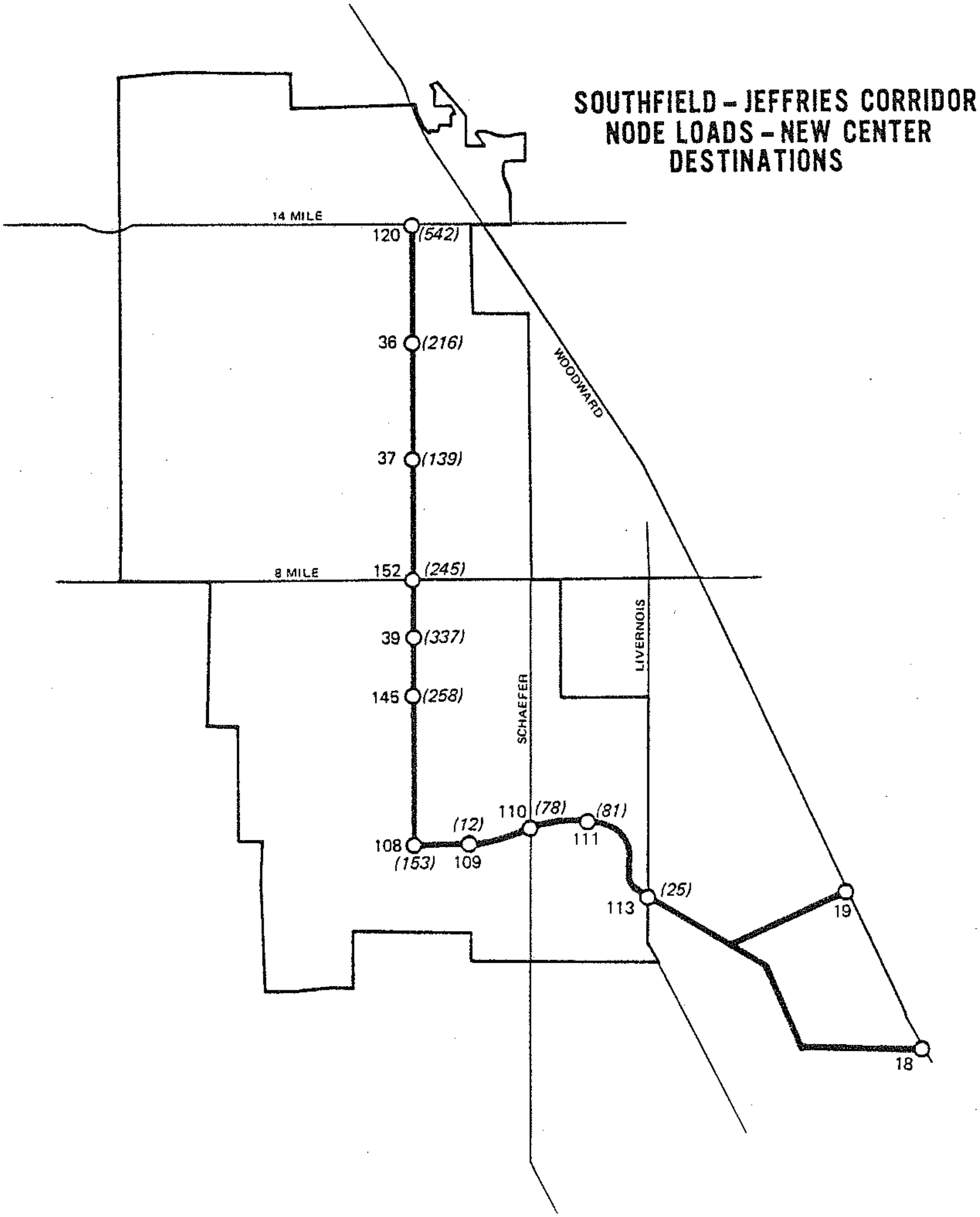

Figure 4-10 Southfield-Jeffries Corridor
Node Loads - New Center Destinations

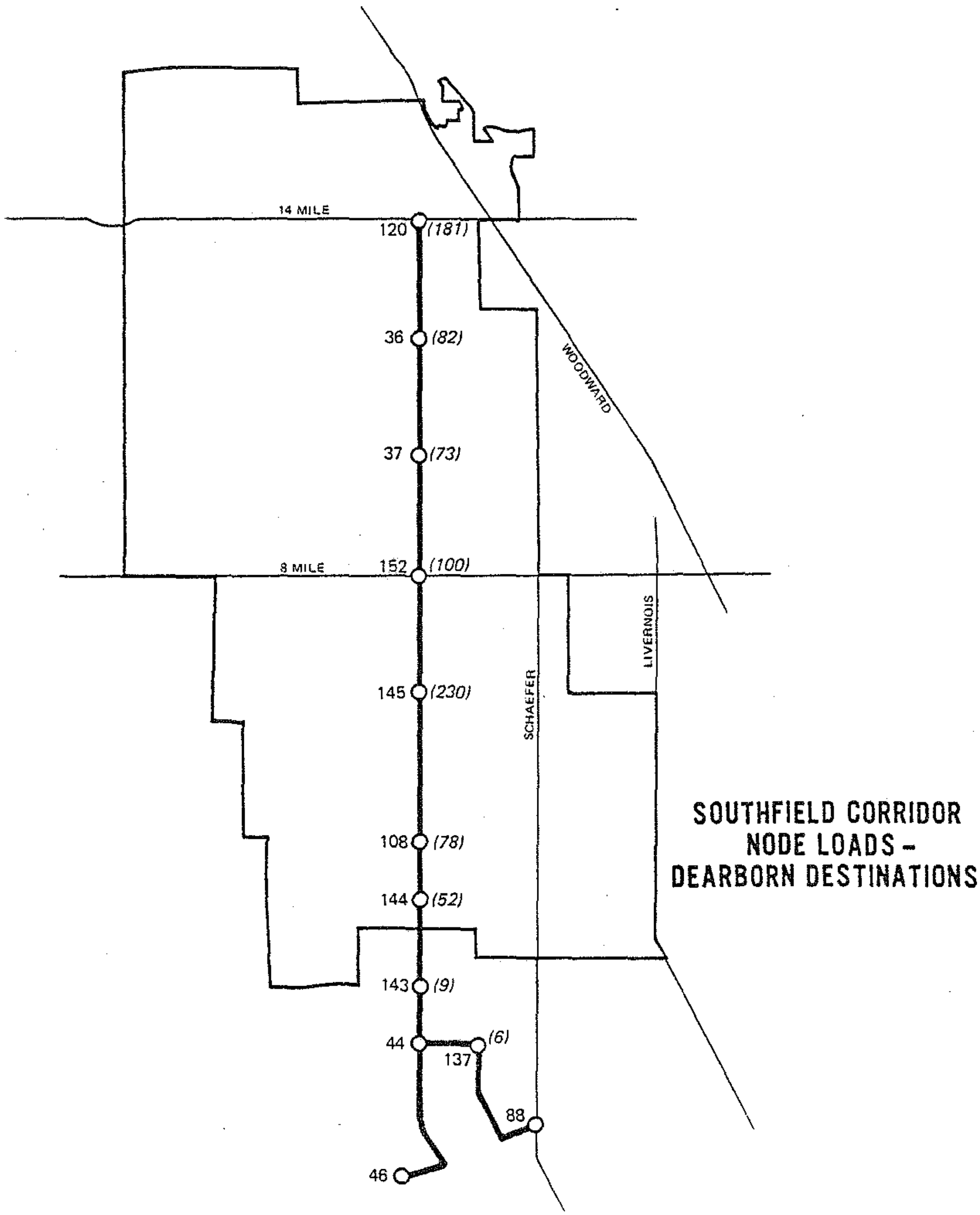

Figure 4-11 Southfield Corridor Node Loads - Dearborn Destinations

GM Transportation Systems

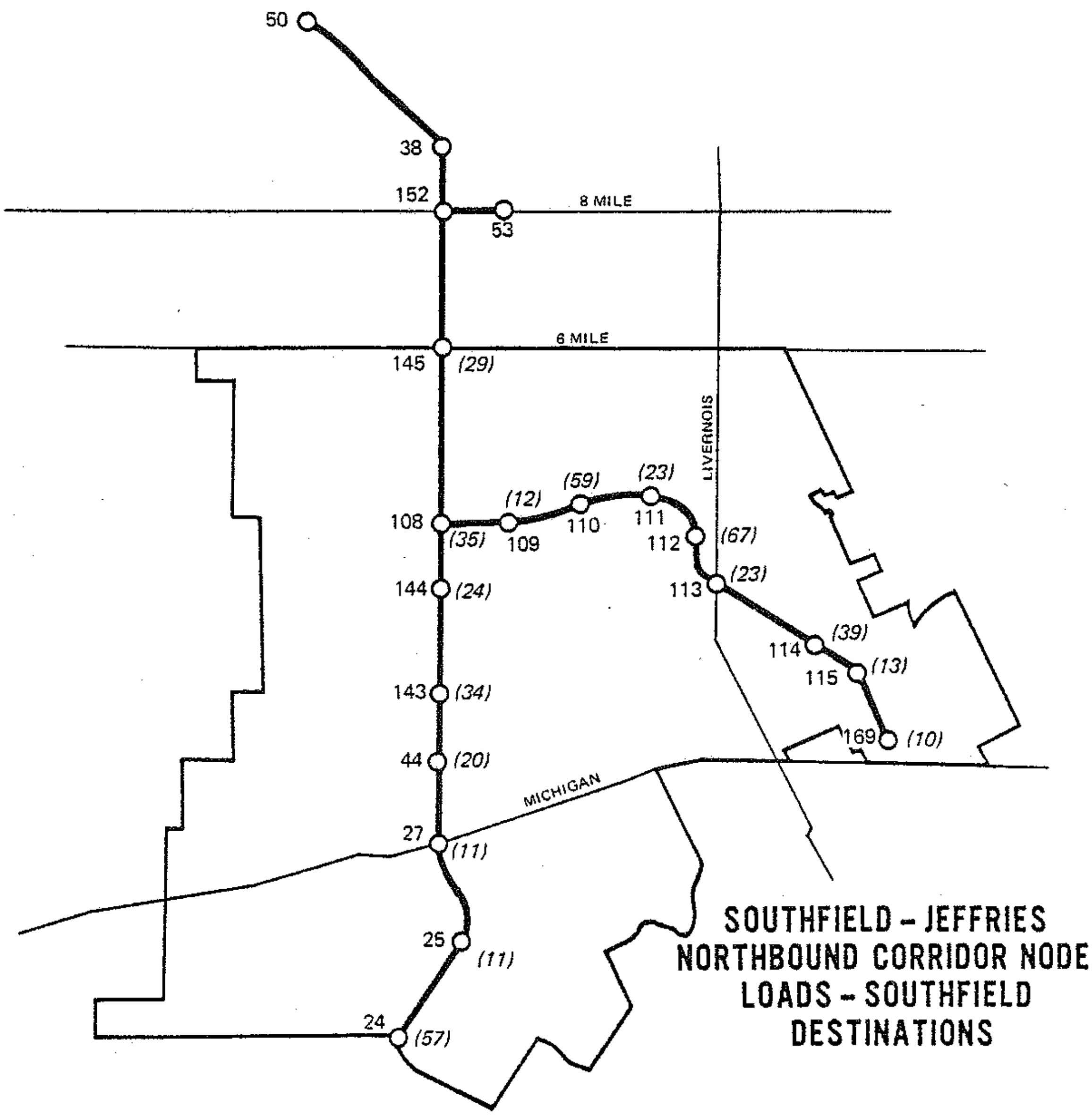

Figure 4-12 Southfield/Jeffries Northbound Corridor Node Loads - Southfield Destinations

4.5.1 BRT Bus Requirements

The number of buses required to provide BRT service from each corridor access point to each major destination during the peak period was determined, based on a simple bus scheduling process. The BRT route is assumed to consist of three parts: a collection phase, a line-haul phase from a particular corridor access node to a particular destination, and a distribution phase at that destination. In the scheduling process, buses are assigned to particular routes and are not reassigned to other routes during the peak period. Both the demand for each route and the number of round trips per bus during the peak period were considered in determining the number of buses required for the corridor.

The time required to complete a round trip on each route was calculated. The time required for the collection phase of each route is assumed to be 30 minutes. The CBD distribution loop is two miles in length. Assuming an average speed of eight mi/h, 15 minutes would be required to complete the loop. The New Center distribution loop is 4.6 miles long. At 10 mi/h, 28 minutes would be required to traverse the loop. The round-trip time for each route also includes an additional 10 minutes for layover and schedule adjustment.

The peak-period BRT demand for each destination associated with each corridor access node was analyzed in the system sizing process. This demand information is summarized in Figures 4-9 and 4-10. In order to avoid the costs of providing BRT service to areas where it is not warranted by sufficient demand, routes which serve fewer than 85 passengers in the peak period were eliminated. This resulted in the elimination of 196 trips from the Southfield/Jeffries corridor demand.

In order to match the required number of bus trips to the BRT demand, the peak period time distribution of demand was determined by analyzing the TALUS Survey data. The time distribution is shown in Table 4-5.

Table 4-5 Time Distribution of Demand in Peak Period

Period	Time Segment	Percent of Peak-Period Demand
Pre-Peak	7:00 - 7:30	10
First Peak	7:30 - 8:30	50
Second Peak	8:30 - 9:30	30
Post-Peak	9:30 - 10:00	10

It is assumed that the demand is uniformly distributed in time during each time segment.

The number of bus trips required to serve the demand for each route during each time segment was determined. The round-trip time and bus occupancy assumptions were then used to determine the number of buses required to make those trips, taking into consideration the number of repeat trips possible during the peak period. A 90 percent load factor is assumed for BRT buses operating in the first and second peak hours (from 7:30 to 9:30) and a 70 percent load factor is assumed for the pre-peak and post-peak half hours. The BRT vehicles are assumed to be 53-passenger coaches.

The total number of trips and buses required to satisfy the demand for each major destination in the corridor is provided in Table 4-6. The number in parentheses in the last column is the total number of BRT vehicles required, including a 7 percent maintenance float to account for buses which may be out of service for one reason or another.

Table 4-6 Southfield/Jeffries Peak-Period BRT Bus Requirements

Destination	BRT Demand	Number of Bus Trips	Number of BRT Buses
CBD	7756	185	119
New Center	1890	53	34
Total	9646	238	153 (164)

The peak-hour BRT vehicle headway, expressed in seconds, is tabulated in Table 4-7 for three locations in the corridor. The minimum headway in the CBD loop, the New Center loop, and at the maximum load point of each corridor is presented. The maximum load point of each corridor occurs on the approach to the CBD and New Center areas. The numbers in parentheses indicate the maximum number of buses per hour which pass through each of the three locations.

Table 4-7 Southfield/Jeffries Corridor Peak-Hour Headway (Seconds)

CBD Loop	New Center Loop	Maximum Load Point
42.9 (84)	156.5 (23)	33.6 (107)

Table 4-8 gives the number of BRT vehicle operating hours and vehicle miles for the Southfield/Jeffries corridor. The figures were generated by considering each route separately in the peak period. Driver scheduling was not attempted in this phase, so the number of drivers required to provide service in the corridor was not explicitly determined. However, total vehicle operating hours can be used to give at least a relative measure of labor requirements in the corridor.

Table 4-8 BRT System Operating Characteristics
Southfield/Jeffries Corridor

Vehicle Hours Per Day	Vehicle Hours Per Year	Vehicle Miles Per Day	Vehicle Miles Per Year
806.2	205,581	16,792.6	4,282,113

4.5.2 Feeder System

In Detroit, it is assumed that DOT buses provide adequate BRT feeder service. DOT also provides bus service to the high-density triangle in Southfield bordered by Northwestern Highway, Nine Mile, and Greenfield Road. In the area north of Eight Mile, SEMTA also provides some limited service. However, since it does not provide the coverage necessary for BRT feeder service, Dial-a-Bus (DAB) feeder service will be provided in this area.*

These buses would also be used to provide off-peak service in the area of the corridor outside Detroit. In the off-peak time passengers coming from the CBD would take regular DOT buses to Northland and then transfer to the DAB service. The off-peak service is assumed to operate in the same area as the peak service; however, the demand in the off-peak hours is assumed to be 5 percent of the demand during the peak hour. Eight hours of off-peak operation are assumed each weekday.

The number of passengers entering the BRT system during the peak period is known for each node, or entry point, on the corridor. It is assumed that one DAB zone is associated with each transit node outside the city of Detroit. As mentioned earlier, the peak hour transit demand is assumed to equal 50 percent of the peak-period demand. It is further assumed that 40 percent of the BRT passengers access the system via DAB. Using these assumptions, the peak-hour DAB demand can be calculated.

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* Phase I analysis showed the potential advantage of DAB feeder service over fixed-route/fixed-schedule feeder service for the range of demand density encountered in the suburban areas.

As in the Phase I report, several assumptions were made in order to estimate the number of DAB vehicles required to serve a given demand. The DAB vehicle is assumed to be a small, 10-17 passenger vehicle. The average number of passengers who are picked up by a DAB vehicle during one round trip through the zone is assumed to be ten. The number of DAB vehicles is given by the following formula:

$$Nb = \left(\frac{D}{10\,n_t}\right) Fm \qquad (1)$$

where Nb = Number of DAB vehicles required for the peak hour

D = Number of passengers requesting DAB pickup during the peak hour

n_t = Number of vehicle round trips per peak hour

Fm = Maintenance float factor to account for vehicles which may be out of service at any given time (1.07)

The number of vehicle trips per peak hour is the inverse of the round trip time in hours. The following assumptions are made to determine round-trip time:

- One minute is required to unload passengers at the bus stop
- The average vehicle speed between passenger pickups is 25 mi/h
- The average distance between passenger pickups is 1 mi
- The average time required for each passenger who is picked up to board the vehicle is 1 minute
- Each bus picks up 10 passengers

Using these assumptions, the average round-trip time equals 35 minutes. The number of vehicle round trips per hour, n_t, equals 1.71.

The relative magnitude of the DAB feeder operation is shown in Table 4-9. The number of vehicle operating hours and vehicle miles are listed for the corridor for both peak and off-peak service. The number of vehicle operating hours per day is a function of passenger demand. The average number of operating hours per peak hour vehicle is 4 for the a.m. and p.m. peak periods and 0.4 for the off-peak period. (The number of peak-hour vehicles is equal to Nb divided by 1.07, the maintenance float factor.) The number of vehicle miles per day is determined by multiplying the number of vehicle operating hours by the assumed average velocity of 15 miles per hour.

Using Equation (1), the number of DAB vehicles was calculated. Table 4-10 provides a summary of the results.

Table 4-9 DAB Feeder System Operating Characterstics

Corridor	Vehicle Hrs/Day	Vehicle Hrs/Yr	Vehicle Mi/Day	Vehicle Mi/Yr
Jeffries				
Peak	112	28560	1680	428,400
Off-Peak	11	2805	165	42,075
Total	123	31365	1845	470,475

Table 4-10 DAB Sizing Results

Corridor	Node Number	Number of Pass. Entering (Np)	Peak-Hr DAB Demand (D) = Np (.5) (.4)	Number of DAB Vehicles (Nb)
Jeffries	120	970	194	12
	36	458	92	6
	37	423	85	5
	152	569	114	7
Total		2420	485	30

In addition to determining the number of DAB vehicles required, it is also necessary to size the control system required to operate the demand-responsive type of feeder system. The DAB control system includes reservation, communication, and dispatch equipment and a computer to perform the necessary passenger/bus scheduling determinations.

The elements of the DAB control system are sized based on the predicted passenger demand, number of DAB vehicles, and the physical area comprising each DAB zone. Because the BRT system serves mainly recurring, work-related trips, it is assumed that 50 percent of all DAB service is on a subscription basis. Subscription service is highly efficient, allowing pre-scheduled routes and pick-up times, thus eliminating the need for patrons to phone in reservations during the peak period. This results in a substantial reduction in reservation equipment and personnel requirements.

The DAB control equipment includes:

- Message Switching Controller - A device needed to switch from data to voice UHF frequencies depending upon communications needs

- Dispatch Equipment - The devices necessary for a dispatcher to interface with system control and communications equipment

- Satellite UHF Complex - All equipment comprising the UHF Receiver/Transmitter assemblies required to communicate with vehicles in the field

- Reservation Agent Complex - Equipment necessary to allow operators to receive reservation requests and input those requests to the system computer for scheduling

- System Management Computer - Performs the scheduling tasks for the control system

Table 4-11 provides a summary of the DAB control equipment needed for each corridor.

The labor requirements of the DAB feeder network include reservation agents and vehicle dispatchers as well as vehicle drivers. Vehicle driver requirements are a function of the total vehicle hours of operation. One vehicle dispatcher is required to be on duty during the hours of DAB system operation. The DAB system operates 14 hours per day (6 hours peak and 8 hours off-peak). Therefore, two dispatchers are required per corridor. The number of reservation agents required per corridor is a function of the predicted peak-hour passenger demand for DAB. During the off-peak period, one reservation agent is adequate to handle the reservation requirements. Because there are two peak periods daily, split shifts are assumed for reservation agents. To determine the number of reservation agents required, it is assumed that 50 percent of the peak-hour DAB trips are reserved by telephone during the peak hour. The remaining 50 percent are pre-scheduled, subscription trips. Assuming each reservation transaction requires 30 seconds to complete, the number of agents was calculated. However, a recent report concerning the operation of the Santa Clara DAB system indicates that approximately half of all

Table 4-11 Jeffries DAB Control Equipment and Labor

Item	Quantity	Remarks
Message Switching Controller	1	1 per corridor
Dispatch Equipment	1	1 per 85 vehicles
Satellite UHF Complex	24	1 per 2.3 sq mi
Telephone Equipment	6 (lines)	
Reservation Agent Complex	4	Each handles 120 calls/h
DAB Zone Control Assembly	8	Approximately 1/every 3 Satellite UHF Complexes
System Management Computer	1	1 per corridor
Reservation Agents	5	
Dispatchers	2	

incoming calls are for information only, not for reservations. Therefore, the calculated number of reservation agents required in the peak hour was doubled so that both information and reservation calls could be adequately answered. The number of telephone lines required for the system is assumed to be 50 percent more than the number of reservation agents required in the peak hour. Table 4-11 also shows the total number of reservation agents and dispatchers required for the corridor.

4.5.3 Park-and-Ride Facilities

There is a wide variation of sub-modal split estimates among existing BRT systems. For example, the sub-modal split for park-and-ride is reported to be about 55 percent for the San Bernardino Busway, but only 14 percent for express buses operating in the I-35W corridor in Minneapolis-St. Paul. The traditional auto dependence of Detroit area residents indicates that the park-and-ride sub-modal split for a BRT system in the metropolitan areas is likely to be relatively high. To obtain an estimate of parking facility requirements, it is assumed that 40 percent of the BRT passengers originating outside Detroit and 30 percent of those passengers originating in Detroit access the system by park-and-ride. The number of park-and-ride spaces required in the corridor is estimated by applying the assumed sub-modal split to the corridor demand estimates. Average automobile occupancy is assumed to be 1.10. The estimated total number of parking spaces required for the Southfield/Jeffries corridor is 3,008.

It is expected that existing parking lots will be used to provide many of these spaces. As an indication of the availability of existing parking facilities in the corridor, a list of parking lots located at retail centers within four miles of each access node was prepared. Table 4-12 lists the location of these parking facilities and the number of parking spaces at each location. The table is based on a list of major retail centers in Southeast Michigan which was compiled by SEMCOG and the Detroit News.

Although other potential park-and-ride lots such as churches, abandoned service stations, and closed industrial and retail facilities should also be considered, the facilities identified in the table give a relative measure of parking availability in the corridor. To estimate parking needs, it is assumed that the number of parking spaces that would be available at existing facilities is equal to five percent of the total identified spaces listed in Table 4-12.

Table 4-13 summarizes the parking requirements and indicates the number of spaces assumed to be provided at existing facilities as well as the number of spaces to be constructed.

4.5.4 Off-Peak Service Policy

Off-peak service is considered to be an important part of the BRT concept. However, the Northland, New Center, and Detroit CBD areas are already adequately served by the DDOT Hamilton and Dexter lines. The Dexter line also serves Nine Mile Road (Providence Hospital) between Northwestern and Greenfield, and Greenfield between Eight and Nine Mile Roads. These DDOT buses operate at headways of less than 30 minutes throughout the day. Therefore, no additional off-peak service by BRT buses is proposed. However, feeder service outside of the DDOT service area is to be provided by the DAB vehicles during off-peak as well as during peak periods.

Table 4-12 Retail Center Parking Facilties - Southfield/Jeffries Corridor

Facilities	Location	No. of Parking Spaces
Atlantic Mills	Bryden & Grand River	1000
Sears	Oakman & Grand River	1700
Crowley, Ward	Greenfield & Grand River	1200
K-Mart	Plymouth & Southfield	850
Federal	Schaefer & McNichols	700
Federal	Seven Mile & Grand River	800
Topps	Schoolcraft & Telegraph	1200
Spartan Atlantic	Livernois & Lyndon	500
K-Mart	Eight Mile & Beech Daly	1000
Topps	Eight Mile & Greenfield	1500
J. L. Hudson	Northland, Greenfield & Eight Mile	10,500
Southfield Plaza	Southfield & 12 1/2 Mile	1800
Tel-Twelve Mall	Telegraph & Twelve Mile	5000
Shoppers Fair	Eight Mile & Meyers	1000
	TOTAL	28,750

Table 4-13 Southfield/Jeffries Corridor Park-and-Ride Facilities

Spaces Required for Park-&-Ride	Identified Parking Spaces	Spaces at Existing Facilities	Spaces to be Constructed
3,008	28,750	1,438	1,570

4.6 Capital Costs

Tables 4-14 and 4-15 provide summaries of the capital cost requirements for the Southfield/Jeffries corridor. The annualized capital costs are included in these summaries.

4.6.1 Exclusive Bus Ramps

Two ramps for exclusive use by buses are proposed for the Southfield/Jeffries corridor. The ramp at the southeast terminus of the Jeffries Freeway is estimated to cost $600,000. This projection is based on the SEMTA estimate for the cost of the ramp. The off-ramp from the Southfield Freeway north of Eight Mile at Winora is estimated to cost $100,000.

The assumed amortization period for exclusive bus ramps is 30 years.

4.6.2 Signs and Pavement Markers

A variety of signs are provided in the corridor to designate priority use of facilities by buses and to identify bus stop locations. In addition, raised reflective pavement markers are provided to help delineate the exclusive bus lanes on the Jeffries Freeway.

Bus stop and bus priority signs used in the collection and distribution areas are assumed to be standard 3- by 4-foot steel signs which cost $100 each, including installation. There are 462 bus priority signs required: 204 for the CBD distribution loop, 256 for the New Center distribution loop, 1 for the exclusive ramp on Southfield at Winora, and 1 allowing left turns from Eight Mile onto the southbound Southfield service drive by buses only. There are 248 bus stop signs needed: 231 in the collection areas, 11 in the CBD loop, and 6 in the New Center loop.

The costs of signs and raised pavement markers for the Jeffries exclusive lanes were extrapolated from the SEMTA cost estimate for lane delineation and signing. Each lane marker is assumed to cost $25, including installation.

The capital cost of signs is amortized over 15 years while the capital cost of pavement markers is amortized over 10 years.

4.6.3 Traffic Signals

Additional traffic signals are required for the CBD and New Center distribution loops. The left turn signals for contra-flow buses require changes in the signal control logic as well as the addition of a signal head. Therefore, the cost of installing each turn signal is estimated to be $2,000. The cost of installing a signal to face the reverse flow direction on one-way streets is estimated to be $500, since no changes in control logic are required. The total cost of signal changes for the CBD distribution loop is $20,500 (5 left-turn signals at $2,000, plus 21 contra-flow signal heads at $500). The traffic

Table 4-14 Capital Cost – BRT System

Item	Unit Cost	Quantity	Total Cost	Amort. Period	Annual Cost
Bus Ramps					
Jeffries – Southeast Terminus			$ 600,000	30	$ 53,298
Southfield – North of Eight Mile	$100,000	1	100,000	30	8,883
Subtotal			$ 700,000		$ 62,181
Signs & Pavement Markers					
Signs – Jeffries Exclusive Lane			$ 117,500	15	$ 13,724
Pavement Markters – Jeffries Lane	25	1704	42,600	10	6,349
Bus Priority	100	462	46,200	15	5,396
Bus Stop	100	248	24,800	15	2,897
Subtotal			$ 231,100		$ 28,366
Traffic Signals					
CBD Loop			$ 20,500	15	$ 2,394
New Center Loop			15,000	15	1,752
Subtotal			$ 35,000		$ 4,146
Shelters	$ 3,000	40	$ 120,000	15	$ 14,016
Park & Ride Lots	$660/space	1570	$ 1,036,200	30	$ 92,046
BRT Vehicles	$70,000 ($60,000)*	164	$11,480,000 ($ 9,840,000)*	10	$1,710,864 ($1,466,455)*
Vehicle Storage Facility	$25/sq ft	68,880	$ 1,722,000	30	$ 152,965
Maintenance Facility					
Heavy Maintenance Garage	$5000/bus	164	$ 820,000	30	$ 72,841
Operating Garage	$2780/bus	164	455,920	30	40,499
Subtotal			$ 1,275,920		$ 113,340
Total			$16,600,720 ($14,960,720)*		$2,177,924 ($1,933,515)*

* $60,000 figure included to allow direct comparisons with previously analyzed corridors.

NOTE: Capital costs for widening Southfield Road from Ten Mile to Fourteen Mile are not included herein.

Table 4-15 Capital Cost - Feeder System

Feeder Type	Item	Unit Cost	Quantity	Total Cost	Amort. Period	Annual Cost
DAB	Vehicles	$35,000	30	$1,050,000	10	$156,482
	DAB Control			200,900	20	20,462
	Vehicle Storage Facilities	$25/sq ft	8190	204,750	30	18,188
	Maintenance Facilities					
	Heavy Maint. Garage	$5000/bus	30	$ 150,000	30	$ 13,325
	Operating Garage	$2780/bus	30	83,400	30	7,408
	Subtotal					$ 20,733
	Total			$1,689,050		$215,865

signal cost for the New Center loop is $15,000 (4 left-turn signals at $2,000, plus 14 contra-flow signal heads at $500). An amortization period of 15 years is assumed for traffic signal equipment.

4.6.4 Shelters

The estimated cost of bus shelters, $3,000 each, is based on typical shelter costs quoted by Columbia Equipment Company plus assumed installation costs. The cost of shelters is amortized over a period of 15 years to obtain estimated annual system costs.

Bus shelters should be located at high demand locations throughout the corridor. They should be located at bus stops along the distribution loops and at each corridor access node. Additional shelters should be located at areas of concentrated demand such as park-and-ride lots and apartment houses. Based on these considerations, it is estimated that 40 shelters would be required for the Southfield/Jeffries corridor.

4.6.5 Park-and-Ride Facilities

The cost of constructing park-and-ride facilities is assumed to be $1.65 per square foot including limited grading, base construction, topping, lighting, and drainage, but excluding the cost of land. Parking space requirements vary from 279 to 579 square feet per space depending on the parking angle relative to the aisle and the average size of the vehicles. It is assumed that 400 square feet are required for each space. Thus, the estimated parking facility cost is $660 per space.

A 30-year amortization period is assumed for park-and-ride lots.

4.6.6 Vehicles

Based on a cursory survey of recent transit coach procurements, as reported in transit industry periodicals, the cost of a 53-passenger vehicle for BRT and fixed-route/fixed-schedule service is assumed to be $70,000. This represents a $10,000 increase over the $60,000 bus unit cost used in the Michigan BRT Demonstration Program Phase I Final Report. Therefore, two capital cost figures were calculated for the BRT system. One, based on a $70,000 unit cost, represents the most current cost estimate. The other, based on the $60,000 cost figure, is included to facilitate comparisons between the Southfield/Jeffries corridor and the corridors previously analyzed in Phase I.

Dial-a-Bus vehicles, including all on-board communications equipment, are assumed to cost $35,000 each.

4.6.7 Dial-a-Bus Control

Dial-a-Bus control equipment costs are based on previous GM TSD dual mode analyses. These values represent the 1974 costs of the equipment.

A 20-year amortization period is assumed for the DAB control equipment.

4.6.8 Storage Facilities

It is estimated that 420 square feet are required for storing large vehicles, and 273 square feet are required for Dial-a-Bus vehicles. Storage building costs are assumed to be $25 per square foot. This does not include cost of land. These capital costs are amortized over a period of 30 years.

4.6.9 Heavy Maintenance Garage and Operating Garage

The heavy maintenance garage capital costs are estimated to be $5,000 for each bus. This is a rough estimate based on the fact that DDOT spent $5,000,000 for a heavy maintenance garage for their 1000-bus system. The estimated costs of operating garages where vehicles are fueled, cleaned, and serviced is $2,780 per bus. This is based upon analyses done on the cost of operating garages for servicing dual mode vehicles. The capital costs of heavy maintenance and operating garages do not include land costs and are amortized over 30 years.

4.7 Operating Costs

Table 4-16 provides a summary of the BRT operating cost and Table 4-17 provides a summary of the DAB feeder system for the Jeffries corridor. These costs are based upon the Phase I work.

The operating costs of the BRT system as well as the feeder system include driver wages, garage expense, and vehicle maintenance expenses. The BRT system operating costs also include restriping costs and shelter maintenance. The DAB feeder system incurs an annual system control cost. Driver costs are estimated to be $12.35 per vehicle operating hour. This is based upon the expected driver costs per revenue hour for DDOT in July 1975. The average base salary is $6.36 per hour. However, since the $12.35 is a cost per revenue hour, it includes non-production time such as sign-on time, travel time, dead head, premium pay, waiting time, lost time, vacation and holiday pay, sick leave, and retirement benefit costs. The garage expenses are those costs incurred at the garages. They include fuel costs, lub costs, cleaning materials, and the labor required to clean and service the vehicles. DDOT garage expense from July 1974 to March 1975 was 17.13 cents per vehicle mile. DDOT buses average about 12 mi/h. Since the BRT buses will average 35-40 mi/h, they will have greater fuel efficiency. It is expected they will get 6 to 6.5 miles per gallon rather than 4 miles per gallon. Therefore, BRT garage

Table 4-16 Annual Operating Cost - BRT System

Item	Unit Cost	Quantity	Total Cost
Shelter Maintenance	$ 300	40	$ 12,000
Vehicle Expense			
Garage	$ .1453/mi	4,282,113	$ 622,191
Maintenance	$ .1954/mi	4,282,113	836,724
Subtotal			$1,458,915
Driver Expense	$ 12.35/v-hr	205,581	$2,538,925
Pavement Markings			
Diamond Markings - Jeffries			$ 278
BRT Lane Striping			5,114
CBD Loop			894
New Center Loop			2,052
Subtotal			$ 8,338
			$4,018,178

Table 4-17 Annual Operating Cost - Feeder System

Item		Unit Cost	Quantity	Total Cost
DAB	Vehicles			
	Garage	$.1453/mi	470,475	$ 68,360
	Maintenance	$.1954/mi	470,475	91,930
	Subtotal			$ 160,290
	DAB Control			
	Dispatchers	$18,215/yr	2	$ 36,430
	Reservation Agents	$18,215/yr	5	91,075
	Equipment Maintenance			9,626
	Subtotal			$ 137,131
	Drivers	$12.35/v-hr	31,365	$ 387,358
	TOTAL			$ 684,779

expenses are estimated to be 14.13 cents per mile (assuming fuel costs at 29.75 cents per gallon). It is assumed that the DAB costs are also 14.13 cents per mile. The vehicles do not average 35-40 mi/h, but they are lighter. The garage expense associated with large feeder buses is assumed to be 17.13 cents per mile because these buses operate at speeds similar to DDOT buses.

The maintenance expense is the cost of heavy maintenance. It includes labor, supervision, and material costs. Also included are the costs of maintaining the buildings and grounds. The DDOT cost of 19.54 cents per vehicle mile was used in the calculations.

Lane striping and diamond-shaped markings are required to delineate exclusive transit lanes on the Jeffries and on public streets. According to Detroit DOT estimates, the cost of striping is 3 cents per linear foot. Two stripes are required along the entire length of the CBD and New Center distribution loops to designate the exclusive bus lane. The cost of this striping is estimated to be $634 for the 2-mile CBD loop, and $1,457 for the 4.6-mile New Center loop. Diamond-shaped pavement markings are also required to identify the exclusive bus lanes in the CBD and New Center areas. Each 12- by 2.5-foot diamond consists of 24.5 linear feet. An average 100-foot spacing is assumed. The cost of these pavement markings, assuming the Detroit DOT estimate of 10 cents per linear foot for hand work, is $260 for the CBD loop and $595 for the New Center loop. The total cost of pavement markings is $894 for the CBD distribution loop and $2052 for the New Center loop. Although public streets usually require restriping twice a year, these transit priority pavement markings are assumed to last a full year due to the lower vehicle volumes associated with a reserved bus lane. The cost of the two 8.07-mile strips on the BRT lane on the Jeffries is $2557, or $5114 for both directions. The cost of the diamond markings which are spaced every 750 feet on the Jeffries is $278. No pavement marking is required along the Northland distribution loops, since no lanes are reserved exclusively for buses.

The annual bus shelter maintenance expense is assumed to be $300 per shelter and includes periodic cleaning and repair.

Dial-a-Bus control operating costs are divided into two categories: personnel costs and maintenance costs. Both dispatchers and reservation agents are assumed to earn $18,215 per year, including benefits. This value is based on previous dual mode transit analyses. The maintenance costs for the DAB electronic control equipment is assumed to be 2 percent of the original purchase price of the equipment per year.

The cost of operating and maintaining park-and-ride lots was not included in the operating cost estimates. In some cases, parking spaces at large retail centers may be available at no cost. In other cases, a nominal lease or service cost (weekday snow removal, for example) may be incurred. The operating costs associated with system-owned park-and-ride facilities will vary with the size and location of the lots but, in general, will include lighting, snow removal, maintenance, and security.

5.0 CORRIDOR COMPARISONS

The objective of the Stage I effort was to determine the BRT potential of the extended corridor and compare its characteristics to those of the Phase I corridors. A summary of capital costs, annualized capital, and annual operating costs are shown in Table 5-1 for the four Phase I corridors as well as the Southfield/Jeffries corridor. Costs for the Southfield/Jeffries are similar to those for the East Jefferson and Michigan/I-94 corridors. Costs for I-94/Crosstown and the Lodge corridors are nearly twice as large. This significant difference is basically due to the magnitude of corridor ridership demand.

Table 5-2 indicates corridor ridership demand as well as other important parameters. The magnitude of demand for the corridors correspond directly to the differences noted in costs from Table 5-1. Travel time ratios of BRT to auto and DAB feeder system cost/peak-period passenger trip show little difference between corridors. BRT cost/peak-period passenger trip, however, is approximately 20 percent higher for the Southfield/Jeffries corridor. This is due primarily to the longer length of the Southfield/Jeffries corridor when compared to Phase I corridors. It should also be noted that the BRT cost/peak-period passenger trip numbers for the Phase I corridors are shown to be slightly higher than originally presented in the Phase I report. Discovery of an error in the original calculations accounts for this difference.

5.1 Assessment of Results

The results of the Stage I effort indicate that the Southfield/Jeffries corridor is not the most promising from a ridership potential standpoint. However, there are significant reasons for continuing the Southfield/Jeffries BRT implementation effort. The Jeffries Freeway is not yet operating at maximum capacity; therefore, the designation of a traffic lane for buses and car pools will be more readily accepted by the driving public. The need for early implementation is also an important factor favoring the corridor since the Jeffries Freeway consists basically of four lanes in each direction obviating the need for new construction. Finally, a major part of the planning has already been accomplished through SEMTA's previous work. Therefore, the Stage II effort will be directed toward further analysis of corridor characteristics in preparation for implementing the BRT system in the Southfield/Jeffries corridor.

Table 5-1 Summary of Annual Costs Including DAB Feeder

Corridor	System Cost Elements (Thousands of Dollars)			
	Capital	Annualized Capital	Annual Operating	Annual Total
East Jefferson	17,084	2,224	4,489	6,713
I-94/Crosstown	29,465	3,802	7,468	11,270
Lodge	30,467	3,906	7,955	11,861
Michigan/I-94	17,602	2,261	4,849	7,110
Southfield/ Jeffries	16,848	2,167	4,703	6,870

Table 5-2 Corridor Comparison

Corridor	Total BRT Demand (a.m. Peak Period)	Travel Time Ratio BRT/Auto	BRT Cost/Peak Period Pass. Trip (Excluding Feeder)	Feeder System (DAB) Cost/Peak Period Feeder Passenger Trip
East Jefferson	9,774	1.36	1.10	1.85
I-94/Crosstown	20,585	1.21	0.91	1.71
Lodge	17,698	1.26	0.97	1.72
Michigan/I-94	9,542	1.24	1.01	1.75
Southfield/ Jeffries	9,646	1.28	1.21	1.82

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1.0 INTRODUCTION

At the conclusion of Stage I, the results of that effort were reported, and a major review meeting was held to discuss the results and the directions for Stage II work. Parties to this review included MDSH&T, SEMTA, DDOT, and GM TSD. As a consequence of this review, the Stage II effort was to continue as a preliminary design program, but some specific work items were to be emphasized or added:

- Evaluation of five alternatives regarding routing and intermediate stops on Southfield Freeway and Greenfield, both to the CBD and New Center and to Dearborn
- Evaluation of the effects of intermediate stops on BRT performance and ridership
- Further analysis and design of capital facilities necessary for BRT implementation
- Analysis of ridership sensitivity to fare structure

Based on Stage I results, it was concluded that the potential demand to the Dearborn area was too low to justify the non-stop (or few-stop) service of a BRT route. However, since the SEMTA 1990 plan calls for intermediate-level service in this corridor, it was decided to include the preliminary design of such service in the Stage II program. This decision had the effect of expanding the Stage II objectives from a straight BRT route design to a system design involving BRT service plus an intermediate-level line between Dearborn and Southfield.

With this decision, the MDSH&T re-directed the Stage II work to include a new evaluation of alternative routes and stopping policies. These alternatives were:

- Intermediate stops on Southfield, plus BRT non-stop service on Southfield and some non-stop service on Greenfield
- Intermediate stops on Greenfield, plus BRT non-stop service on Southfield and Greenfield
- Intermediate stops on Southfield and Greenfield, plus BRT non-stop service on Southfield and Greenfield
- Intermediate stops on Southfield south of the Jeffries interchange
- Intermediate stops on Greenfield south of the Jeffries interchange

This evaluation was performed, and the resulting recommendations are to:

- Provide the BRT non-stop service on Southfield
- Provide the intermediate-level service on Greenfield, with stops about one mile apart
- Extend the intermediate-level service on Greenfield to the Fairlane Center in Dearborn

Evaluation of the effects of intermediate stops on BRT performance and ridership showed that, while BRT ridership would not be reduced substantially by the time delay associated with three or four well-designed intermediate stops, the additional demand for destinations served by such intermediate stops was small. The net effect of a few intermediate stops was essentially no change in total ridership.

Early in Stage II, it was tentatively decided to include some intermediate stopping pattern on the Southfield Freeway and Jeffries Freeway portions of the BRT route. In order to permit such stops, it was necessary to construct new ramps in the Jeffries median to bring the BRT buses up to the surface streets at the stops. Further analysis showed that only a small number of buses would use these expensive ramps, and it was judged to be a poor investment. Thus the decision was reviewed, and the BRT route reverted to essentially a non-stop line haul. The intermediate stop access ramps were eliminated.

The BRT system, as finally configured, does actually include one intermediate stop—at the Wyoming transfer station. This stop, however, is not included to serve local origins and destinations. Rather, it is necessary to provide for concentration of New Center passengers at a single transfer point. The original Stage I concept of separate BRT buses destined for the New Center originating at each access node is impractical because the relatively low level of midtown demand leads to very long headways on most routes.

The Wyoming transfer station assumed increased significance because of the need to integrate existing express bus service in the corridor into the BRT system. In essence, this integration is accomplished by (a) having all BRT collection routes on the Mile roads west of the Southfield Freeway enter the line haul at the Southfield Freeway; while (b) all BRT collection on Mile roads east of the Southfield Freeway would be by BRT buses starting at the Southfield Freeway and running east to Wyoming, then entering the line haul at Wyoming.

Other major efforts in Stage II were:

- Detailed analysis of the integration of existing express bus service in the corridor
- Design of feeder service, park-and-ride capability, and routes in Oakland County

- Cost analysis and fare sensitivity

- Development of an improved and integrated computer program for demand estimation; based on the use of diversion curves, origin-destination data, and travel time calculations.

Preliminary design of the Greenfield intermediate level service was accomplished; including selection of traffic signal pre-emption as the bus priority method, design of distribution loops in Southfield and Dearborn, and system sizing and cost estimates.

It is to be noted that the Greenfield intermediate service may be considered to be independent of the BRT system serving the New Center and CBD. The major interface between the two is at the Northland terminal in Southfield. Other interfaces exist where the Greenfield intermediate line intersects BRT collection routes at the Mile roads.

This portion of the report begins with a description of the extensive modifications to the demand analysis computer program that were made during Stage II. Section 3.0 presents the details of the BRT system design, and Section 4.0 documents the Greenfield Intermediate Service design effort. The final section of the report is a preliminary staged implementation plan covering both the BRT system and the Greenfield Intermediate Service.

2.0 DEMAND ANALYSIS PROGRAM

During Phase I and Stage I of Phase IA of the BRT project, ridership estimates were employed in the relative evaluation of service alternatives and in preliminary system sizing. As the need for such analyses arose, a series of modal split computer programs evolved. The programs, however, were quite limited in their versatility and in the levels of detail and accuracy with which trips could be modeled. The following limitations are among those found to be most significant:

- Both auto and transit trips were assigned to a single route, as defined by a series of nodes connected by one-way links. That is, the possibility that autos may travel on shorter, alternative routes was not evaluated in determining transit-to-auto travel time ratios.

- Only two speeds were allowed for each route: an overall average speed for autos and a similar speed for transit. Trips utilizing the route segment to which the average speed applied were accurately represented, while other trips were less accurately modeled.

- All transit trips (for a particular computer run) were evaluated on the basis of a single set of parameters (trip time elements, speeds, and cost factors). No convenient method existed, for example, to distinguish between transit trips originating in Oakland County and those originating in northwest Detroit. Without such a distinction, the same parameters were applied to both transit origins--even though certain trip characteristics (e.g., fare structure, feeder bus transfer time, and route access speed) would actually differ somewhat.

A refined corridor analysis program package, designed to overcome many of the limitations associated with the programs utilized earlier in the BRT project, has been developed. Prominent features of the new package are described below.

2.1 Network Definition

The first two shortcomings of the previous analysis programs (a single route for both auto and transit and a single average speed for each mode on the route) have been alleviated by changes in the method of representing the routes. Rather than define a linear route as an ordered list of nodes, the program user specifies two completely independent networks, each with a node list and a link list describing the node connectivity.

Associated with each node is an identification number, a description of the node's location, x-y coordinates precisely locating the node, and a node type designation.

Each node may be one of the following types:

- Access (ACC) - Trips may enter, but not leave, the network at such a node.
- Egress (EGR) - Trips may leave the network at an egress node, but cannot enter.
- Bidirectional (BID) - Trips may either enter or leave the network at a bidirectional node.
- Reference (REF) - Trips may neither enter nor leave the network at a reference node; this type of node exists only to serve as a link terminus when a separate link is necessary to define the network geometry or the travel time for a network segment.

Each network link is a one-way, straight-line roadway segment connecting two nodes. The location and travel direction of a link are defined by specifying the identification numbers of its end nodes in a "from-to" sequence. Other data associated with each link include a travel speed, a travel time, and a type designation. Link speed and time information are combined to produce an overall link traversal time. Normally, the specified link speed and the link length (determined from the locations of the end nodes) are used to compute a partial travel time, which is then added to the specified time (possibly a delay time) to produce an overall travel time for the link. The link speed may be specified as zero to indicate that only the given time is to be used for the link travel time. Also, the specified link time may be negative, zero, or positive to model special conditions. These capabilities overcome the earlier program's single-speed limitation for each travel mode. Any of the following link types may be specified:

- Collection (COL) - This link type is used by buses acquiring passengers prior to its entering a non-stop or few-stop, line-haul portion of the route.
- Line-haul (LIN) - This link type is associated with direct travel along the main route.
- Distribution (DST) - Distribution links are traveled by buses discharging passengers in a series of stops.

Since the modal split program compiles trip data and applies cost parameters separately by link type, it may sometimes be advantageous to specify link types on a basis other than strictly by function (e.g., to modify the fare structure of a particular segment of the transit route by specifying link types which differ from those of other segments).

2.2 Route Assignment

As discussed above, the newly developed BRT modal split program alleviates two of the earlier program's significant limitations by modeling auto and transit routes separately and in a more sophisticated manner. These limitations are further avoided by the new program's capability to assign each trip (auto or transit) to follow a minimum-time path through the network (auto or transit) between the trip's entry and exit nodes. Each trip is assigned to enter a network at the "access" or "bidirectional" node located at the least radial distance from the trip's origin zone centroid. Similarly, a trip leaves a network at the "egress" or "bidirectional" node closest to the trip's destination zone centroid.

2.3 Mode Choice Model

The new version of the BRT modal split program employs the same mode choice model as included in the previous program: the Peat, Marwick, Mitchell and Company model used by SEMCOG in estimating 1990 transit ridership for the Detroit area. The model consists of 80 diversion curves which relate the propensity to use transit for a particular trip to the following factors:

- Origin zone household income
- Ratio of door-to-door transit and automobile travel times
- Ratio of out-of-vehicle transit and automobile travel times
- Ratio of "out-of-pocket" transit and automobile travel costs

The model does not utilize actual values for the above factors. Instead, the values are classified, and the class numbers are used to access the diversion curve data in "table look-up" fashion. Since many of the travel time ratios for BRT service are expected to be in the range of 1.00 to 2.00, and no diversion curve data points are provided between those values, transit probabilities are computed by linear interpolation on the basis of travel time ratios. The class numbers of other input values are used without interpolation.

2.4 Travel Mode Comparison

The refined BRT modal split program allows an automobile trip to be compared with up to six transit modes. The program does not, however, model the complex decision-making process of a traveler choosing a particular mode from among three or more alternatives, since the diversion curves are intended to model only the choice between an automobile and a single transit mode. This restriction limits the use of the program to applications in which the various transit modes' service areas do not significantly overlap or in which the overlap may be accounted for by adjusting or specially interpreting the program's output data.

The program accommodates multiple transit modes by permitting the user to specify up to six sets of transit parameters (in addition to a set of auto parameters). The parameters used to characterize each travel mode (auto and transit) are listed below:

- Access speed. This parameter represents the average speed of travel from an origin zone's centroid to the trip's network entry node. This speed, in conjunction with x-y coordinates of the zone centroid and entry node, allows the program to calculate a travel time for the "access" portion of the trip. Since information defining the street layout of every zone is not available to the program, travel between the zone centroid and the entry node is assumed to be direct (i.e., along a straight line).

- Access out-of-vehicle ("excess") time. This parameter is the total of all out-of-vehicle times experienced by a traveler during the access, collection, line-haul, and distribution segments of a trip. Walking, waiting, transferring, and auto starting times are included in this total. Out-of-vehicle time associated with the "egress" portion of the trip is identified separately.

- Access cost. This information includes a calculation method, rate, and fixed additional cost to be attributed to access travel. The calculation method may be "flat" or "graduated." If the method is "flat," the specified rate is assumed to represent a fixed cost which is independent of travel distance. Therefore, the sum of the rate and any additional amount is used as the access cost. In the case of a "graduated" cost calculation method, the specified rate is multiplied by the trip's access distance. The resulting amount is then added to any fixed portion of the access cost.

- Collection cost. A separate cost calculation method and rate may be applied to travel on network links of the "collection" type. As described above, either a fixed or distance-related cost may be specified.

- Line-haul cost. The cost of line-haul travel is also computed separately for each trip by each mode.

- Distribution cost. The cost of travel on "distribution" links is computed in the same manner as for collection and line-haul travel, but with separately specified parameters.

- Egress speed. This parameter is the average speed of travel to the destination zone centroid from the network exit node. Three separate egress speeds are specified; the trip's destination zone classification (CBD, activity center, or local) determines which of the three speeds is used for a particular trip.

- Egress cost. Egress cost parameters are similar to those for access cost (i.e., a calculation method, cost rate, and fixed cost are specified). Three sets of egress cost parameters for each mode allow a different set of parameters to be used for each destination zone type. Auto parking costs are an example of an egress cost which varies with destination zone type.

• Egress excess time. This parameter includes all elements of out-of-vehicle time not accounted for in the "access" out-of-vehicle time described above. Typically, a walking time is specified for transit trips, and a combined parking and walking time is applied to auto trips. This parameter, like other egress parameters, has a separate value for each destination zone type.

Associated with each origin zone is a set of six "submodal weighting factors." A submodal weighting factor is a positive (or zero) value by which the total travel demand between an origin-destination zone pair is multiplied before application of the mode choice model. Since a submodal weighting factor is associated with each transit mode, the total travel demand is effectively split into as many as six parts. Each part is then divided into an auto group and a transit group when the mode choice model is separately applied to the trips in that part. The modal split problem for an individual part of an O/D pair's total demand, then, is reduced to a choice between only two modes: the automobile and the single transit mode (the mode associated with the submodal weighting factor which was used to obtain that part of the total demand).

Through careful selection of submodal weighting factors and transit mode parameters, a high degree of versatility may be obtained from the BRT modal split program, including the following capabilities:

• An origin zone may be completely eliminated from transit consideration by setting all of its weighting factors to zero without constructing a new corridor zone list and trip matrix.

• The entire corridor's modal split may be evaluated on the basis of a single transit mode (as was done with the previous BRT modal split program) by setting that mode's weighting factor to unity (and other modes' weighting factors to zero) for all origin zones in the corridor.

• When two or more transit modes offer non-overlapping service in the analysis corridor, each mode's weighting factor is set to unity for all zones in which the mode provides service. For any single zone, then, no more than one non-zero submodal weighting factor is specified.

• The above concept may be extended to subdivide individual zones, if the program user is aware of the implicit assumptions and consequences. Instead of limiting weighting factor values to unity or zero, this technique uses a weighting factor for each mode chosen to represent the fraction of a zone's trips (or land area or population) within that mode's service area. If all of a zone's trips have a transit mode available, the zone's submodal weighting factors should total unity; if a portion of the zone's tripmakers have no transit service, a lower weighting factor total should result. The most important restriction to the use of this technique is that no significant overlap exists among the service areas of the transit modes being evaluated. This constraint may be satisfactorily met in certain analyses of feeder bus and pedestrian access modes. Modes involving automobile travel (e.g., park-and-ride and kiss-and-ride) have less well-defined service area boundaries and do not allow the possibility of extensive service area overlap to be ignored.

Furthermore, this method of zone subdivision provides no means for creating new subzone centroids; distance calculations, then, are all based upon the original centroid locations.

2.5 Program Outputs

The refined BRT modal split program reads a variety of corridor definition data and run control parameters, determines the characteristics of travel by each mode for every origin-destination zone pair, applies the mode choice model to the corridor trip matrix, compiles a summary of the corridor analysis results, and produces a data file for subsequent output on a high-speed line printer. The following items are among those included in the program's output:

- Each network's nodes are listed in numerical order, as shown in the partial list of Figure 2-1. The information presented for each node includes an identifying number, a description of the node, a node type designation, a list of other nodes to which links radiate from the given node, and the x-y coordinates of the node's centroid.

- Figure 2-2 is a partial auto network link list; a similar list is produced for the corresponding transit network. Each link is defined by the identification numbers of the nodes it connects, a link type designation, the link length, and the link travel time (which includes any in-vehicle delay time).

- Next, trip data are summarized for each origin zone separately by destination zone group. The program user must assign all destination zones to one of up to nine groups. Groups one or two are program-specified to include Detroit CBD and New Center area zones, respectively. Other zones may each be assigned to any single destination group. Figure 2-3 illustrates the types of data generated for trips to a single group of destination zones from several origin zones. In each of the following data categories, values pertaining to auto-only trips, transit trips by submode, and total transit trips are output:

    - Person-trips produced (the number of persons traveling between the origin zone and one of the zones in the specified destination group during the analysis period by the indicated mode)

    - Modal split (the percentage of the zone's total production of trips to the specified destination group during the analysis interval by all modes combined which is represented by the above number of trips for a single mode)

    - Trip density (the zone's trip production divided by the zone's land area in square miles)

    - Average travel time (the average door-to-door travel time of trips from the origin zone to the specified destination group, by the indicated mode)

NODE ID NUMBER	N O D E D E S C R I P T I O N	NODE TYPE	NODE CONNECTIVITY TO	TO	TO	TO	NODE LOCATION X	Y
1	WOODWARD AND MAPLE	ACC	17	0	0	0	435.99	72.61
2	WOODWARD AND 14-MILE	ACC	3	0	0	0	436.67	71.57
3	GREENFIELD AND 14-MILE	ACC	23	0	0	0	436.48	71.56
4	GREENFIELD AND 13-MILE	ACC	29	0	0	0	436.51	70.57
5	GREENFIELD AND 12-MILE	ACC	36	0	0	0	436.55	69.52
6	GREENFIELD AND 11-MILE	ACC	42	0	0	0	436.59	68.53
7	GREENFIELD AND 10-MILE	ACC	48	0	0	0	436.65	67.53
9	GREENFIELD AND 9-MILE	BID	53	0	0	0	436.70	66.50
10	GREENFIELD AND 8-MILE	BID	9	11	0	0	436.74	65.50
11	NORTHLAND TERMINAL	EGR	0	0	0	0	436.51	65.81
12	INKSTER AND MAPLE	ACC	18	0	0	0	430.51	72.31
13	FRANKLIN AND MAPLE	ACC	19	0	0	0	431.40	72.35
14	TELEGRAPH AND MAPLE	ACC	20	0	0	0	432.36	72.43
15	LAHSER AND MAPLE	ACC	16	0	0	0	433.43	72.48
16	EVERGREEN AND MAPLE	ACC	17	0	0	0	434.35	72.50
17	SOUTHFIELD AND MAPLE	ACC	23	23	0	0	435.67	72.60
18	INKSTER AND 14-MILE	ACC	24	0	0	0	430.56	71.12
19	FRANKLIN AND 14-MILE	ACC	25	0	0	0	431.35	71.31
20	TELEGRAPH AND 14-MILE	ACC	26	0	0	0	432.36	71.36
21	LAHSER AND 14-MILE	ACC	22	0	0	0	433.41	71.40
22	EVERGREEN AND 14-MILE	ACC	23	0	0	0	434.41	71.45
23	SOUTHFIELD AND 14-MILE	ACC	29	0	0	0	435.46	71.51
24	INKSTER AND 13-MILE	ACC	30	0	0	0	430.61	70.25
25	FRANKLIN AND 13-MILE	ACC	32	0	0	0	431.35	70.28
26	TELEGRAPH AND 13-MILE	ACC	33	0	0	0	432.36	70.35
27	LAHSER AND 13-MILE	ACC	34	0	0	0	433.51	70.40
28	EVERGREEN AND 13-MILE	ACC	29	0	0	0	434.54	70.46
29	SOUTHFIELD AND 13-MILE	ACC	36	0	0	0	435.50	70.50
30	INKSTER AND NORTHWESTERN HIGHWAY	ACC	32	0	0	0	430.65	69.72
31	INKSTER AND 12-MILE	ACC	32	0	0	0	430.65	69.21
32	NORTHWESTERN HIGHWAY AND 12-MILE	ACC	38	0	0	0	431.28	69.25
33	TELEGRAPH AND 12-MILE	ACC	38	0	0	0	432.42	69.30
34	LAHSER AND 12-MILE	ACC	40	0	0	0	433.57	69.37
35	EVERGREEN AND 12-MILE	ACC	36	0	0	0	434.58	69.42
36	SOUTHFIELD AND 12-MILE	ACC	42	0	0	0	435.58	69.50
37	INKSTER AND 11-MILE	ACC	43	0	0	0	430.67	68.20
38	NORTHWESTERN HIGHWAY AND TELEGRAP	ACC	40	0	0	0	432.43	68.65
39	NORTHWESTERN HIGHWAY AND 11-MILE	ACC	0	0	0	0	433.24	68.39
40	LAHSER AND 11-MILE	BID	47	0	0	0	433.61	68.31
41	EVERGREEN AND 11-MILE	ACC	47	0	0	0	434.61	68.37
42	SOUTHFIELD AND 11-MILE	ACC	48	0	0	0	435.62	68.43
43	INKSTER AND 10-MILE	ACC	44	0	0	0	430.75	67.20
44	TELEGRAPH AND 10-MILE	ACC	45	0	0	0	432.62	67.30
45	LAHSER AND 10-MILE	ACC	47	0	0	0	433.67	67.36
47	EVERGREEN AND 10-MILE	BID	40	53	0	0	434.68	67.36
48	SOUTHFIELD AND 10-MILE	BID	53	0	0	0	435.67	67.47
49	INKSTER AND 9-MILE	ACC	54	0	0	0	430.80	66.19
50	TELEGRAPH AND 9-MILE	ACC	56	0	0	0	432.80	66.30
51	LAHSER AND 9-MILE	ACC	52	0	0	0	433.71	66.36
52	EVERGREEN AND 9-MILE	ACC	58	0	0	0	434.74	66.40
53	SOUTHFIELD AND 9-MILE	BID	47	48	59	0	435.71	66.44
54	INKSTER AND 8-MILE	ACC	55	60	0	0	430.86	65.19

Figure 2-1 Auto Network Definition Node List

LINK ID FROM	LINK ID TO	LINK TYPE	LINK LENGTH (MI.)	LINK TIME (MIN.)
1	17	LIN	0.32	0.48
2	3	LIN	0.19	0.29
3	23	LIN	1.02	1.53
4	29	LIN	1.01	1.96
5	36	LIN	0.97	1.88
6	42	LIN	0.98	1.89
7	48	LIN	0.98	1.90
9	53	LIN	0.99	1.92
10	9	LIN	1.00	1.94
10	11	LIN	0.39	0.75
12	18	LIN	1.19	1.79
13	19	LIN	1.05	1.57
14	20	LIN	1.07	1.53
15	16	LIN	0.92	1.38
16	17	LIN	1.32	1.99
17	23	LIN	1.11	1.67
17	23	LIN	1.11	1.67
18	24	LIN	0.87	1.31
19	25	LIN	1.03	1.54
20	26	LIN	1.01	1.44
21	22	LIN	1.00	1.94
22	23	LIN	1.05	2.04
23	29	LIN	1.01	1.73
24	30	LIN	0.53	0.80
25	32	LIN	1.03	1.55
26	33	LIN	1.05	1.50
27	34	LIN	1.03	2.00
28	29	LIN	0.96	1.86
29	36	LIN	1.00	1.72
30	32	LIN	0.79	1.35
31	32	LIN	0.63	1.22
32	38	LIN	1.30	2.22
33	38	LIN	0.65	1.11
34	40	LIN	1.06	2.05
35	36	LIN	1.00	1.94
36	42	LIN	1.07	1.84
37	43	LIN	1.00	1.94
38	40	LIN	1.23	1.67
40	47	LIN	1.43	1.95
41	47	LIN	1.01	1.96
42	48	LIN	0.96	1.65
43	44	LIN	1.87	3.62
44	45	LIN	1.05	2.04
45	47	LIN	1.01	1.95
47	40	LIN	1.43	1.95
47	53	LIN	1.38	1.88
48	53	LIN	1.03	1.77
49	54	LIN	1.00	1.94
50	56	LIN	1.03	1.77
51	52	LIN	1.03	2.00
52	58	LIN	1.00	1.94
53	47	LIN	1.38	1.88

Figure 2-2 Auto Network Definition Link List

ORIGIN ZONE	ZONAL DATA DESCRIPTION	AUTO ONLY	BUS RAPID TRANSIT DATA BY SUBMODE: FEED1	FEED2	FEED3	PK-RD	KS-RD	WALK	BRT TOTAL
	AVG. TRIP COST (CENTS):	22.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1331	** NO TRIPS PRODUCED **								
1332	PERSON-TRIPS PRODUCED:	28.0	0.0	4.7	0.0	0.0	0.0	0.0	4.7
	MODAL SPLIT (PERCENT):	85.5	0.0	14.5	0.0	0.0	0.0	0.0	14.5
	DENSITY (TRIPS/SQ.MI.):	28.6	0.0	4.9	0.0	0.0	0.0	0.0	4.9
	AVG. TRAVEL TIME (MIN.):	25.7	0.0	50.4	0.0	0.0	0.0	0.0	50.4
	AVG. EXCESS TIME (MIN.):	3.0	0.0	20.0	0.0	0.0	0.0	0.0	20.0
	ROUTE ACCESS TIME (MIN.):	4.7	0.0	8.8	0.0	0.0	0.0	0.0	8.8
	AVG. TRIP COST (CENTS):	57.5	0.0	45.0	0.0	0.0	0.0	0.0	45.0
1333	PERSON-TRIPS PRODUCED:	178.0	0.0	8.9	0.0	0.0	0.0	0.0	8.9
	MODAL SPLIT (PERCENT):	95.2	0.0	4.8	0.0	0.0	0.0	0.0	4.8
	DENSITY (TRIPS/SQ.MI.):	94.2	0.0	4.7	0.0	0.0	0.0	0.0	4.7
	AVG. TRAVEL TIME (MIN.):	14.3	0.0	51.2	0.0	0.0	0.0	0.0	51.2
	AVG. EXCESS TIME (MIN.):	3.0	0.0	20.0	0.0	0.0	0.0	0.0	20.0
	ROUTE ACCESS TIME (MIN.):	1.9	0.0	3.6	0.0	0.0	0.0	0.0	3.6
	AVG. TRIP COST (CENTS):	32.4	0.0	45.0	0.0	0.0	0.0	0.0	45.0
1334	PERSON-TRIPS PRODUCED:	135.5	0.0	10.5	0.0	0.0	0.0	0.0	10.5
	MODAL SPLIT (PERCENT):	92.8	0.0	7.2	0.0	0.0	0.0	0.0	7.2
	DENSITY (TRIPS/SQ.MI.):	100.2	0.0	7.8	0.0	0.0	0.0	0.0	7.8
	AVG. TRAVEL TIME (MIN.):	19.4	0.0	56.9	0.0	0.0	0.0	0.0	56.9
	AVG. EXCESS TIME (MIN.):	3.0	0.0	20.0	0.0	0.0	0.0	0.0	20.0
	ROUTE ACCESS TIME (MIN.):	4.3	0.0	8.1	0.0	0.0	0.0	0.0	8.1
	AVG. TRIP COST (CENTS):	50.2	0.0	45.0	0.0	0.0	0.0	0.0	45.0
2032	PERSON-TRIPS PRODUCED:	145.6	6.9	0.0	0.0	0.0	0.0	0.0	6.9
	MODAL SPLIT (PERCENT):	95.5	4.5	0.0	0.0	0.0	0.0	0.0	4.5
	DENSITY (TRIPS/SQ.MI.):	150.9	7.1	0.0	0.0	0.0	0.0	0.0	7.1
	AVG. TRAVEL TIME (MIN.):	10.0	35.0	0.0	0.0	0.0	0.0	0.0	35.0
	AVG. EXCESS TIME (MIN.):	3.0	20.0	0.0	0.0	0.0	0.0	0.0	20.0
	ROUTE ACCESS TIME (MIN.):	1.2	1.7	0.0	0.0	0.0	0.0	0.0	1.7
	AVG. TRIP COST (CENTS):	20.6	45.0	0.0	0.0	0.0	0.0	0.0	45.0
2034	PERSON-TRIPS PRODUCED:	622.6	19.8	0.0	0.0	0.0	0.0	0.0	19.8
	MODAL SPLIT (PERCENT):	96.9	3.1	0.0	0.0	0.0	0.0	0.0	3.1
	DENSITY (TRIPS/SQ.MI.):	654.7	20.8	0.0	0.0	0.0	0.0	0.0	20.8
	AVG. TRAVEL TIME (MIN.):	14.5	32.9	0.0	0.0	0.0	0.0	0.0	32.9
	AVG. EXCESS TIME (MIN.):	3.0	20.0	0.0	0.0	0.0	0.0	0.0	20.0
	ROUTE ACCESS TIME (MIN.):	1.2	1.2	0.0	0.0	0.0	0.0	0.0	1.2
	AVG. TRIP COST (CENTS):	32.5	45.0	0.0	0.0	0.0	0.0	0.0	45.0
2040	** NO TRIPS PRODUCED **								
2041	PERSON-TRIPS PRODUCED:	223.2	10.7	0.0	0.0	0.0	0.0	0.0	10.7
	MODAL SPLIT (PERCENT):	95.4	4.6	0.0	0.0	0.0	0.0	0.0	4.6
	DENSITY (TRIPS/SQ.MI.):	271.7	13.1	0.0	0.0	0.0	0.0	0.0	13.1
	AVG. TRAVEL TIME (MIN.):	16.4	40.0	0.0	0.0	0.0	0.0	0.0	40.0
	AVG. EXCESS TIME (MIN.):	3.0	20.0	0.0	0.0	0.0	0.0	0.0	20.0
	ROUTE ACCESS TIME (MIN.):	1.2	1.8	0.0	0.0	0.0	0.0	0.0	1.8

Figure 2-3 Origin Zone Summary of BRT Corridor Analysis Data (Group 5)

- Average excess time (the average portion of door-to-door travel time classified as out-of-vehicle time for the origin zone, destination group, and mode indicated)

- Route access time (the time required to travel from the zone centroid to the nearest network access point by the indicated mode)

- Average trip cost (the average cost for a complete trip from the origin zone to the specified destination group by the indicated mode)

• Destination zone data, analogous to the data listed for origin zones above, are output in the format shown in Figure 2-4. These data apply to all trips in the corridor which terminate in the particular destination zone, and differ from the origin zone data in the following ways:

- Trip quantities refer to trip attraction rather than trip production.

- Route egress times, instead of access times, are given. (Egress time is the travel time from the network exit node to the destination zone centroid.)

• Figure 2-5 illustrates the format in which auto network node loads are output. The example shown lists the number of auto person-trips terminating in the indicated destination group which have been assigned to enter the network at each node. A similar list (not shown) of trips leaving the network is also output. Bidirectional nodes may appear in either list, while reference nodes and other nodes with zero trip loadings are screened from the output lists.

• A node load list for a transit network is presented in Figure 2-6. In this list, trip quantities are subdivided by transit mode and totaled in the rightmost column. Again, a separate access node load list is output for each destination zone group, and a similar set of lists is produced for network access.

• Trip loads are listed for several auto network links in Figure 2-7. Unlike node loads, link loads are not listed separately for trips to each destination group; only total loads are output.

• Figure 2-8 illustrates the listing format employed for transit network link loads. Transit link loads are subdivided by mode, but are not listed separately for each destination group.

• Finally, as shown by the example in Figure 2-9, an overall summary is output for each destination zone group. This summary includes the following data for auto trips, transit trips by submode, and total transit trips:

- Total person-trips attracted to the destination zone group
- Modal split percentages corresponding to the above trips

- Average door-to-door travel times of all trips to the destination zone group
- Average out-of-vehicle trip times
- Average total out-of-pocket trip costs (i.e., those perceived by the travelers as direct, trip-related expenses)

DEST'N ZONE	ZONAL DATA DESCRIPTION	AUTO ONLY	BUS RAPID TRANSIT DATA BY SUBMODE FEED1	FEED2	FEED3	PK-RD	KS-RD	WALK	BRT TOTAL
	AVG. TRIP COST (CENTS):	20.3	45.0	45.0	0.0	0.0	0.0	0.0	45.0
932	PERSON-TRIPS ATTRACTED:	430.6	2.4	4.4	0.0	0.0	0.0	0.0	6.8
	MODAL SPLIT (PERCENT):	98.4	0.6	1.0	0.0	0.0	0.0	0.0	1.6
	DENSITY (TRIPS/SQ.MI.):	1229.0	7.0	12.5	0.0	0.0	0.0	0.0	19.4
	AVG. TRAVEL TIME (MIN.):	8.9	48.6	40.4	0.0	0.0	0.0	0.0	43.3
	AVG. EXCESS TIME (MIN.):	3.0	20.0	20.0	0.0	0.0	0.0	0.0	20.0
	ROUTE EGRESS TIME (MIN.):	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	AVG. TRIP COST (CENTS):	17.0	45.0	45.0	0.0	0.0	0.0	0.0	45.0
960	PERSON-TRIPS ATTRACTED:	2008.1	32.2	18.3	0.0	0.0	0.0	0.0	50.4
	MODAL SPLIT (PERCENT):	97.6	1.6	0.9	0.0	0.0	0.0	0.0	2.4
	DENSITY (TRIPS/SQ.MI.):	2011.3	32.2	18.3	0.0	0.0	0.0	0.0	50.5
	AVG. TRAVEL TIME (MIN.):	9.9	34.5	39.4	0.0	0.0	0.0	0.0	36.3
	AVG. EXCESS TIME (MIN.):	3.0	20.0	20.0	0.0	0.0	0.0	0.0	20.0
	ROUTE EGRESS TIME (MIN.):	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	AVG. TRIP COST (CENTS):	19.7	45.0	45.0	0.0	0.0	0.0	0.0	45.0
963	PERSON-TRIPS ATTRACTED:	2674.3	0.0	33.5	0.0	0.0	0.0	0.0	33.5
	MODAL SPLIT (PERCENT):	98.8	0.0	1.2	0.0	0.0	0.0	0.0	1.2
	DENSITY (TRIPS/SQ.MI.):	2706.8	0.0	33.9	0.0	0.0	0.0	0.0	33.9
	AVG. TRAVEL TIME (MIN.):	8.7	0.0	45.2	0.0	0.0	0.0	0.0	45.2
	AVG. EXCESS TIME (MIN.):	3.0	0.0	20.0	0.0	0.0	0.0	0.0	20.0
	ROUTE EGRESS TIME (MIN.):	1.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	AVG. TRIP COST (CENTS):	15.5	0.0	45.0	0.0	0.0	0.0	0.0	45.0
970	PERSON-TRIPS ATTRACTED:	980.8	2.7	3.7	0.0	0.0	0.0	0.0	6.4
	MODAL SPLIT (PERCENT):	99.4	0.3	0.4	0.0	0.0	0.0	0.0	0.6
	DENSITY (TRIPS/SQ.MI.):	3130.3	8.6	11.8	0.0	0.0	0.0	0.0	20.3
	AVG. TRAVEL TIME (MIN.):	8.9	35.0	45.8	0.0	0.0	0.0	0.0	41.2
	AVG. EXCESS TIME (MIN.):	3.0	20.0	20.0	0.0	0.0	0.0	0.0	20.0
	ROUTE EGRESS TIME (MIN.):	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	AVG. TRIP COST (CENTS):	15.7	45.0	45.0	0.0	0.0	0.0	0.0	45.0
971	PERSON-TRIPS ATTRACTED:	354.4	2.5	4.8	0.0	0.0	0.0	0.0	7.3
	MODAL SPLIT (PERCENT):	98.0	0.7	1.3	0.0	0.0	0.0	0.0	2.0
	DENSITY (TRIPS/SQ.MI.):	696.1	4.9	9.5	0.0	0.0	0.0	0.0	14.4
	AVG. TRAVEL TIME (MIN.):	9.8	52.3	30.8	0.0	0.0	0.0	0.0	38.2
	AVG. EXCESS TIME (MIN.):	3.0	20.0	20.0	0.0	0.0	0.0	0.0	20.0
	ROUTE EGRESS TIME (MIN.):	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	AVG. TRIP COST (CENTS):	19.8	45.0	45.0	0.0	0.0	0.0	0.0	45.0
972	PERSON-TRIPS ATTRACTED:	1161.3	6.8	5.8	0.0	0.0	0.0	0.0	12.6
	MODAL SPLIT (PERCENT):	98.9	0.6	0.5	0.0	0.0	0.0	0.0	1.1
	DENSITY (TRIPS/SQ.MI.):	2346.8	13.8	11.7	0.0	0.0	0.0	0.0	25.5
	AVG. TRAVEL TIME (MIN.):	8.3	36.5	45.6	0.0	0.0	0.0	0.0	40.6
	AVG. EXCESS TIME (MIN.):	3.0	20.0	20.0	0.0	0.0	0.0	0.0	20.0
	ROUTE EGRESS TIME (MIN.):	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	AVG. TRIP COST (CENTS):	15.1	45.0	45.0	0.0	0.0	0.0	0.0	45.0
1204	PERSON-TRIPS ATTRACTED:	1294.6	0.0	37.5	0.0	0.0	0.0	0.0	37.5
	MODAL SPLIT (PERCENT):	97.2	0.0	2.8	0.0	0.0	0.0	0.0	2.8

Figure 2-4 Dest'n Zone Summary of BRT Corridor Analysis Data (Group 5)

ACCESS NODE	NODE DESCRIPTION	NODE LOAD
1	WOODWARD AND MAPLE	62.3
5	GREENFIELD AND 12-MILE	246.4
6	GREENFIELD AND 11-MILE	223.2
7	GREENFIELD AND 10-MILE	622.6
9	GREENFIELD AND 9-MILE	145.6
10	GREENFIELD AND 8-MILE	628.9
27	LAHSER AND 13-MILE	29.2
28	EVERGREEN AND 13-MILE	29.1
29	SOUTHFIELD AND 13-MILE	126.2
33	TELEGRAPH AND 12-MILE	93.7
34	LAHSER AND 12-MILE	272.4
35	EVERGREEN AND 12-MILE	89.3
40	LAHSER AND 11-MILE	107.9
42	SOUTHFIELD AND 11-MILE	336.7
43	INKSTER AND 10-MILE	264.5
47	EVERGREEN AND 10-MILE	125.3
48	SOUTHFIELD AND 10-MILE	147.9
50	TELEGRAPH AND 9-MILE	59.5
51	LAHSER AND 9-MILE	44.4
52	EVERGREEN AND 9-MILE	109.1
53	SOUTHFIELD AND 9-MILE	241.8
55	BEECH-DALY AND 8-MILE	179.8
56	TELEGRAPH AND 8-MILE	61.8
57	LAHSER AND 8-MILE	379.8
58	EVERGREEN AND 8-MILE	361.7
59	SOUTHFIELD AND 8-MILE	125.3
62	TELEGRAPH AND 7-MILE	78.7
63	LAHSER AND 7-MILE	226.3
64	EVERGREEN AND 7-MILE	552.3
65	SOUTHFIELD AND 7-MILE	2624.8
66	GREENFIELD AND 7-MILE	668.6
67	LODGE AND 7-MILE	984.6
69	LAHSER AND 6-MILE	111.2
71	SOUTHFIELD AND 6-MILE	909.0
72	GREENFIELD AND 6-MILE	985.8
74	SCHAEFER AND 6-MILE	867.4
75	LODGE AND 6-MILE	175.5
76	TELEGRAPH AND FENKELL	53.3
77	LAHSER AND FENKELL	333.9
78	EVERGREEN AND FENKELL	266.9
79	GRAND RIVER AND FENKELL	1044.1
80	SOUTHFIELD AND FENKELL	589.1
81	GREENFIELD AND FENKELL	288.8
82	SCHAEFER AND FENKELL	74.1
83	WYOMING AND FENKELL	791.2
88	TELEGRAPH AND SCHOOLCRAFT	32.0
90	EVERGREEN AND SCHOOLCRAFT	134.9
91	SOUTHFIELD AND SCHOOLCRAFT	924.9
92	GREENFIELD AND SCHOOLCRAFT	431.8
93	GREENFIELD AND GRAND RIVER	867.9
95	WYOMING AND SCHOOLCRAFT	213.0
98	SCHAEFER AND JEFFRIES	215.0

Figure 2-5 Auto Route Access Node Trip Loadings (Group 5)

ACCESS NODE	NODE DESCRIPTION	BUS RAPID TRANSIT NODE LOADINGS BY SUBMODE FEED1	FEED2	FEED3	PK-RD	KS-RD	WALK	BRT TOTAL
1	WOODWARD AND MAPLE	3.0	0.0	0.0	0.0	0.0	0.0	3.0
5	GREENFIELD AND 12-MILE	7.0	0.0	0.0	0.0	0.0	0.0	7.0
6	GREENFIELD AND 11-MILE	10.7	0.0	0.0	0.0	0.0	0.0	10.7
8	GREENFIELD AND VERNOR	19.8	0.0	0.0	0.0	0.0	0.0	19.8
9	GREENFIELD AND 9-MILE	6.9	0.0	0.0	0.0	0.0	0.0	6.9
11	NORTHLAND TERMINAL	17.1	0.0	0.0	0.0	0.0	0.0	17.1
27	LAHSER AND 13-MILE	2.2	0.0	0.0	0.0	0.0	0.0	2.2
28	EVERGREEN AND 13-MILE	2.3	0.0	0.0	0.0	0.0	0.0	2.3
29	SOUTHFIELD AND 13-MILE	5.2	0.0	0.0	0.0	0.0	0.0	5.2
33	TELEGRAPH AND 12-MILE	6.7	0.0	0.0	0.0	0.0	0.0	6.7
34	LAHSER AND 12-MILE	13.7	0.0	0.0	0.0	0.0	0.0	13.7
35	EVERGREEN AND 12-MILE	4.9	0.0	0.0	0.0	0.0	0.0	4.9
39	NORTHWESTERN HIGHWAY AND 11-MILE	5.1	0.0	0.0	0.0	0.0	0.0	5.1
40	LAHSER AND 11-MILE	7.8	0.0	0.0	0.0	0.0	0.0	7.8
42	SOUTHFIELD AND 11-MILE	15.3	0.0	0.0	0.0	0.0	0.0	15.3
48	SOUTHFIELD AND 10-MILE	8.2	0.0	0.0	0.0	0.0	0.0	8.2
52	EVERGREEN AND 9-MILE	3.4	0.0	0.0	0.0	0.0	0.0	3.4
53	SOUTHFIELD AND 9-MILE	16.6	0.0	0.0	0.0	0.0	0.0	16.6
57	LAHSER AND 8-MILE	0.0	7.6	0.0	0.0	0.0	0.0	7.6
58	EVERGREEN AND 8-MILE	0.0	13.9	0.0	0.0	0.0	0.0	13.9
61	GRAND RIVER AND 7-MILE	4.2	4.3	0.0	0.0	0.0	0.0	8.6
63	LAHSER AND 7-MILE	0.0	3.7	0.0	0.0	0.0	0.0	3.7
64	EVERGREEN AND 7-MILE	0.0	3.4	0.0	0.0	0.0	0.0	3.4
65	SOUTHFIELD AND 7-MILE	0.0	18.6	0.0	0.0	0.0	0.0	18.6
66	GREENFIELD AND 7-MILE	0.0	10.3	0.0	0.0	0.0	0.0	10.3
67	LODGE AND 7-MILE	0.0	6.1	0.0	0.0	0.0	0.0	6.1
71	SOUTHFIELD AND 6-MILE	0.0	2.6	0.0	0.0	0.0	0.0	2.6
72	GREENFIELD AND 6-MILE	0.0	9.4	0.0	0.0	0.0	0.0	9.4
73	GREENFIELD AND OUTER DRIVE	0.0	3.3	0.0	0.0	0.0	0.0	3.3
74	SCHAEFER AND 6-MILE	0.0	9.5	0.0	0.0	0.0	0.0	9.5
75	LODGE AND 6-MILE	0.0	1.7	0.0	0.0	0.0	0.0	1.7
76	TELEGRAPH AND FENKELL	0.0	5.1	0.0	0.0	0.0	0.0	5.1
77	LAHSER AND FENKELL	0.0	4.3	0.0	0.0	0.0	0.0	4.3
78	EVERGREEN AND FENKELL	0.0	2.0	0.0	0.0	0.0	0.0	2.0
79	GRAND RIVER AND FENKELL	0.0	10.7	0.0	0.0	0.0	0.0	10.7
80	SOUTHFIELD AND FENKELL	0.0	3.0	0.0	0.0	0.0	0.0	3.0
83	WYOMING AND FENKELL	0.0	9.6	0.0	0.0	0.0	0.0	9.6
91	SOUTHFIELD AND SCHOOLCRAFT	0.0	4.5	0.0	0.0	0.0	0.0	4.5
92	GREENFIELD AND SCHOOLCRAFT	0.0	1.6	0.0	0.0	0.0	0.0	1.6
93	GREENFIELD AND GRAND RIVER	0.0	1.3	0.0	0.0	0.0	0.0	1.3
95	WYOMING AND SCHOOLCRAFT	0.0	5.0	0.0	0.0	0.0	0.0	5.0
98	SCHAEFER AND JEFFRIES	0.0	4.1	0.0	0.0	0.0	0.0	4.1
119	EVERGREEN AND PLYMOUTH	0.0	6.1	0.0	0.0	0.0	0.0	6.1
120	SOUTHFIELD AND PLYMOUTH	0.0	4.0	0.0	0.0	0.0	0.0	4.0
121	GREENFIELD AND PLYMOUTH	0.0	9.4	0.0	0.0	0.0	0.0	9.4
122	SCHAEFER AND PLYMOUTH	0.0	2.3	0.0	0.0	0.0	0.0	2.3
123	WYOMING AND PLYMOUTH	0.0	6.9	0.0	0.0	0.0	0.0	6.9
124	EVERGREEN AND JOY	0.0	19.3	0.0	0.0	0.0	0.0	19.3
125	SOUTHFIELD AND JOY	0.0	4.2	0.0	0.0	0.0	0.0	4.2
126	GREENFIELD AND JOY	0.0	11.2	0.0	0.0	0.0	0.0	11.2
127	SCHAEFER AND JOY	0.0	2.2	0.0	0.0	0.0	0.0	2.2
128	WYOMING AND JOY	0.0	15.8	0.0	0.0	0.0	0.0	15.8

Figure 2-6 BRT Route Access Node Trip Loadings (Group 5)

LINK ENDS FROM NODE	TO NODE	LINK TYPE	LINK LOAD
1	17	LIN	217.9
5	36	LIN	590.5
6	42	LIN	276.0
7	48	LIN	770.9
9	53	LIN	660.5
10	9	LIN	1912.8
10	11	LIN	4425.2
17	23	LIN	217.9
17	23	LIN	217.9
23	29	LIN	217.9
27	34	LIN	154.0
28	29	LIN	56.3
29	36	LIN	528.6
32	38	LIN	44.4
33	38	LIN	153.2
34	40	LIN	831.2
35	36	LIN	345.1
36	42	LIN	1454.2
38	40	LIN	197.6
40	47	LIN	1062.3
42	48	LIN	2341.9
43	44	LIN	410.8
44	45	LIN	658.7
45	47	LIN	658.7
47	40	LIN	559.3
47	53	LIN	2205.3
48	53	LIN	4089.4
50	56	LIN	276.5
51	52	LIN	161.2
52	58	LIN	600.5
53	47	LIN	462.3
53	48	LIN	504.7
53	59	LIN	5717.9
55	56	LIN	397.8
56	57	LIN	848.6
57	58	LIN	1555.9
58	59	LIN	3617.3
59	10	LIN	5026.8
59	53	LIN	1128.7
59	65	LIN	4801.1
62	63	LIN	137.8
63	64	LIN	468.8
64	65	LIN	1154.4
65	59	LIN	2345.3
65	66	LIN	1268.8
65	71	LIN	4493.1
66	10	LIN	682.3
66	65	LIN	566.6
66	67	LIN	676.4
66	72	LIN	480.7
67	66	LIN	812.5
68	69	LIN	23.6

Figure 2-7 Auto Route Link Trip Loadings

LINK ENDS			BUS RAPID TRANSIT NETWORK LINK LOADINGS BY SUBMODE						BRT
FROM NODE	TO NODE	LINK TYPE	FEED1	FEED2	FEED3	PK-RD	KS-RD	WALK	TOTAL
1	2	COL	10.6	0.0	0.0	0.0	0.0	0.0	10.6
2	3	COL	10.6	0.0	0.0	0.0	0.0	0.0	10.6
3	23	COL	10.6	0.0	0.0	0.0	0.0	0.0	10.6
4	5	COL	15.4	0.0	0.0	0.0	0.0	0.0	15.4
5	6	COL	73.1	0.0	0.0	0.0	0.0	0.0	73.1
6	7	COL	89.3	0.0	0.0	0.0	0.0	0.0	89.3
7	8	COL	89.3	0.0	0.0	0.0	0.0	0.0	89.3
8	9	COL	112.2	0.0	0.0	0.0	0.0	0.0	112.2
9	11	COL	130.5	0.0	0.0	0.0	0.0	0.0	130.5
10	11	LIN	12.6	161.5	0.0	0.0	0.0	0.0	174.1
10	66	LIN	265.0	30.6	0.0	0.0	0.0	0.0	295.6
11	10	LIN	247.8	0.0	0.0	0.0	0.0	0.0	247.8
11	53	DST	6.6	53.1	0.0	0.0	0.0	0.0	59.7
23	29	COL	10.6	0.0	0.0	0.0	0.0	0.0	10.6
27	28	COL	8.8	0.0	0.0	0.0	0.0	0.0	8.8
28	4	COL	15.4	0.0	0.0	0.0	0.0	0.0	15.4
29	36	COL	19.1	0.0	0.0	0.0	0.0	0.0	19.1
33	34	COL	12.5	0.0	0.0	0.0	0.0	0.0	12.5
34	35	COL	33.1	0.0	0.0	0.0	0.0	0.0	33.1
35	5	COL	48.0	0.0	0.0	0.0	0.0	0.0	48.0
36	42	COL	19.1	0.0	0.0	0.0	0.0	0.0	19.1
39	40	COL	31.0	0.0	0.0	0.0	0.0	0.0	31.0
40	41	COL	38.8	0.0	0.0	0.0	0.0	0.0	38.8
41	42	COL	38.8	0.0	0.0	0.0	0.0	0.0	38.8
42	48	COL	75.4	0.0	0.0	0.0	0.0	0.0	75.4
47	40	DST	3.5	18.6	0.0	0.0	0.0	0.0	22.1
48	53	COL	83.6	0.0	0.0	0.0	0.0	0.0	83.6
52	9	COL	9.4	0.0	0.0	0.0	0.0	0.0	9.4
53	11	COL	100.2	0.0	0.0	0.0	0.0	0.0	100.2
53	47	DST	3.5	18.6	0.0	0.0	0.0	0.0	22.1
57	58	COL	8.8	12.4	0.0	0.0	0.0	0.0	21.2
58	59	COL	8.8	30.6	0.0	0.0	0.0	0.0	39.4
59	10	COL	17.2	30.6	0.0	0.0	0.0	0.0	47.8
61	69	COL	16.7	16.3	0.0	0.0	0.0	0.0	33.0
63	64	COL	0.0	10.9	0.0	0.0	0.0	0.0	10.9
64	65	COL	0.0	21.7	0.0	0.0	0.0	0.0	21.7
65	66	COL	0.0	45.7	0.0	0.0	0.0	0.0	45.7
66	10	LIN	12.6	200.7	0.0	0.0	0.0	0.0	213.3
66	73	LIN	265.0	92.7	0.0	0.0	0.0	0.0	357.7
67	66	COL	0.0	6.1	0.0	0.0	0.0	0.0	6.1
68	69	COL	0.0	2.8	0.0	0.0	0.0	0.0	2.8
69	70	COL	12.6	10.9	0.0	0.0	0.0	0.0	23.5
69	79	COL	4.1	19.2	0.0	0.0	0.0	0.0	23.3
70	71	COL	12.6	10.9	0.0	0.0	0.0	0.0	23.5
71	72	COL	12.6	16.3	0.0	0.0	0.0	0.0	28.9
72	73	LIN	12.6	279.1	0.0	0.0	0.0	0.0	291.7
72	81	LIN	184.6	137.9	0.0	0.0	0.0	0.0	322.4
73	66	LIN	12.6	209.2	0.0	0.0	0.0	0.0	221.8
73	72	LIN	196.2	101.1	0.0	0.0	0.0	0.0	297.4
74	72	COL	0.0	26.7	0.0	0.0	0.0	0.0	26.7
75	74	COL	0.0	5.3	0.0	0.0	0.0	0.0	5.3
76	77	COL	0.0	7.3	0.0	0.0	0.0	0.0	7.3

Figure 2-8 BRT Route Link Trip Loadings

DATA ITEM DESCRIPTION	AUTO ONLY	BUS RAPID TRANSIT DATA BY SUBMODE FEED1	FEED2	FEED3	PK-RD	KS-RD	WALK	BRT TOTAL
PERSON-TRIPS ATTRACTED:	29844.9	160.0	447.4	0.0	0.0	0.0	0.0	607.4
MODAL SPLIT (PERCENT):	98.0	0.5	1.5	0.0	0.0	0.0	0.0	2.0
AVG. TRAVEL TIME (MIN.):	10.3	41.5	40.1	0.0	0.0	0.0	0.0	40.4
AVG. EXCESS TIME (MIN.):	3.0	20.0	20.0	0.0	0.0	0.0	0.0	20.0
AVG. TRIP COST (CENTS):	20.0	45.0	45.0	0.0	0.0	0.0	0.0	45.0

Figure 2-9 Overall Summary of Group 5 Trips

3.0 BRT SYSTEM

The proposed BRT system evolved as the result of an iterative process involving analyses of existing express bus service in the Southfield/Jeffries corridor, demand estimates and sensitivities, and requirements for new construction. These analyses, including the results of some preliminary iterations, are described in this section. In addition to the system design rationale, discussion of physical design and construction requirements, demand estimates, system sizing and costing, and cost revenue considerations are presented in this section. However, before the details of the BRT system design process are discussed, an overview of the proposed BRT system concept is presented.

3.1 Overview of BRT System Operation

The objective of the BRT System is to substantially improve the speed of bus transit service provided in the Southfield/Jeffries corridor to destinations in the Detroit CBD and New Center by utilizing the reserved bus lane on the Jeffries Freeway and other high speed links. In peak periods, each BRT route consists of three segments: collection, line-haul, and distribution. The first segment involves local collection in which the BRT bus interfaces with park-and-ride lots, feeder buses, and local bus stops along the route. BRT collection routes are designated on each of the "mile" roads in Detroit from Eight Mile Road to Joy Road. In Oakland County, collection buses originate at various park-and-ride lots. In general, all BRT collection buses which originate west of Southfield are routed onto the Southfield Freeway, where they operate in mixed traffic to the Jeffries Freeway. At the Jeffries Freeway, BRT buses weave across to the median lane of the inner roadway, which is reserved exclusively for BRT vehicles. These buses make an intermediate stop at Wyoming to discharge New Center transfer passengers, and then travel nonstop to the CBD in the Jeffries reserved bus lane. Shuttle buses operate between the transfer point at Wyoming and the New Center Distribution Loop.

Additional BRT collection buses originate east of Southfield on each of the mile roads in Detroit. These buses travel east on the mile roads and eventually enter the Jeffries reserved bus lane via an exclusive bus entrance ramp at Wyoming. These buses stop at Wyoming to discharge New Center transfer patrons before entering the freeway for the express run to the CBD.

The line-haul portion of the BRT routes utilize the reserved bus lane on the Jeffries Freeway. In order to minimize the need for buses to weave across lanes of freeway traffic, exclusive bus access ramps are proposed for three locations. In addition to the proposed ramp from Wyoming to the reserved lane of the Jeffries Freeway mentioned earlier, a ramp from the reserved lane to Scotten is proposed to provide access to the New Center. The third construction project which is proposed to minimize weaving and to give buses priority involves the southeast terminus of the exclusive bus lane. It is proposed that the exclusive bus lanes on the Jeffries be extended on the Fisher Freeway to Third Street by using the median of the Fisher Freeway as exclusive bus lanes.

A bus-only exit ramp at Third Street which permits buses to exit the reserved median lane without weaving is proposed.

The final segment of the inbound BRT trip is distribution in the CBD or New Center. Distribution routes have been proposed to serve both of these areas in an efficient manner. In general, the routes are characterized by mixed-traffic operation on one-way streets.

The need for local feeder service to the BRT system in Detroit during peak periods is minimized by the 1-mile spacing of BRT collection routes. However, local buses in Detroit, especially those operating on north-south streets, are assumed to provide any additional feeder service which is necessary. The local bus service which is presently provided in Oakland County is quite limited, and the proposed BRT collection routes interface with only a small number of park-and-ride lots. Therefore, a need does exist for feeder service to the BRT system in Oakland County. To satisfy this need, a local bus system operating on the mile roads from Ten Mile to Fifteen Mile and focused on Northland Center is proposed.

In order to provide a reasonable transit alternative to BRT patrons who must return home during off-peak periods, limited BRT line-haul service is proposed for the period between the morning and evening peak periods and for a few hours after the evening peak. During off-peak periods, it is proposed that BRT vehicles complete the CBD Distribution Loop and then follow a modified Imperial Express route. The route utilizes the Jeffries reserved bus lane from the CBD to Wyoming, runs north on Wyoming to James Couzens, follows James Couzens to the Northland bus terminal, and then back to Greenfield, runs south on Greenfield to Seven Mile, and then follows Seven Mile Road across the corridor. The New Center shuttle should also operate between the New Center and the Wyoming transfer point during off-peak periods.

It should be apparent from this description of the operation of the proposed BRT system that the intersection of Wyoming and the Jeffries Freeway is the focal point of the BRT system. All BRT buses which do not enter the Jeffries reserved lane at Southfield do so at Wyoming. In addition, this area is a vital link in the BRT service to the New Center. With few exceptions, the demand for New Center service along each of the BRT collection routes is insufficient to support New Center express service at less than 30-minute headways during the peak hour. An alternative to long headways for New Center service is to require a transfer from CBD-bound collection buses, which run at relatively short headways, to New Center buses. The headway of these New Center buses is minimized by consolidating the New Center demand at a single transfer point--Wyoming. Therefore, the proposed BRT system includes construction of a passenger transfer station at Wyoming, which is integrated with the entrance/exit ramps to the Jeffries reserved bus lanes. The proposed transfer station, illustrated in Figure 3-1, is located at surface-street grade over the median of the Jeffries Freeway west of the Wyoming bridge. Bus access to the station, and subsequently to the exclusive bus lane, is provided from the service drive. In addition, exclusive ramps are provided from the reserved lanes on the freeway to the Wyoming Station to accommodate intermediate stops. Due to the volume of buses, the station is used only by inbound buses in the morning peak period and by outbound buses in the evening peak. Figure 3-1 illustrates how the station would be

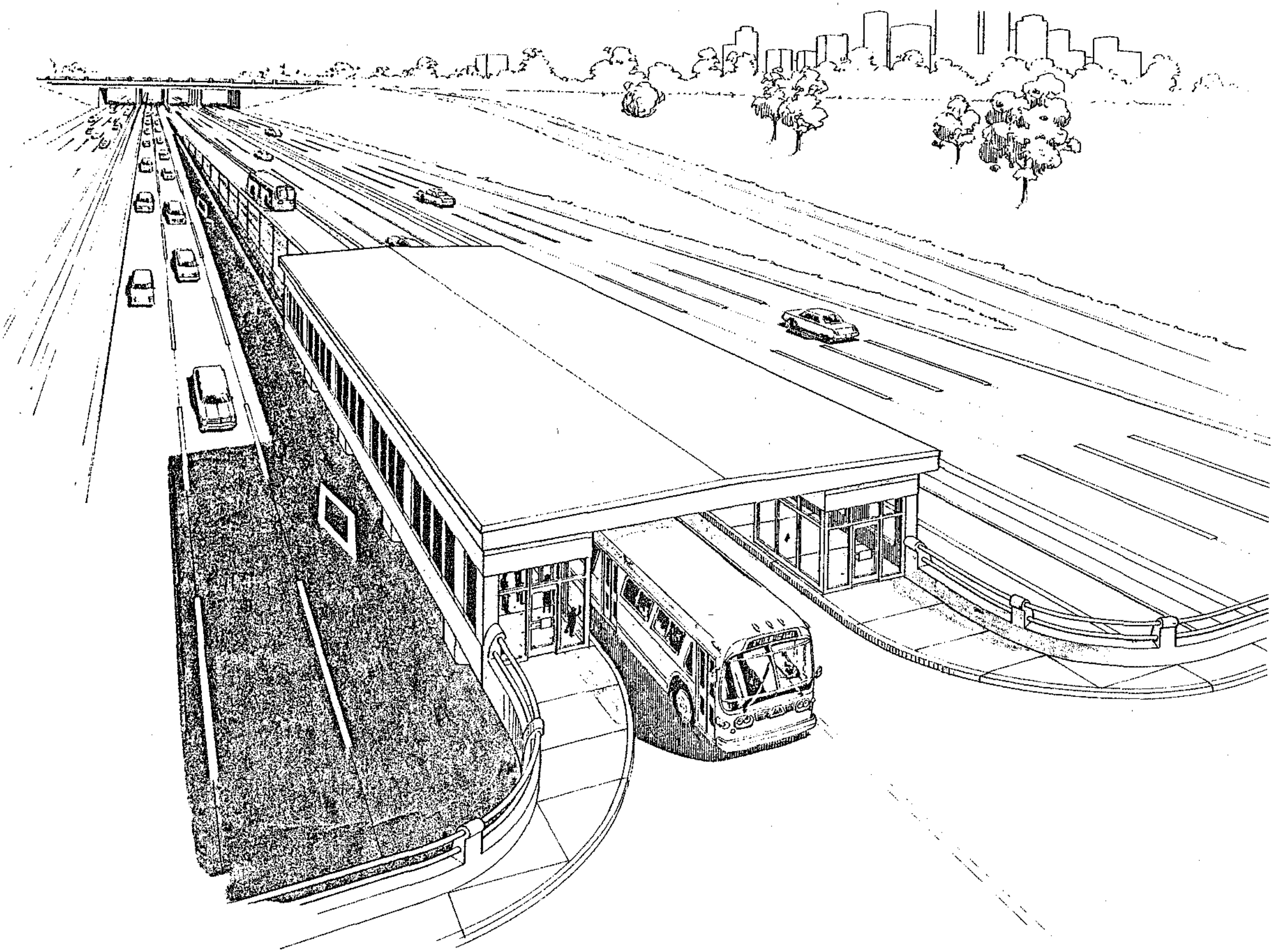


Figure 3-1 Proposed BRT Transfer Station at Wyoming

used during the evening peak period. Since two lanes are provided in the station itself, it can be used by both inbound and outbound buses during off-peak periods provided the number of buses involved is small and ramp signals facilitate the safe use of the one-lane ramps.

3.2 Intermediate Stop Analysis

The peak-period demand for BRT service to the New Center was estimated in Stage I and is reported in Figure 4-10. An analysis of these data indicates that the New Center demand from most individual nodes is not sufficient to support non-stop service to the New Center at reasonably short headways, even in the peak hour. If express service to the New Center area is to be provided, efficiency dictates that an attempt be made to aggregate the demand to minimize the required number of buses. An intermediate stop analysis was therefore conducted to evaluate the effects of intermediate stops on net BRT system demand. Both the loss in estimated BRT ridership to primary destinations (CBD and New Center) due to increased trip times and the potential increase in ridership resulting from providing service to intermediate destinations were considered in order to evaluate the net effect on BRT ridership.

First, the potential loss in BRT ridership was estimated by evaluating the sensitivity of the modal split estimates to changes in travel time due to intermediate stop delays. Efficient stops, involving no deviation from the mainline route and an average dwell time of only 15 s at each stop location, were assumed. The time required for deceleration from 50 mi/h at 0.15 g and acceleration to 50 mi/h at .05 g is included. The total increase in trip time associated with each intermediate stop is about 45 s as determined by the foregoing assumptions. This estimate of intermediate stop delay time assumes no queuing of buses at the intermediate stop location. If many buses stop at the same location, some queuing will occur, and perhaps a better estimate of intermediat stop delay time would be 90 s.

The sensitivity of demand estimates to variations in travel time due to intermediate stops for trips to the CBD originating at selected corridor access points is illustrated in Figure 3-2. For the four stops, representing a total delay of 3 minutes, the estimated loss in potential BRT ridership ranges from 3 percent for the longest trip (access node 120, Fourteen Mile and Southfield) to about 7 percent for the shortest trip (access node 111, Wyoming and Jeffries Freeway). The variation in modal split sensitivity to intermediate stops is due not only to changes in travel time ratio, but also to variations in origin zone income class and cost ratio.

Figure 3-3 illustrates the sensitivity of New Center demand estimates to intermediate stop delays for trips accessing the BRT route at selected nodes. The estimated losses in BRT ridership to the New Center due to delays associated with four quick intermediate stops range from about 5 percent of trips originating at node 120 (Fourteen Mile and Southfield) to about 13 percent for shorter trips (e.g., trips originating at node 108, Southfield and Jeffries).

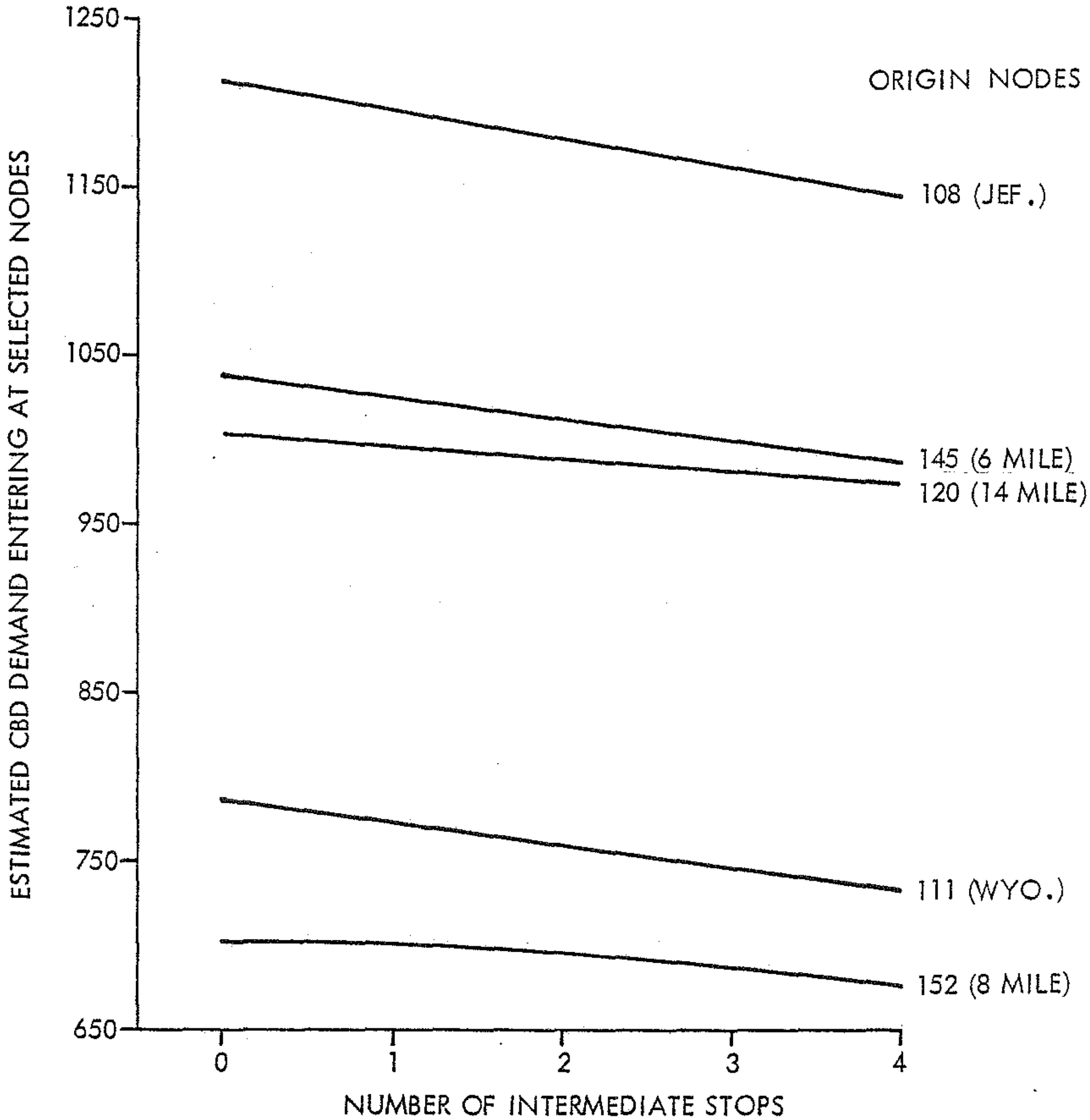


Figure 3-2 Sensitivity of CBD Demand to Intermediate Stops

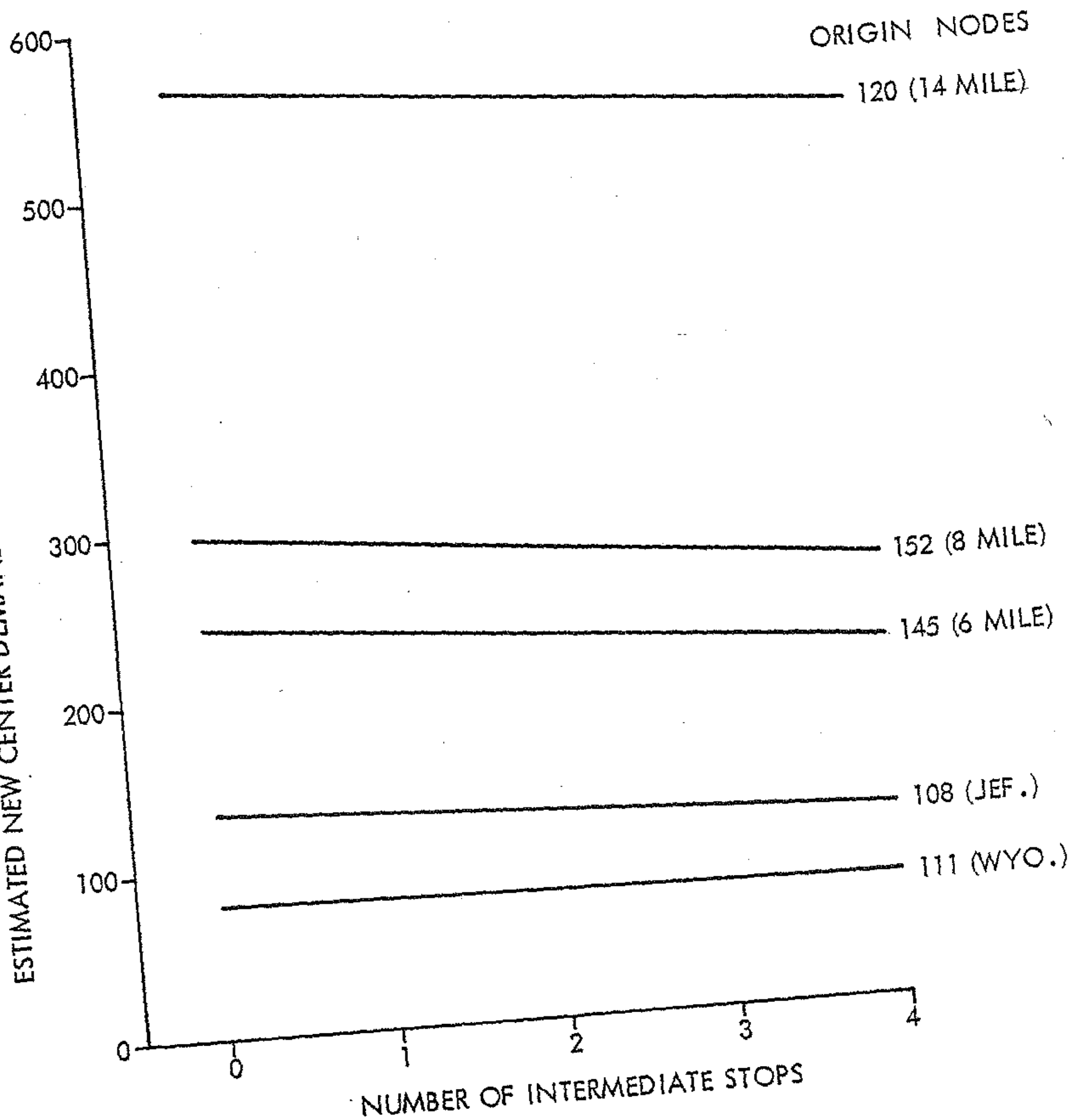


Figure 3-3 Sensitivity of New Center Demand to Intermediate Stops

This analysis shows that the diversion curves used in the modal split estimates are relatively insensitive to small variations in travel time ratio. It can be concluded that a number of efficient intermediate stops can be scheduled if necessary without significant loss of BRT ridership potential to primary destinations.

The next step in the analysis is to estimate the potential increase in BRT ridership as a result of serving intermediate destinations. Since the Southfield corridor between the cities of Southfield and Dearborn is to be served by an intermediate level system, only zones located along the Jeffries were considered as intermediate stop potential destinations for the BRT system. Initially, a morning peak period trip matrix from all zones in the Southfield/Jeffries corridor to all other zones in the corridor was generated. An analysis of the trip matrix revealed no zones which attract a significant number of trips and which can be conveniently served by an intermediate stop on the Jeffries. The two zones in the general vicinity of the Jeffries Freeway which attract the largest number of trips in the peak period (zones 704 and 723) are both located more than one mile from the freeway. Assuming a modal split of 5 percent, which has been predicted using the diversion curves for similar trips to destinations where convenient free parking is available for the auto alternative, each zone attracts only about 160 transit trips in the 3-hour morning peak period. Since no single major attraction zone exists along the Jeffries, all zones adjacent to freeway exits or along Grand River from Livernois to West Grand Boulevard were considered as potential intermediate stop destinations. The total number of trips attracted from the corridor to these zones during the morning peak period is 12,597. With an average modal split of 5 percent, the number of peak period transit trips attracted to these zones totals 629. Table 3-1 summarizes the zones that were considered, and the number of trips attracted to each of the potential intermediate stop destinations. The number of transit trips attracted to these zones is approximately equal to the total estimated loss in ridership to primary destinations due to intermediate stop delays.

In conclusion, although the concept of incorporating a number of intermediate stops into the BRT system does not offer the potential for significantly increased ridership by serving intermediate destinations, the delays associated with efficient stops do not seriously reduce the potential ridership to primary destinations. Therefore, although an intermediate stopping policy need not be considered in this corridor as a means of increasing BRT ridership, it can be considered as a means of consolidating demand to decrease headways on certain routes.

Table 3-1 Potential BRT Demand for Intermediate Destinations

ZONE	TRIP ATTRACTION	
	ALL MODE	TRANSIT*
144	400	20
145	1186	59
512	153	8
513	366	18
514	723	36
515	810	40
516	652	33
701	1316	66
702	1239	62
713	2083	104
724	878	44
725	1504	75
731	788	39
732	499	25
TOTAL	12,597	629

* Assuming 5 percent modal split

3.3 Integration of Existing Service

The purpose of the service integration task was to determine the recommended route structure for BRT collection, line haul, and additional feeder service within the framework of the existing bus service in the corridor. The objective was to integrate the existing service with the proposed BRT service to the greatest extent possible.

For the most part, DDOT operates the routes south of Eight Mile Road while SEMTA operates those north of Eight Mile. The express routes are the prime candidates in the corridor for integration into the BRT system. In some cases, local buses can serve as feeders to the BRT collection routes.

Table 3-2 shows the ten DDOT express bus services operating in the corridor and the number of trips to the CBD in the a.m. peak period. The Dexter express also operates in the corridor, along Outer Drive, but since its prime service along Dexter is not in the corridor, its integration into BRT service was not considered. No SEMTA service to the CBD is included because substantial portions of the SEMTA routes lie outside the corridor and they serve several intermediate destinations in addition to the Detroit CBD.

As shown in Table 3-2, there are a total of 101 express vehicle trips in the a.m. peak period into the CBD. According to DDOT ride checks, there are over 9,500 daily express trips on these lines in the a.m. and p.m. peak periods. The importance of integrating these lines into the BRT system is obvious: the present express bus ridership forms an excellent demand base for the initial BRT system. Figure 3-4 shows a comparison of the number of daily trips on the Shirley Highway Busway in Washington, D.C., the San Bernardino El Monte Busway in Los Angeles, and the Minneapolis Bus Rapid Transit operating on I-35W. The existing DDOT express bus ridership is greater than the ridership on the Minneapolis bus system and only about 5,000 trips per day less than the San Bernardino Busway.

Table 3-2 DDOT Express Service in BRT Corridor

Route	Number of Trips A.M. Peak Period
Grand River Red Express	22
Grand River Blue Express	10
7 Mile Imperial Express	23
7 Mile Hamilton Express	6
6 Mile Second Avenue Express	4
Fenkell Express (5 Mile Road)	11
Schoolcraft (4 Mile Road)	3
Plymouth (3 Mile Road)	7
Chicago Davison (2 1/2 Mile Road)	3
Joy (2 Mile Road)	12
Total	101

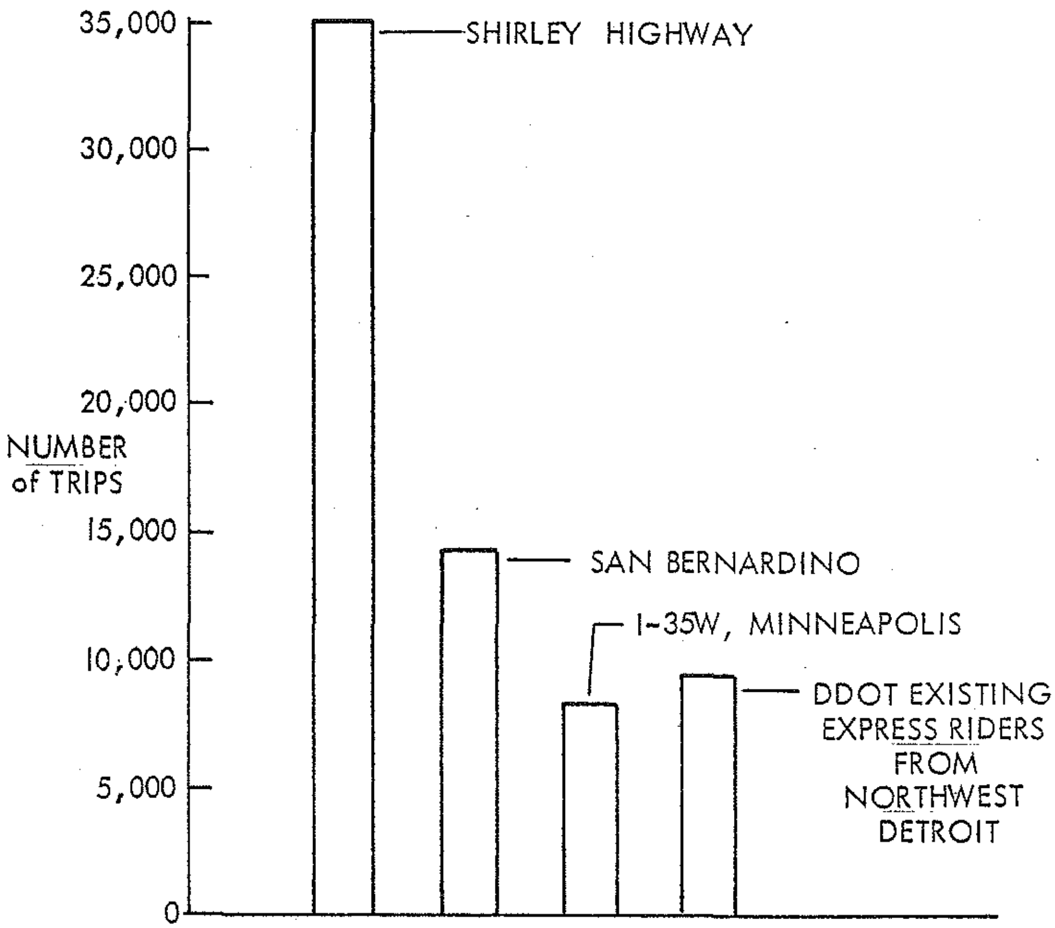


Figure 3-4 Daily BRT Ridership Comparison

The following set of guidelines for the integration of the existing express routes in the BRT system were developed:

- Improve, or at least equal, the travel time of present riders.
- Do not eliminate express service to those who presently have express service available to them.
- Do not substantially increase headways over those of present service.

The approach taken in the task of integrating existing routes was to:

- Identify bus routes
- Determine frequency of service
- Determine travel time to the CBD from major intersections along the route
- Postulate alternative BRT treatments
- Determine travel time on BRT alternatives
- Compare travel times of existing express bus service with BRT alternatives
- Assess impact of BRT alternative services on headway and physical construction requirements
- Develop a recommended BRT service

The existing express bus service collection and line-haul travel times were based on published schedules. The BRT collection times were based on the existing express bus collection. The line-haul speed on Southfield was assumed to be 37 mi/h as determined in Stage I on the basis of numerous speed runs. The average speed on the Jeffries reserved bus lane was assumed to be 50 mi/h. The travel times for the existing service and BRT service do not include downtown distribution. The present express services have different CBD distributions for almost every route, while in the BRT system, one distribution route is envisioned for all the buses. A detailed discussion of the CBD distribution route is presented in Section 3.4.

The results of this task are presented in two parts. First, the recommended BRT route structure for the portion of the corridor inside the city of Detroit is presented. The integration of each existing DDOT express bus line is presented in detail followed by a brief discussion of the feeder service which can be provided by existing DDOT local bus lines in the corridor. The second part of the section describes the existing SEMTA service in the Oakland County portion of the corridor.

3.3.1 Integration of DDOT Service

3.3.1.1 Seven Mile and Eight Mile Roads

Seven Mile is presently served by the Hamilton Local, the Hamilton Express, and the Imperial Express. Figure 3-5 shows the route of each of the above lines. The Hamilton Local has three points of origin: Grand River and Redford, Seven Mile and Southfield, and the Northland Center. Before 7:00 a.m. buses originate at either Grand River and

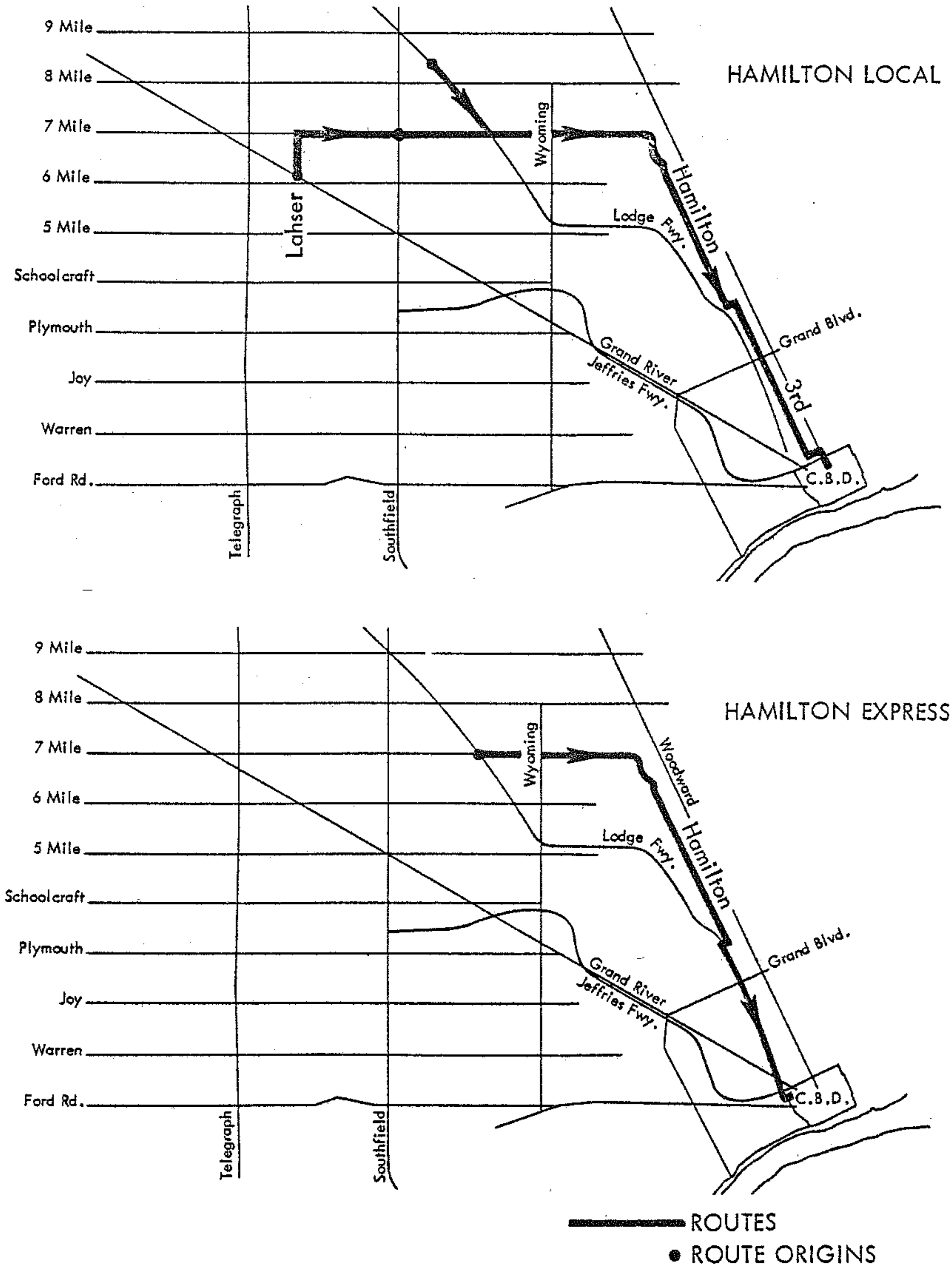


Figure 3-5 Sketch of Existing Express Routes on Seven Mile Road (Sheet 1 of 2)

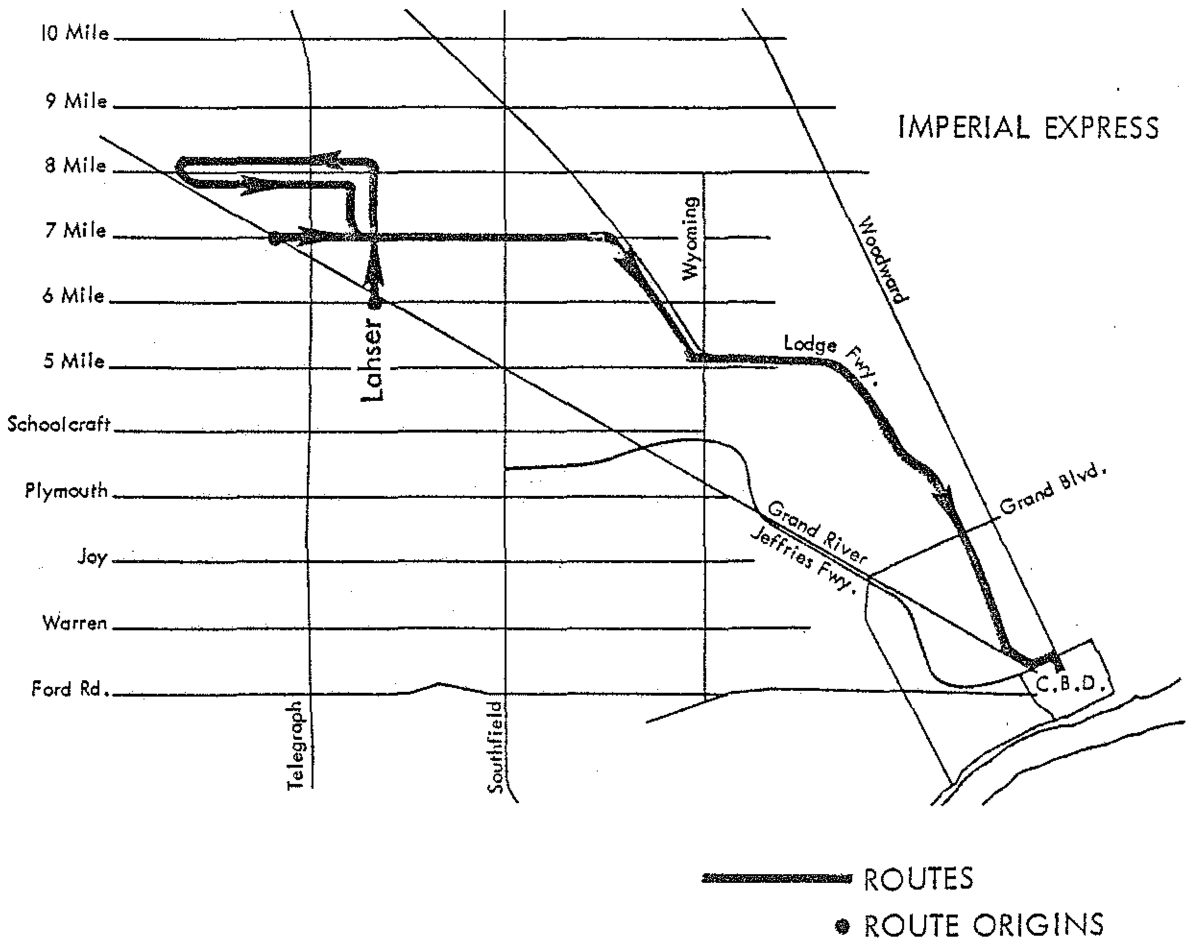


Figure 3-5 Sketch of Existing Express Routes on Seven Mile Road
(Sheet 2 of 2)

Redford or Seven Mile and Southfield. After 7:00 a.m. buses originate at either Grand River and Redford or at the Northland Center. The Hamilton locals go across Seven Mile to Hamilton. The buses then go south on Hamilton, on Third Street, and on Woodward to the CBD.

The Seven Mile Road Imperial Express provides express bus service along Seven Mile Road from Grand River east to James Couzens, and the Hamilton Express provides express service along Seven Mile Road from James Couzens east to Hamilton. The Imperial Express originates at either Seven Mile and Grand River or Lahser and McNichols and makes a loop before heading for the CBD. The buses leave Lahser and McNichols, go north on Lahser to Eight Mile Road, and west on Eight Mile to Grand River. At Grand River and Eight Mile the buses turn around, proceed east on Eight Mile to Lahser, and then south on Lahser to Seven Mile. After originating at either of the two points, the Imperial Expresses go east on Seven Mile, operating as a local to James Couzens. The buses follow the James Couzens service drive (still operating as local service) to the Wyoming entrance of the John Lodge Freeway. The buses exit the freeway at Grand River, and take Henry Street to Woodward to their terminal point at Larned and Randolph.

As pointed out, the Hamilton Express begins at Seven Mile and James Couzens and goes east on Seven Mile to Hamilton. It then goes south on Hamilton to Clairmont, where it enters the Lodge Freeway. It exits the Lodge at Bagley, goes down Cass to State, to Griswold to East Jefferson.

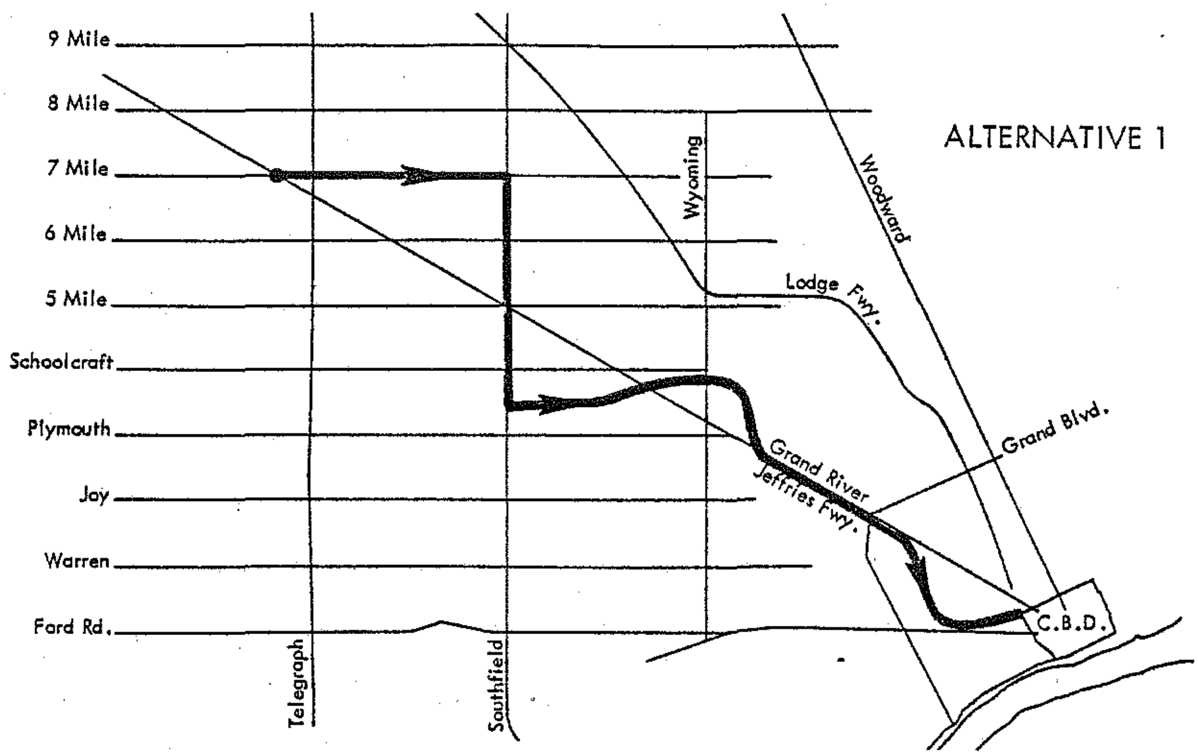
Table 3-3 shows the frequency of service along Seven Mile Road. The number of buses arriving in the CBD in each half hour in the peak period is tabulated. The Hamilton Local has about five-minute headways. The Imperial Express has 8- to 10-minute headways except from 8:00-8:30 a.m. when the headways are 4 to 5 minutes. The Hamilton Express has headways of 20 minutes during the peak period.

There are many alternative ways to serve the Seven Mile corridor with the new BRT service, and several feasible alternatives are illustrated in Figure 3-6. These alternatives will now be discussed, and then various ways of integrating the existing service into the BRT service will be presented.

The first alternative is to have a BRT collection route along Seven Mile Road from Grand River to Southfield as illustrated in Figure 3-6. The bus would then enter the Southfield Freeway and follow the BRT line haul route. In coordination with this alternative, a second alternative is to start a BRT collection bus at Southfield and Seven Mile, go east on Seven Mile to James Couzens, take James Couzens to Wyoming, and Wyoming to the Jeffries. The third alternative is to start at Seven Mile and Grand River, proceed east to James Couzens to Wyoming, and then on Wyoming to the Jeffries Freeway. These three alternatives cover the present Imperial Express routes. A fourth alternative is to start a BRT collection bus at Meyers and Seven Mile Road and proceed west to Southfield to the line haul. A fifth alternative is to provide service between Meyers and James Couzens with westbound Hamilton Local buses and then require patrons to transfer to a BRT collection bus at James Couzens.

Table 3-3 Frequency of Existing Service on Seven Mile Road

Route Name	Type of Service	Route Number	Point of Origin	Point of Termination	Number of Buses Arriving in the CBD in the A.M.						
					7:00-7:29	7:30-7:59	8:00-8:29	8:30-8:59	9:00-9:29	9:30-10:00	TOTAL
Hamilton	Local	23	7 Mile & Southfield	Cobo Hall	2	2	-	-	-	-	4
			Grand River	Cobo Hall	3	2	3	3	3	3	17
			Northland Center	Cobo Hall	-	-	3	3	3	3	12
			TOTAL		5	4	6	6	6	6	33
Imperial	Express	78	Lahser & McNichols	Larned & Randolph	1	1	1	2	1	0	6
			7 Mile & Grand River	Larned & Randolph	2	3	6	1	3	2	17
			TOTAL		3	4	7	3	4	2	23
Hamilton	Express	77	7 Mile & Jas. Couzens	Shelby & Jefferson	1	1	2	1	1	0	6



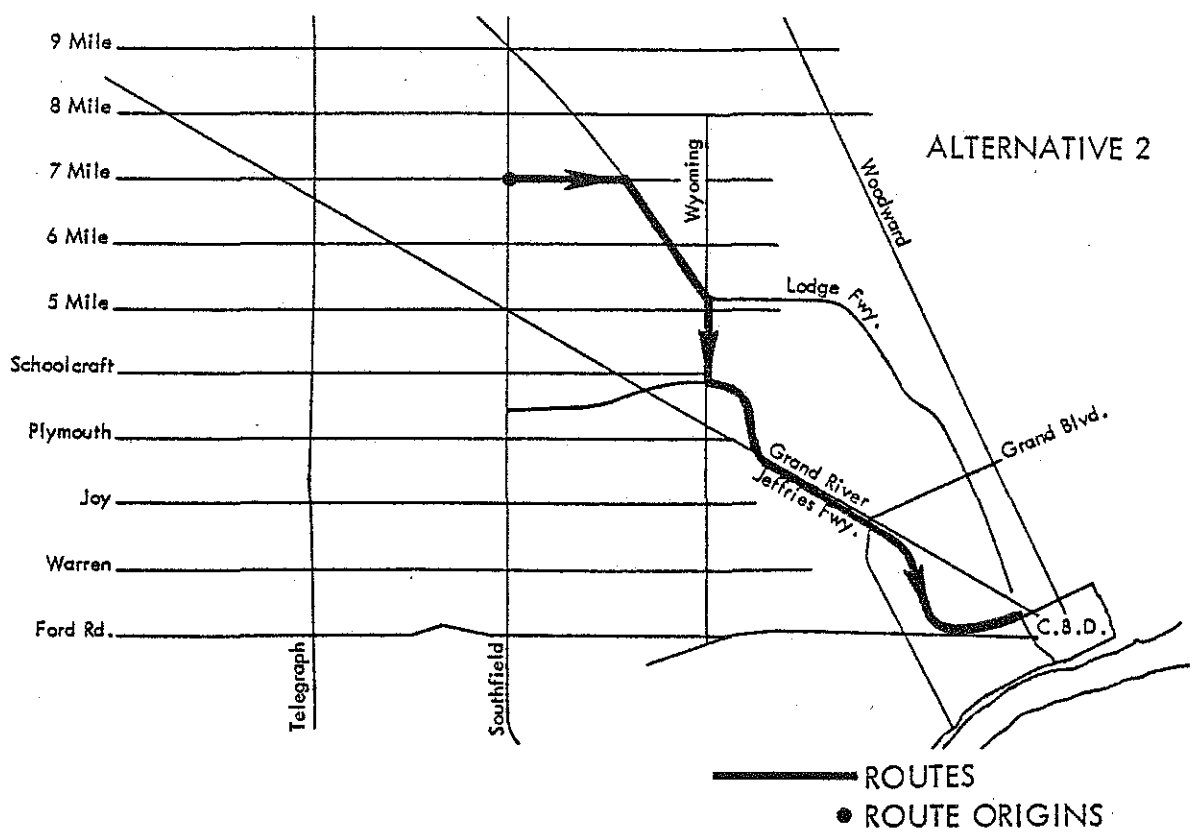


Figure 3-6 Sketch of Alternative BRT Routes on Seven Mile Road (Sheet 1 of 2)

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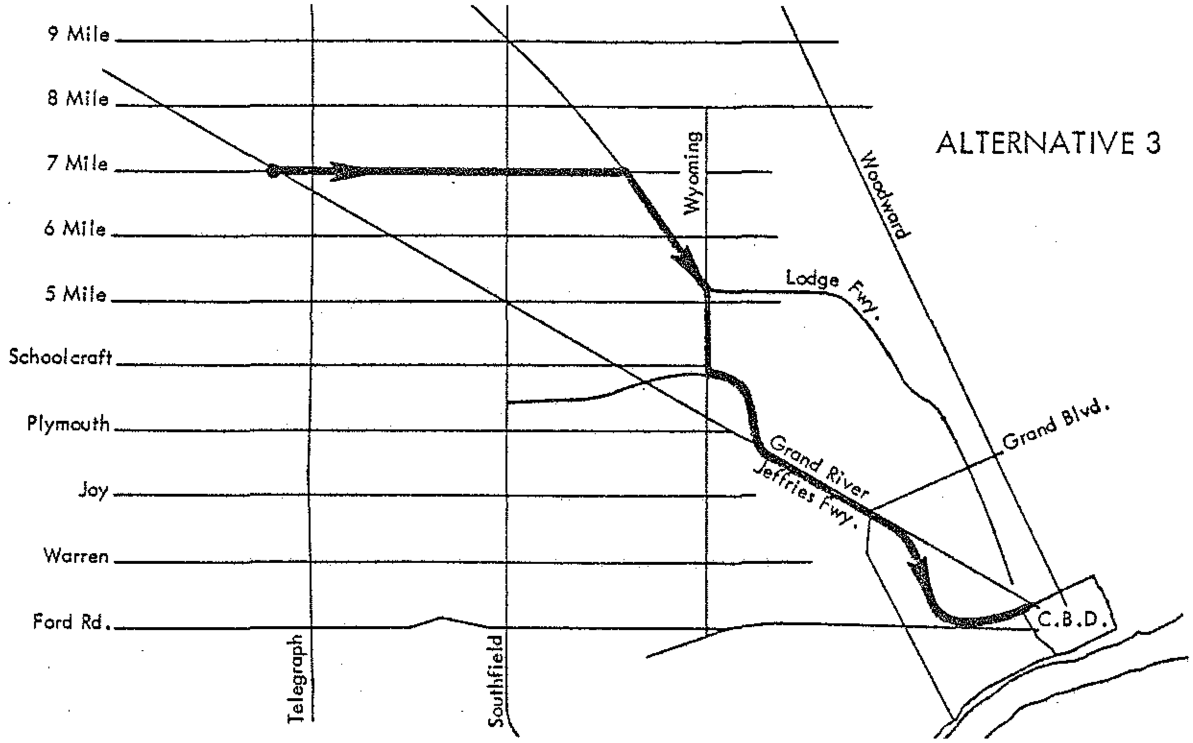

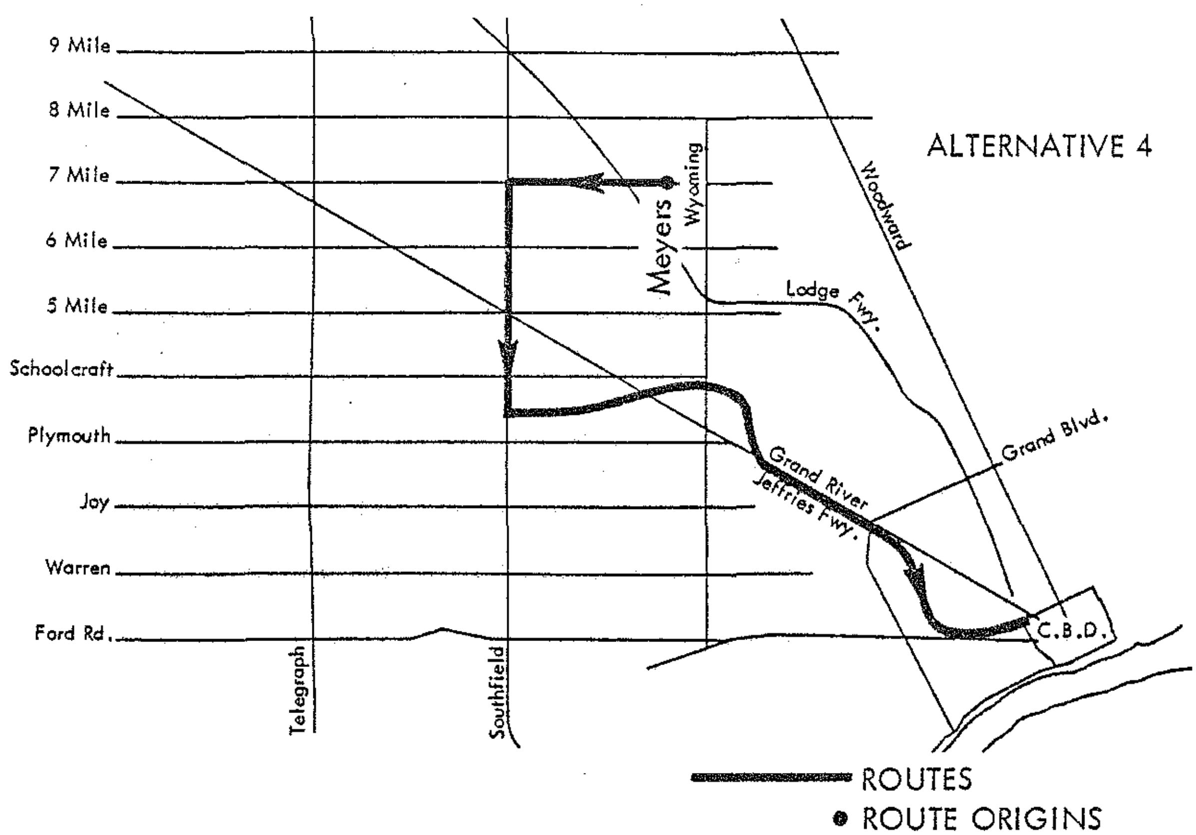

Figure 3-6 Sketch of Alternative BRT Routes on Seven Mile Road (Sheet 2 of 2)

The next step is to compare the travel times of the Imperial Express to the estimated travel time of each of the alternative BRT routes. The travel time to the CBD for each BRT alternative from major intersections along the collection route was calculated. The results are shown in Figure 3-7. Also shown in the graph are the travel times to the CBD via the Imperial Express, which serves as a benchmark for evaluating the BRT alternatives.

Given the graph shown in Figure 3-7, Table 3-4 summarizes the evaluation of the alternatives in coordination with the Southfield line haul.

Considering the alternatives, the following recommendations are made:

1. Originate BRT collection service at Seven Mile and Grand River, and proceed east along Seven Mile Road to enter the BRT line-haul at Seven Mile and Southfield.

2. Originate BRT collection service at Seven Mile and Southfield, and proceed east along Seven Mile to James Couzens, southeast on James Couzens to Wyoming, and south on Wyoming to the Jeffries.

3. Continue to serve the area between James Couzens and Meyers with the existing Hamilton Express.

To integrate the present Imperial Express into the recommended alternatives, it is suggested that the Imperial Express service be split into two parts corresponding to the first two recommendations. This new service will result in a time savings of 13 to 14 minutes for people along Seven Mile Road between Grand River and Southfield. For people living east of Southfield along the Imperial Express route, there will be about a one-minute travel time savings. Also, there should be better reliability of running time because the buses may operate on an exclusive lane on the Jeffries rather than free-flow on the Lodge.

From an operational point of view, there will be improved utilization of equipment because the travel time to the CBD will be less than that of the Imperial Express. Consequently, the buses will be able to make more trips during the peak period.

The disadvantage of Alternatives 1 and 2 is that people along the corridor see less frequent service. In general, average headways are increased by a factor of 2, from about 5 minutes to about 10 minutes in the peak hour and from about 8 minutes to about 20 minutes during the remainder of the peak period.

The decision to split the Imperial Express equally east and west of Southfield is based upon the fact that the demand is split about equally on either side of Southfield. A more refined estimate of how to split the present Imperial Express to integrate it into the BRT system requires that a route load profile of the Imperial Express be performed. However, the existence of BRT service on adjacent mile roads may alter the load profile on

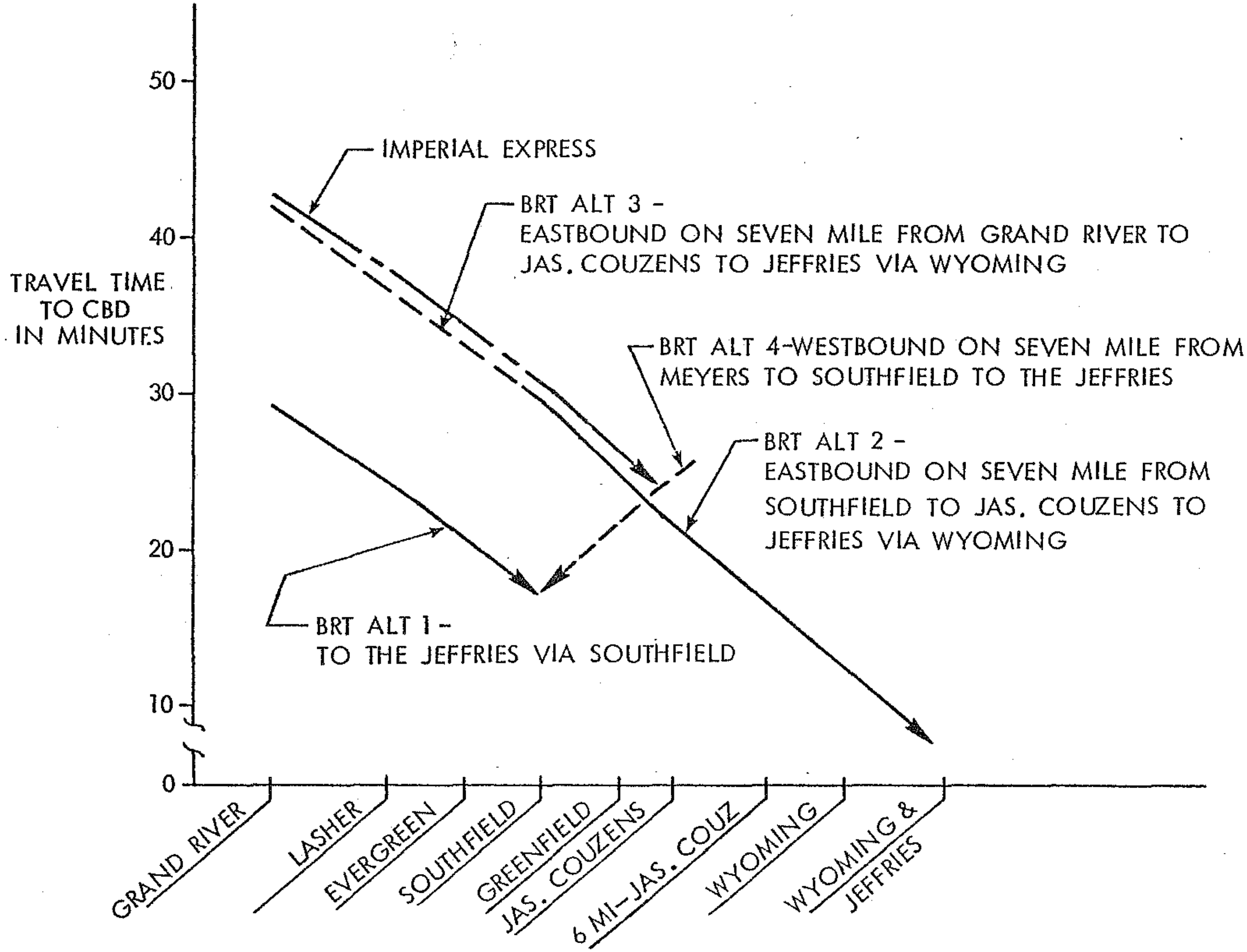

Figure 3-7 Travel Time Comparisons for Seven Mile Road to the CBD

Table 3-4 Summary of BRT Alternatives for Seven Mile Road

COLLECTION	LINE HAUL	TRAVEL TIME OF BRT ALTERNATIVE AS COMPARED TO IMPERIAL EXPRESS	COMMENTS
1. Eastbound from 7 Mile & Grand River* to Southfield via BRT Collection	Enter line haul at Southfield	Time savings of 13-14 min over Imperial Express	
2. Eastbound from 7 Mile & Southfield to Jas. Couzens & then SE on Jas. Couzens to Wyoming via BRT Collection	Enter Jeffries line haul at Wyoming	Travel time is about 1 min less than the travel time of the Imperial Express	Travel time reliability may be improved with exclusive lane
3. Eastbound from 7 Mile & Grand River to Jas. Couzens to Wyoming	Enter Jeffries line haul at Wyoming	Travel time about 1 min less than the travel time of Imperial Express	Travel time reliability may be improved with exclusive lane
4. Westbound from 7 Mile & Meyers** to Southfield via BRT Collection	Enter line haul at Southfield	For people east of Jas. Couzens, travel time is greater than Imperial Express. For those west of Greenfield, travel time is less than the Imperial Express	This alternative does not provide service to the Jas. Couzens service drive between 7 Mile & Wyoming
5. Westbound from 7 Mile & Meyers to Jas. Couzens via Hamilton Local	Transfer at Jas. Couzens to BRT Collection	Travel time is about the same for people who take the Hamilton Local to transfer to the Imperial Express	Area on 7 Mile between Jas. Couzens & Meyers is also served by Hamilton Express

* Grand River is the western boundary of the corridor at Seven Mile Road.

** Meyers is the eastern boundary of the corridor at Seven Mile Road these routes. Therefore, although the Seven Mile route is assumed to be split equally as recommended above for the purposes of BRT system design, it may be necessary to re-evaluate this decision after the BRT system has been deployed.

The third recommendation is to continue to serve the area between James Couzens and Meyers along Seven Mile Road with the present Hamilton Express. This decision was made for several reasons. First, the Hamilton Express offers fairly good service to the CBD. It takes only 30 minutes to get to the CBD from James Couzens and Seven Mile Road. Second, if the eastbound BRT collection went south on Meyers rather than James Couzens, the collection time would increase. Also, people along James Couzens who presently are served by the Imperial would no longer have express service available to them. If one tried to run two BRT collection routes, one down James Couzens and one down Meyers, the result would be fragmented bus service. Note that the people between Meyers and James Couzens could take a westbound Hamilton local to a BRT collection stop at James Couzens and Seven Mile Road. They presently can do this to meet the Imperial Express. This would result in a small time savings over the Hamilton Express, but may not be worth the transfer. One reason a person might do this is that the frequency of the service of the BRT collection in the peak hour will be greater than the 20-minute headway service of the Hamilton Express.

As indicated in Figure 3-5, one of the existing Imperial Express routes includes a link on Eight Mile Road between Inkster and Lahser. In order to conform to the guidelines established for service integration, a BRT collection route operating on Eight Mile Road is recommended. Two alternative BRT collection routes seem reasonable to serve Eight Mile Road. Both routes begin at the corridor boundary--Inkster Road--and proceed east on Eight Mile. The first alternative route uses the Southfield Freeway to access the Jeffries reserved lane. In the second alternative, buses continue on Eight Mile past Southfield to the Lodge Freeway, travel on the Lodge to Wyoming, and then access the Jeffries reserved lane from Wyoming.

The travel time of the existing Imperial Express from Eight Mile and Inkster to the CBD is 51 minutes. The estimated travel times for the two BRT alternative routes are 39 minutes for the first alternative which uses Southfield and 43 minutes for the second alternative which uses the Lodge and Wyoming. Both routes result in a time saving over the existing Imperial Express. Although the second alternative results in a slightly longer travel time than the first, it has the advantage of extending the service area of the Eight Mile route to the section between Southfield and Greenfield. Primarily for this reason, the second alternative, which routes Eight Mile Road collection buses down the Lodge Freeway to Wyoming and then on to the Wyoming Station, is recommended. Based on the estimated demand which is reported in Section 3.6, the average headway of BRT collection buses operating on Eight Mile Road is somewhat shorter than the headway of the existing Imperial Express. Ten BRT bus trips are proposed for the peak period while only six trips are currently provided.

3.3.1.2 McNichols Road

McNichols (Six Mile Road) is presently served by the Second Avenue Local and the Second Avenue Express. Figure 3-8 shows the route of each of the above lines. The Second Avenue Local originates at the following points along McNichols:

- Middlebelt Road
- Beech-Daly Road
- Rockdale (near Lahser)
- Southfield Road
- Schaefer Road

During the peak period the Second Avenue Local goes to the CBD via Second Avenue. During the mid-day, it terminates at McNichols and Woodward.

The Second Avenue Express originates at Rockdale, near Lahser. It goes east on McNichols to the Chrysler Freeway, I-75, south on the Chrysler to the East Jefferson exit, and follows East Jefferson to Woodward to Grand Circus Park. Table 3-5 shows the frequency of the Second Avenue Local and Express.

The BRT alternatives for McNichols are very similar to Seven Mile Road BRT alternatives. Schematic representations of the alternative routes are presented in Figure 3-9. The BRT alternatives for McNichols can be thought of in two sets. The first set, Alternatives 1 through 5, starts at Rockdale and goes east to Livernois, Wyoming, James Couzens, Schaefer, or Southfield. The second set, Alternatives 6 through 9, starts on Southfield and goes east to Livernois, Wyoming, James Couzens, or Schaefer. These alternatives would be used if buses originating at Rockdale were routed to the Jeffries via Southfield.

Table 3-6 summarizes the BRT alternatives for McNichols, and Figure 3-10 shows comparison of travel time between the Second Avenue Express and the various BRT alternatives. Figure 3-10 shows that the BRT alternative routes which enter the Jeffries at Livernois result in no time savings over the present Second Avenue Express. The routes which utilize Wyoming, James Couzens, and Schaefer each result in a time saving of about 6 to 8 minutes over existing express service. Finally, the route which enters the Jeffries at Southfield results in a substantial time saving of about 19 minutes over the existing Second Avenue Express.

It is recommended that the present Second Avenue Express ultimately be split into three routes. The first route would start at Rockdale and run to Southfield and then run south on Southfield to the Jeffries reserved lane. The second route would start at Southfield, proceed east on McNichols to Wyoming, and then south on Wyoming to the Jeffries. The third route would follow the existing Second Avenue Express route, but it would start at Wyoming. It is necessary to retain this modified Second Avenue Express route, which is not a part of the BRT system, to preserve service to those people who live east of Wyoming and presently are served by the Second Avenue Express.

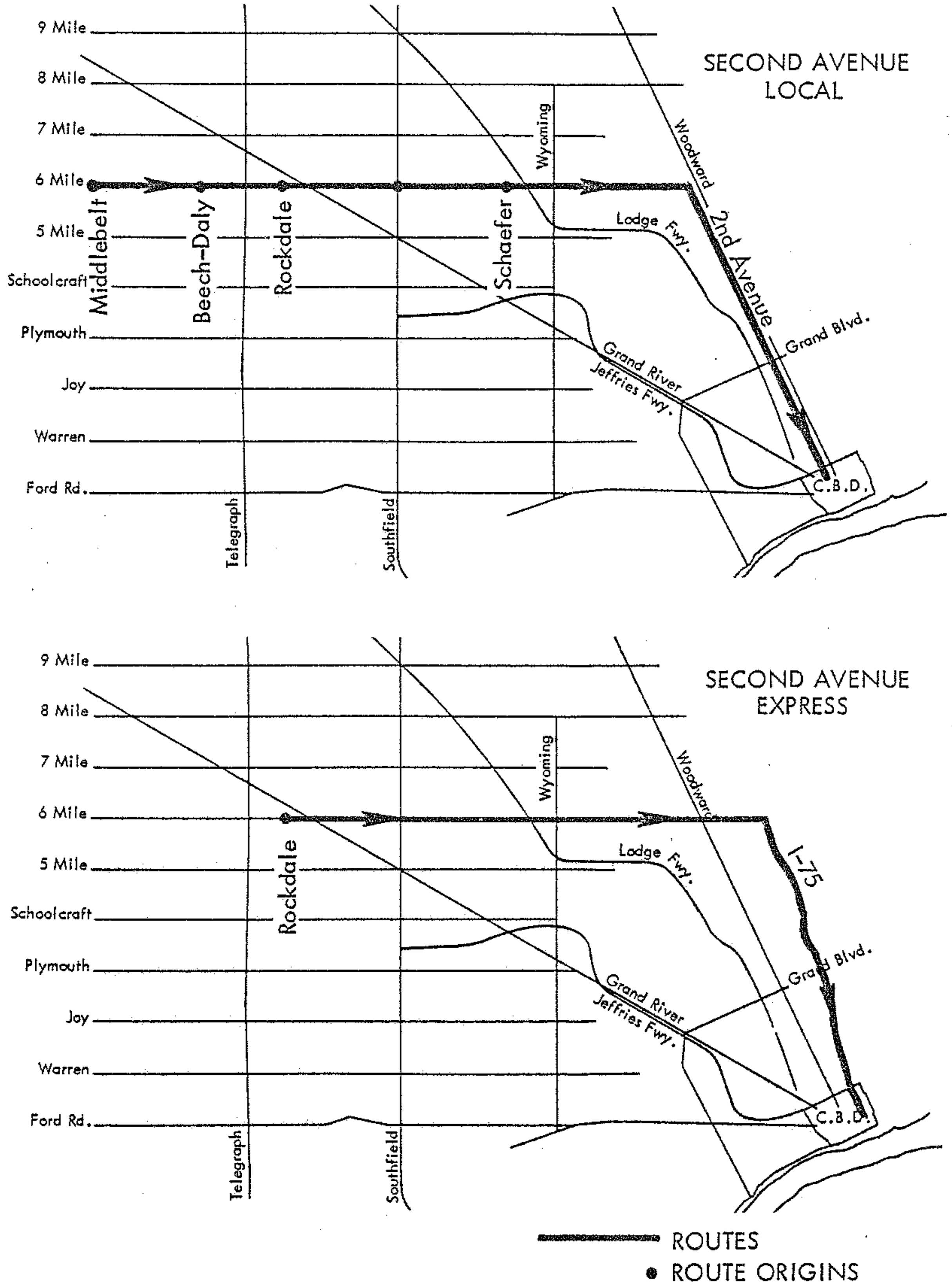

Figure 3-8 Sketch of Existing Express Routes on Six Mile

Table 3-5 Frequency of Existing Service on Six Mile Road

ROUTE NAME	TYPE OF SERVICE	ROUTE NO.	POINT OF ORIGIN	POINT OF TERMINATION	NUMBER OF BUSES ARRIVING IN THE CBD IN THE A.M.						
					7:00-7:29	7:30-7:59	8:00-8:29	8:30-8:59	9:00-9:29	9:30-10:00	TOTAL
Second	Local	44	McNichols & Middlebelt	Jefferson & Randolph		2		1	1	1	5
			McNichols & Beech-Daly	Jefferson & Randolph		1	2	1			4
			McNichols & Rockdale	Jefferson & Randolph	2						2
			McNichols & Southfield	Jefferson & Randolph		1					1
			McNichols & Schaefer	Jefferson & Randolph	2						2
			TOTAL		4	4	2	2	1	1	14
Second	Express	85	Rockdale	Grand Circus Park		1	1	1	1		4

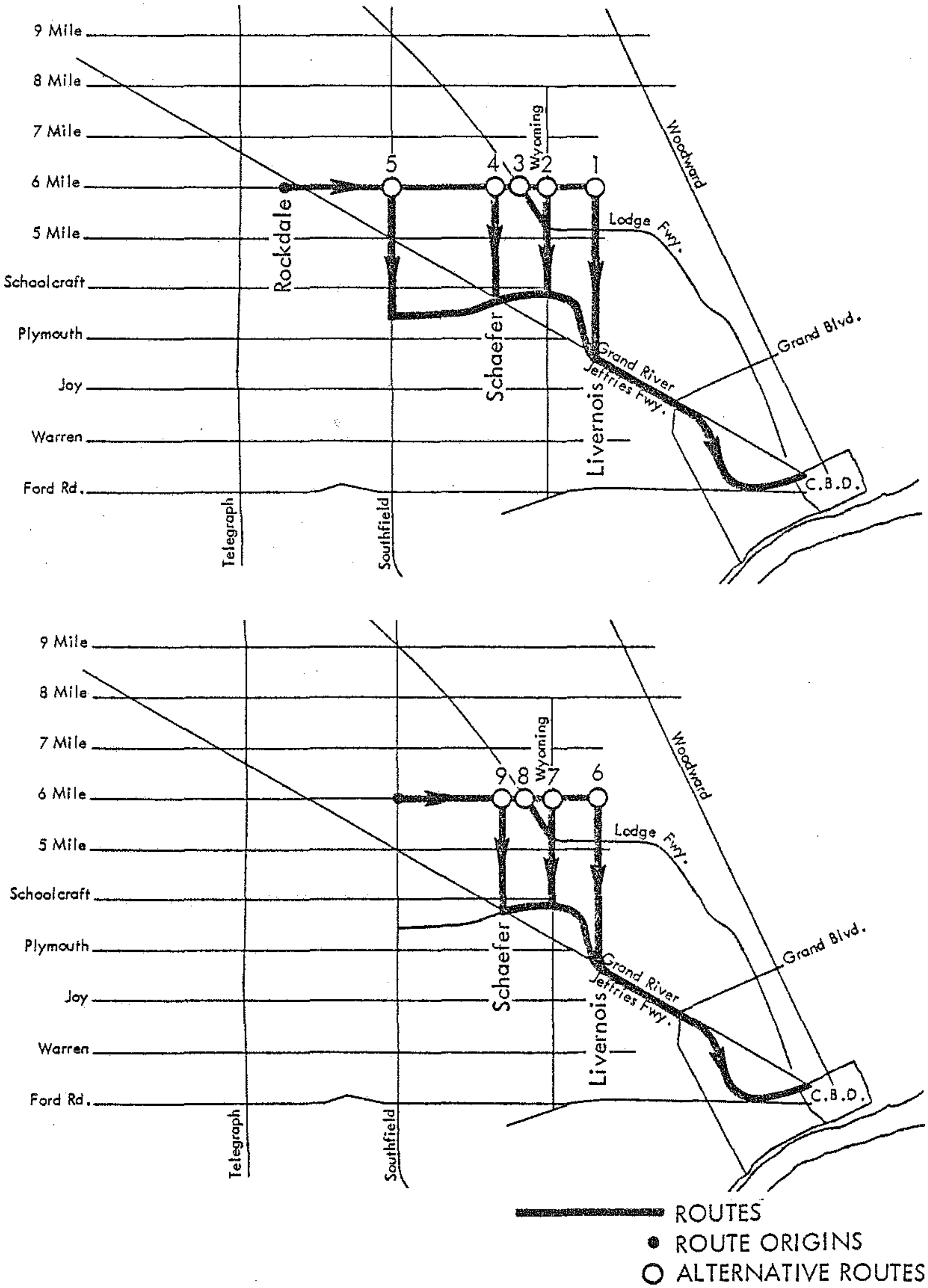

Figure 3-9 Sketch of Alternative BRT Routes on Six Mile Road

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Table 3-6 Summary of BRT Alternatives for Six Mile Road

Collection	Line Haul	Travel Time of BRT Alternative as Compared to Second Avenue Express
BRT Alt 1 - E on McNichols from Rockdale to Livernois	Enter Jeffries at Livernois	Same Travel Time
BRT Alt 2 - E on McNichols from Rockdale to Wyoming	Enter Jeffries at Wyoming	6-7 minutes less travel time
BRT Alt 3 - E on McNichols from Rockdale to James Couzens	Enter Jeffries at Wyoming	7-8 minutes less travel time
BRT Alt 4 - E on McNichols from Rockdale to Schaefer	Enter Jeffries at Schaefer	8 minutes less travel time
BRT Alt 5 - E on McNichols from Rockdale to Southfield	Enter Jeffries via Southfield	19 minutes less travel time
BRT Alt 6 - E on McNichols from Southfield to Livernois	Enter Jeffries at Livernois	Same Travel Time
BRT Alt 7 - E on McNichols from Southfield to Wyoming	Enter Jeffries at Wyoming	6-7 minutes less travel time
BRT Alt 8 - E on McNichols from Southfield to Jas Couzens	Enter Jeffries at Wyoming	7-8 minutes less travel time
BRT Alt 9 - E on McNichols from Southfield to Schaefer	Enter Jeffries at Schaefer	8 minutes less travel time

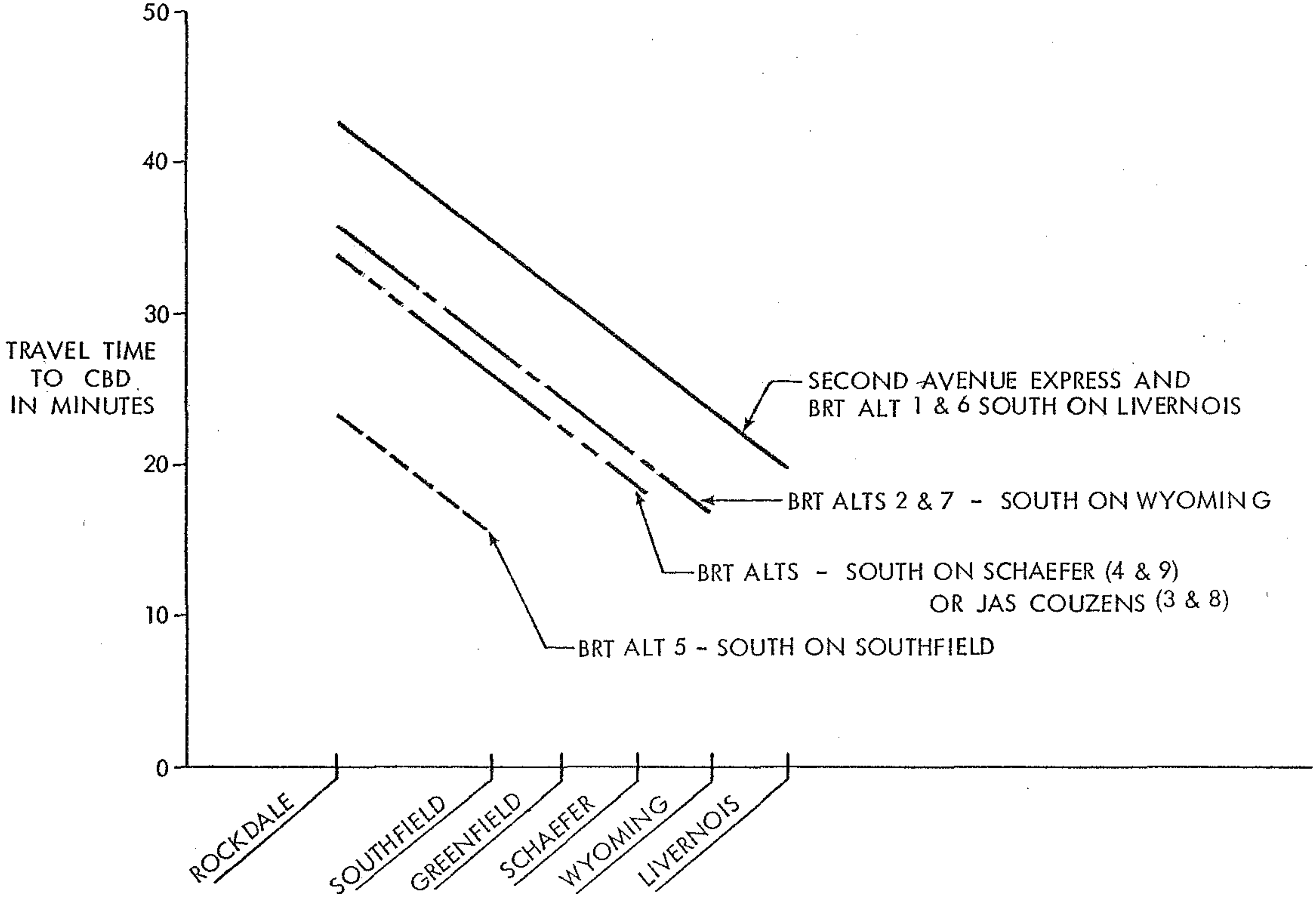

Figure 3-10 Travel Time Comparisons for Six Mile Road Alternatives

The first route, which uses Southfield to access the Jeffries, is recommended on the basis of the estimated BRT demand reported in Section 3.6. Based on that data, three bus trips will be scheduled on the route in the peak hour, and a total of seven trips will be scheduled during the three-hour peak period. Since there are presently only four Second Avenue Express buses in the peak period, the recommendation implies a substantial increase in the existing demand as a result of the improved service. If the demand does not materialize as expected after the BRT system has been implemented, this route can be combined with the other BRT collection route operating on McNichols.

As indicated above, the second part of the McNichols collection route begins at Southfield and uses Wyoming as the north-south route between McNichols and the Jeffries. This route was selected over the shorter James Couzens and Schaefer alternatives so that BRT service could be provided to Mary Grove College and to Wyoming between McNichols and Fenkell. The James Couzens route would duplicate service provided by the Seven Mile collection route.

3.3.1.3 Fenkell Road

Fenkell (Five Mile Road) is presently served by the Fenkell Local and Express. Figure 3-11 shows the route of each of the above lines. The Fenkell Local starts at:

- Farmington Road
- Middlebelt Road
- Dale (Detroit City Limits)
- Southfield
- Schaefer

The buses go east on Fenkell to 14th, south on 14th to I-75 Service Drive, east on the I-75 Service Drive to Woodward, and south on Woodward for CBD distribution. The Fenkell Express originates at either Dale or Southfield, goes east on Fenkell to the Lodge Freeway, and enters the Lodge at Davison. It exits the Lodge at Bagley and goes to Grand River, to Capitol Park, to Griswold, to East Jefferson for its CBD distribution. Table 3-7 summarizes the frequency of service of the existing Fenkell Local and Express.

The BRT alternatives for Fenkell are a little different from the McNichols and Seven Mile Road treatments. The alternatives are illustrated in Figure 3-12. Basically, the Fenkell BRT alternatives can be thought of in two sets. The first set of routes, Alternatives 1 through 4, starts at Dale, the Detroit City limits, and runs to either Livernois, Wyoming, Schaefer, or Southfield to access the Jeffries Freeway. The second set, Alternatives 5 and 6, starts at Southfield and runs to either Livernois or Wyoming to access the Jeffries. Figure 3-13 shows a comparison of travel times between the Fenkell Express and the BRT alternatives, and Table 3-8 summarizes the BRT alternatives.

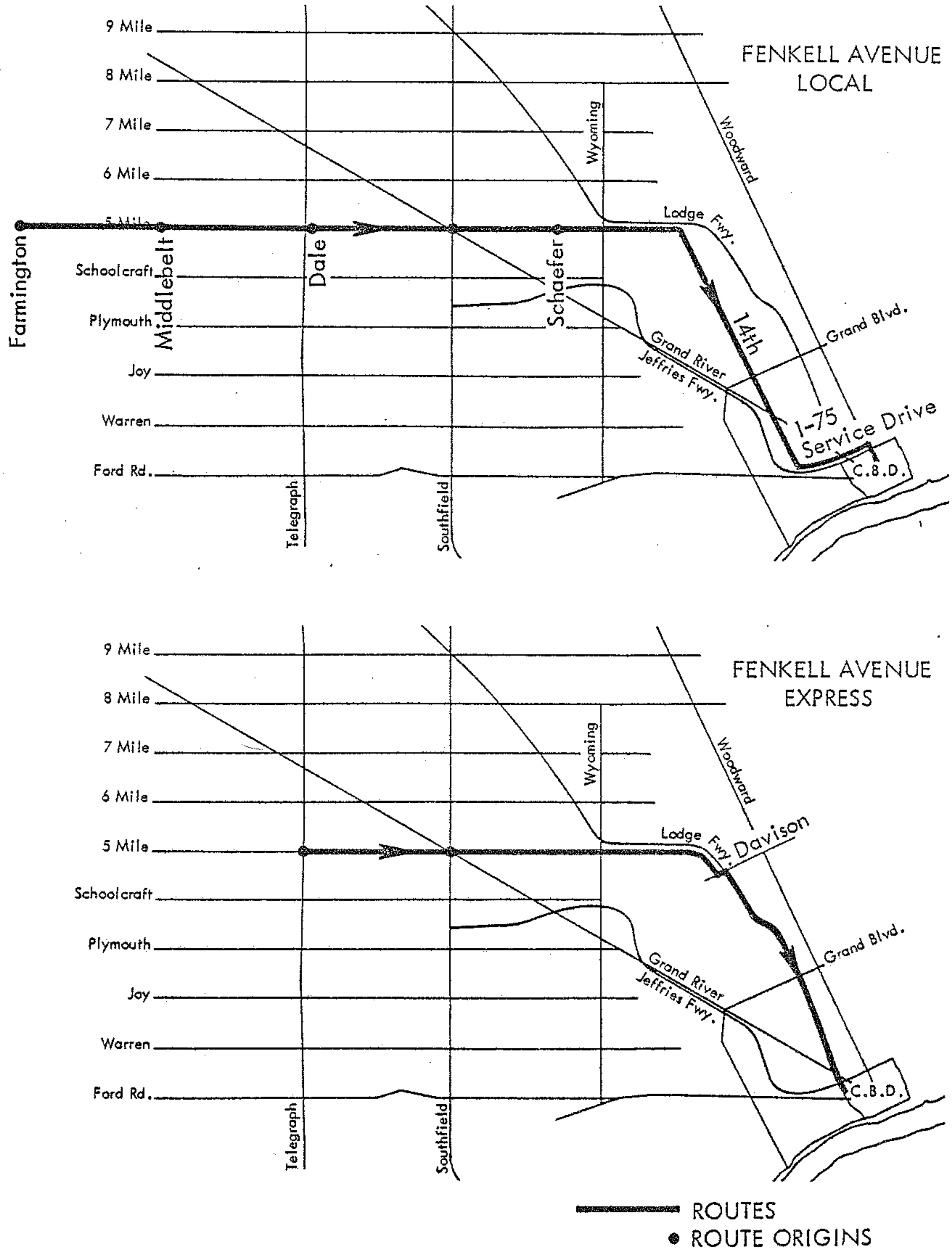

Figure 3-11 Sketch of Existing Express Routes on Fenkell

Table 3-7 Frequency of Existing Service on Fenkell

ROUTE NAME	TYPE OF SERVICE	ROUTE NO.	POINT OF ORIGIN	POINT OF TERMINATION	NUMBER OF BUSES ARRIVING IN THE CBD IN THE A.M.						
					7:00-7:29	7:30-7:59	8:00-8:29	8:30-8:59	9:00-9:29	9:30-10:00	TOTAL
Fenkell	Local	18	Farmington	Griswold & Jefferson	-	-	-	-	1	-	1
			Middlebelt	"	1	1	1	2	-	1	6
			Dale (near Telegraph)	"	3	3	3	3	1	2	15
			Southfield	"	1	-	-	-	-	-	1
			Schaefer	"	1	-	-	-	-	-	1
			TOTAL		6	4	4	5	2	3	24
Fenkell	Express	73	Dale	Griswold & Jefferson	-	3	2	2	1	-	8
			Southfield	"		1	1	1			3
			TOTAL			4	3	3	1		11

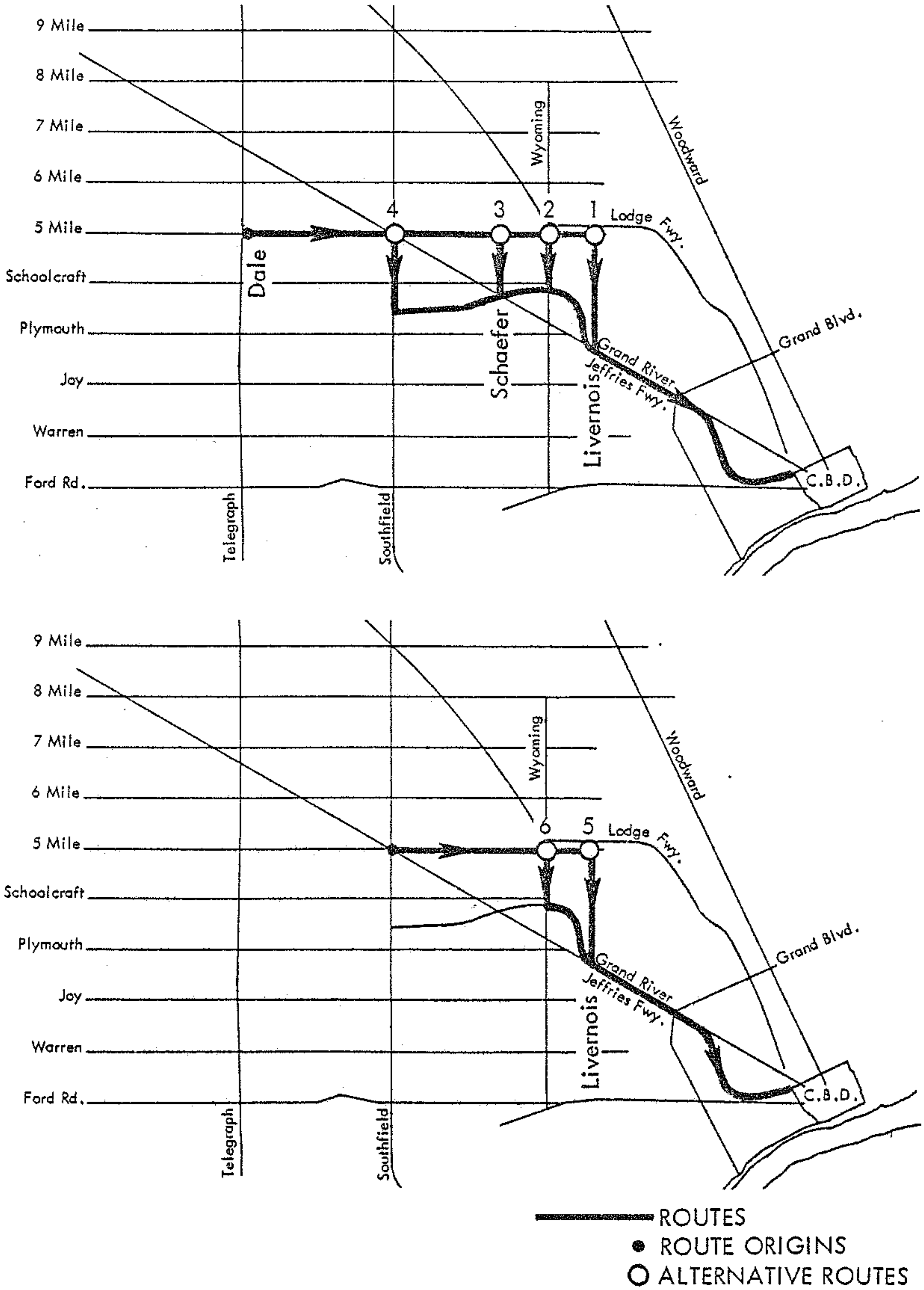

Figure 3-12 Sketch of Alternative BRT Routes on Five Mile Road

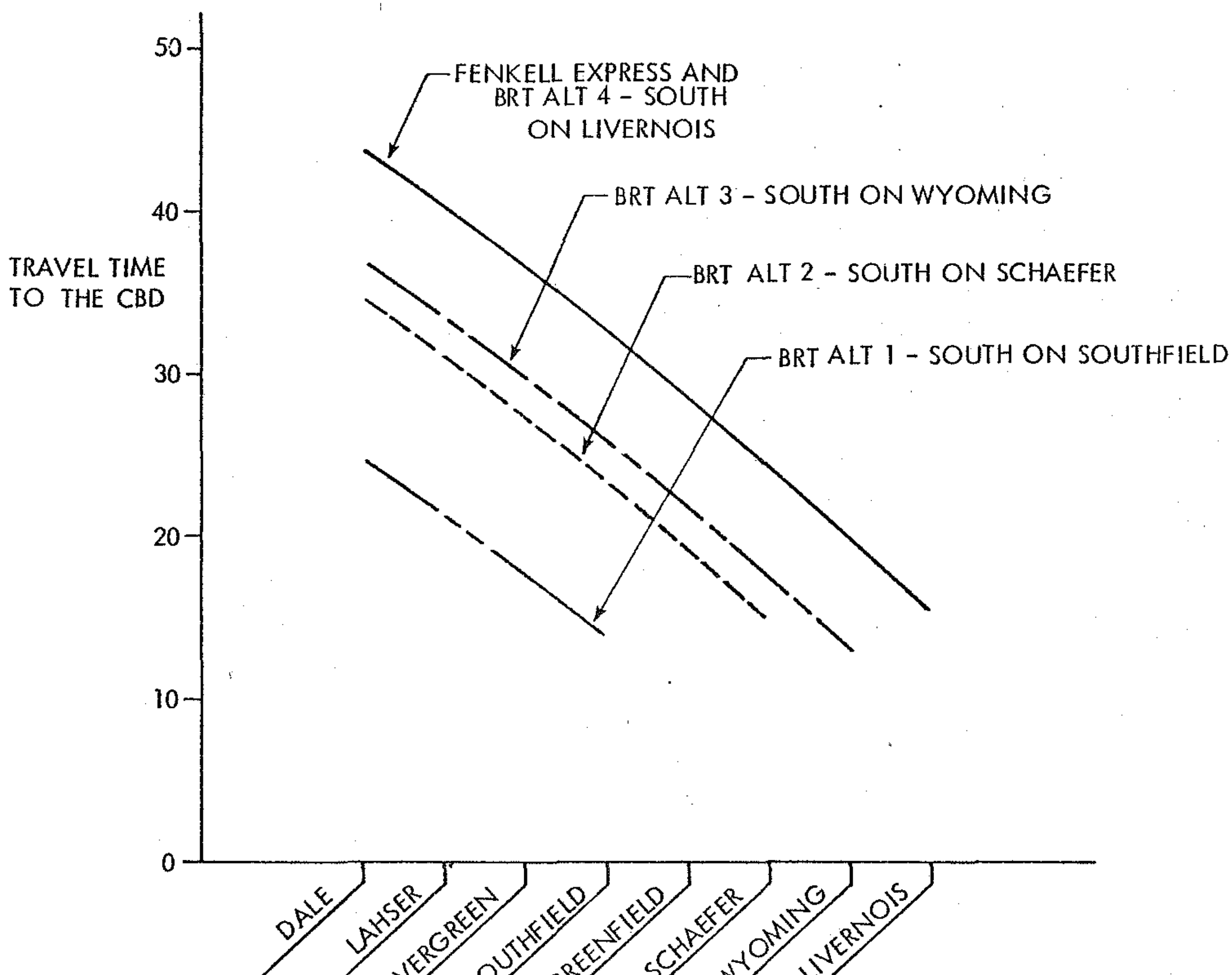

Figure 3-13 Travel Time Comparison for Fenkell Alternatives

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Table 3-8 Summary of BRT Alternatives for Fenkell

BRT COLLECTION	LINE HAUL	TIME SAVINGS AS COMPARED TO FENKELL EXPRESS
BRT Alt 1 - E on Fenkell from Dale to Livernois	Enter Jeffries at Livernois	Same travel time
BRT Alt 2 - E on Fenkell from Dale to Wyoming	Enter Jeffries at Wyoming	7-8 min less travel time
BRT Alt 3 - E on Fenkell from Dale to Schaefer	Enter Jeffries at Schaefer	9-10 min less travel time
BRT Alt 4 - E on Fenkell from Dale to Southfield	Enter Jeffries at Southfield	19 min less travel time
BRT Alt 5 - E on Fenkell from Southfield to Livernois	Enter Jeffries at Livernois	Same travel time
BRT Alt 6 - E on Fenkell from Southfield to Wyoming	Enter Jeffires at Wyoming	7-8 min less travel time

It is recommended that the Fenkell BRT collection be split into two routes. The first route begins at Dale, proceeds east on Fenkell to Southfield, and then accesses the Jeffries reserved lane from Southfield. As indicated in Table 3-8, this route--Alternative 4--results in a time saving of 19 minutes over the existing Fenkell Express. As in the case of McNichols, this recommendation is based on the estimated BRT demand presented in Section 3.6 which implies an increase in existing demand as a result of the improved service. After the BRT system has been implemented, if the demand on Fenkell west of Southfield does not develop sufficiently to fill the buses, then this route can be extended east of Southfield and combined with the other Fenkell route.

The other half of the BRT collection route on Fenkell begins at Southfield and ultimately uses Wyoming to access the Jeffries Freeway. This route is listed as Alternative 6 in Table 3-8, and, as indicated in the table, it saves 7 to 8 minutes over the existing Fenkell Express as well as over Alternative 5 which uses Livernois to access the Jeffries.

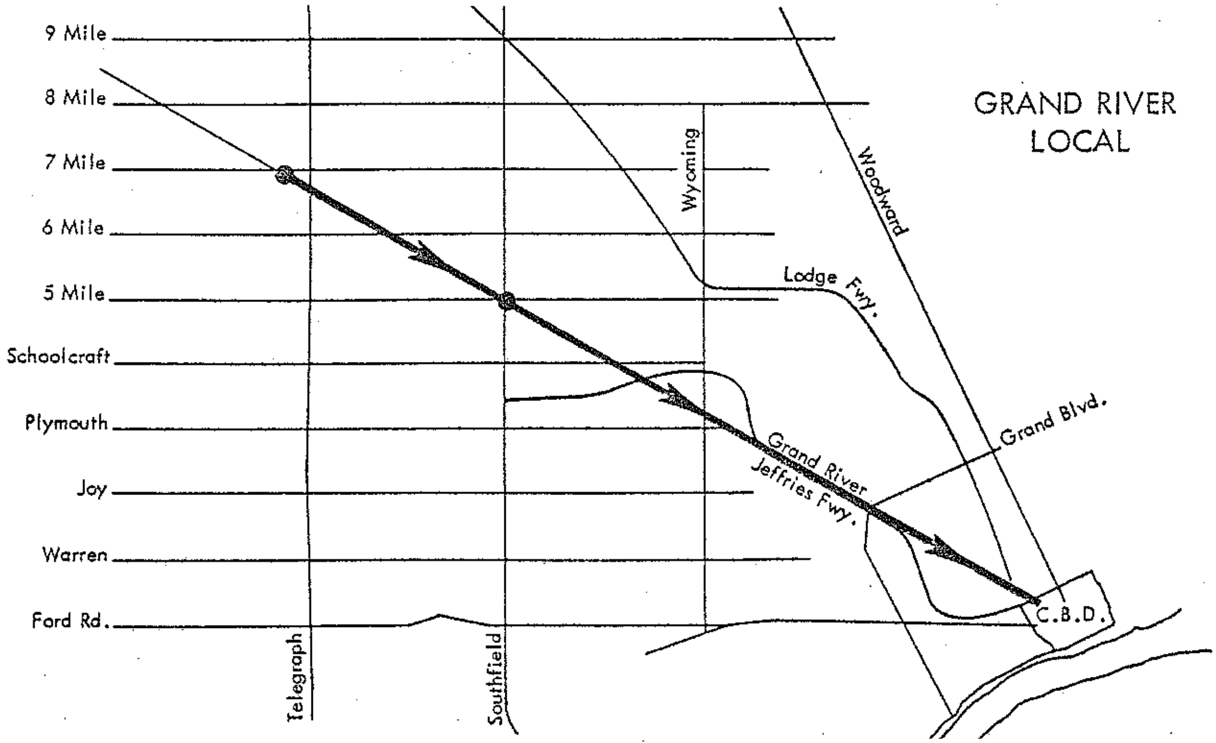
Splitting the Fenkell route into two parts to take advantage of the reduced travel time of the Fenkell-Southfield-Jeffries route has the effect of increasing the average headway on each route compared to the headway provided by the existing Fenkell Express. The peak hour headways increase from 8.5 minutes for the existing service to 20 minutes for the Fenkell-Southfield-Jeffries route and 15 minutes for the Fenkell-Wyoming-Jeffries route. During the remainder of the peak period, the number of bus trips on each of the two BRT collection routes is the same as the number scheduled for the existing service--4.

The disadvantage of these recommended BRT collection routes is that express bus service to the CBD is eliminated from Fenkell between Wyoming and the Lodge Freeway. However, frequent local service to the CBD is still to be provided. According to the schedule, the travel time of the local service from Wyoming and Fenkell to the CBD is approximately 50 percent longer than the travel time of the existing express service--45 minutes for the local versus 30 minutes for the express. The local service can also be used to access the BRT collection route at Wyoming. If it is determined that the local service does not represent an adequate alternative to direct express service to the CBD, then either the BRT collection route which originates at Southfield can be extended to the Lodge then routed back to the Jeffries at Wyoming, or a new express service which uses the Lodge can be initiated at Wyoming.

3.3.1.4 Grand River and Schoolcraft

Grand River is presently served by the Grand River Local, Grand River Red Express, and Grand River Blue Express. Schoolcraft is served by the Grand River Blue Express. Figure 3-14 shows the route of each of the above lines. The Grand River Local has two points of origin, Seven Mile Road and Southfield Freeway. It terminates at Capitol Park. The Grand River Red Express originates at three points, Farmington, Inkster, and Seven Mile Road. The buses that start at Farmington Road operate as a local between Farmington and Seven Mile Road. Between Seven Mile Road and Schaefer, they stop at the major cross streets only. At Schaefer, the buses enter the Jeffries Freeway. The Red Expresses that originate at Inkster Road and Seven Mile Road operate from their respective origins, local to Schaefer, where they enter the Jeffries Freeway. The Red Expresses exit the Jeffries at Scotten, have an intermediate stop at West Grand Boulevard and proceed to the CBD via Grand River. The downtown distribution route is Grand River to State, to Griswold, to Larned, to the terminal point at Beaubien and Larned. The evening Red Expresses originate at St. Antoine and East Jefferson and terminate at Seven Mile, Inkster, and Farmington Road. However, the evening Red Express does not utilize the Jeffries Freeway for part of its line-haul portion.

The Grand River Blue Express begins service on Grand River and Schaefer. This is the point where the Red Express begins non-stop service. The Blue Express operates local between Schaefer and West Grand Boulevard and begins the express portion of the route at Grand Boulevard. It follows Grand River to the CBD. The Blue Express has the same CBD distribution as the Red Express. The Schoolcraft Express is integrated into the Blue Express route. The Schoolcraft Express buses start at Schoolcraft and Dale (Detroit City limits near Telegraph), and follow Schoolcraft to Grand River, operating in a local collection manner. The buses then turn right onto Grand River, continue local collection to West Grand Boulevard, and follow the Blue Express route to the CBD to Beaubian and Larned.



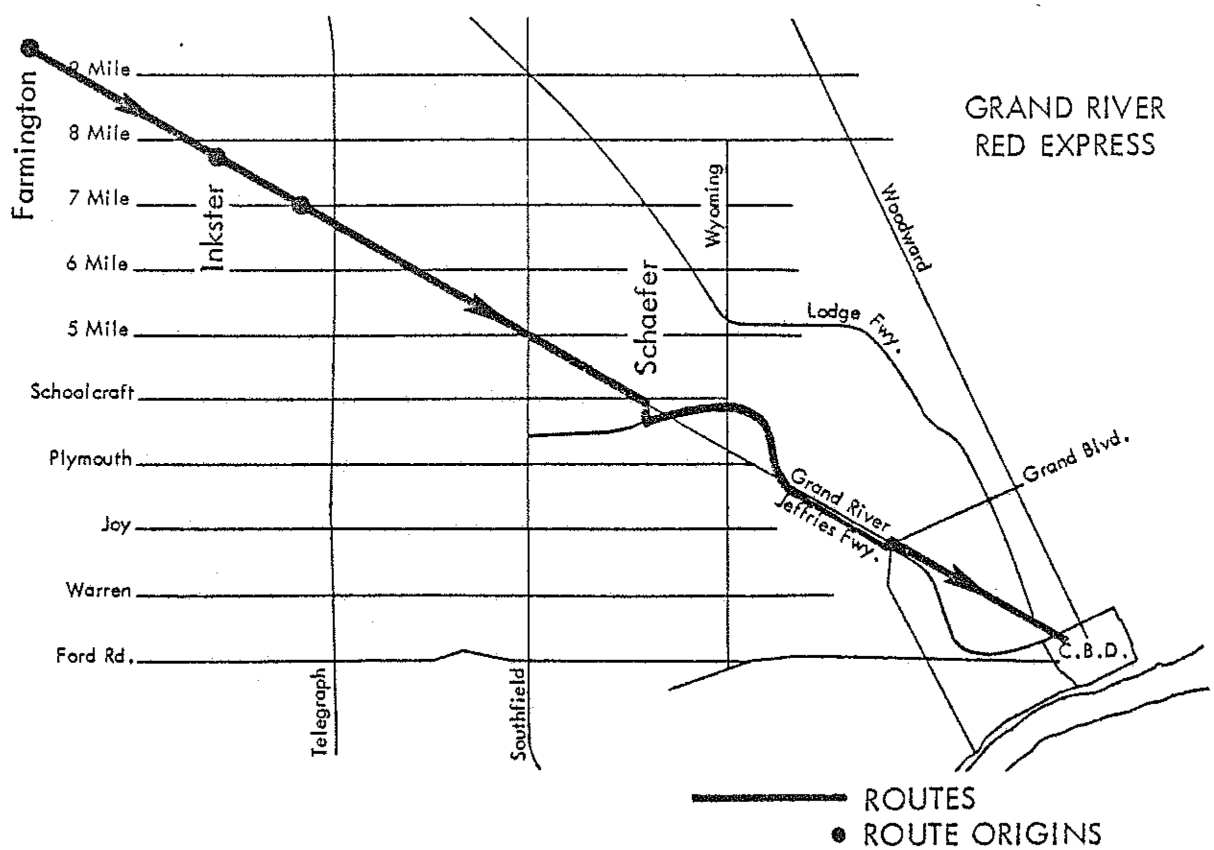


Figure 3-14 Sketch of Existing Express Routes on Grand River (Sheet 1 of 2)

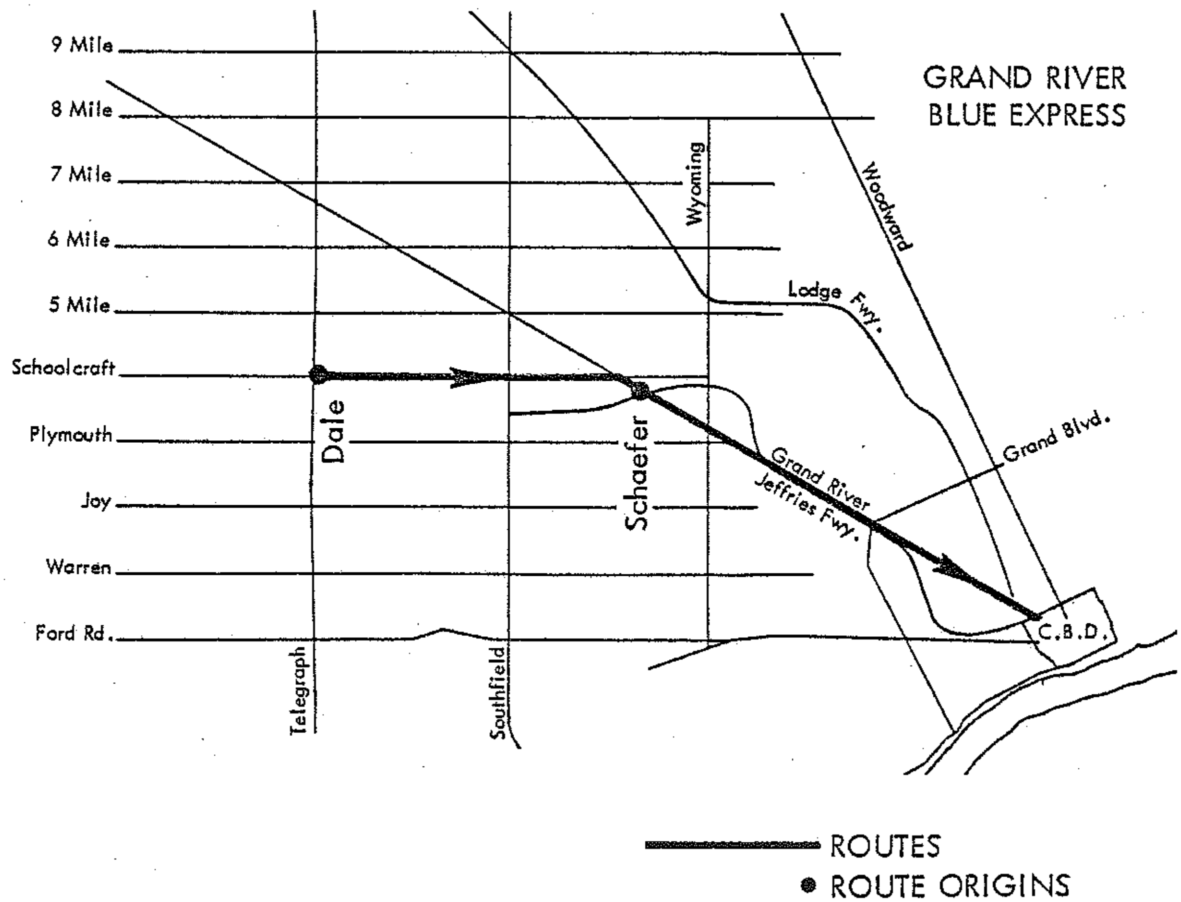


Figure 3-14 Sketch of Existing Express Routes on Grand River
(Sheet 2 of 2)

Table 3-9 shows the frequency of service along Grand River. The number of buses arriving in the CBD in each half-hour of the peak period is tabulated. The Grand River Local between Seven Mile and Southfield has about 15-minute headways, and between Southfield and the CBD it has 7- to 8-minute headways. The Red Express service is concentrated for the most part into the period between 7:30 and 9:00 a.m. Buses arrive in the CBD with 4- to 6-minute headways during that time. Note from Farmington Road there are only three buses with one-half hour headways. The Grand River Blue Express has 8- to 14-minute headways during the peak period.

Five alternative treatments have been developed for integrating the express bus service on Grand River into the BRT system. These five alternatives plus one alternative for integrating the Schoolcraft Express are illustrated in Figure 3-15. The first BRT alternative is similar to the present Red Express service. Buses originate at either Farmington, Inkster, or Seven Mile Road and enter the Jeffries reserved bus lane at Wyoming. Note the present Red Express enters the Jeffries Freeway at Schaefer. When all of the BRT collection routes are considered, the Grand River and Schoolcraft routes are the only ones for which entry to the Jeffries at Schaefer might be desirable. Since a special bus-only ramp would be required to provide access to the reserved lane on the inner roadway, and since the need for such a ramp at Wyoming has already been established, alternative routes involving access to the Jeffries at Schaefer were not considered for Grand River and Schoolcraft. It is important to note that presently the p.m. Red Express does not use the Jeffries, and, consequently, the travel time of the p.m. Red Express is 11 minutes greater than the a.m. Red Express. In the BRT alternatives, the Jeffries reserved lane is utilized both in the a.m. and p.m. periods, and, as a result, the evening trip will be significantly shorter than the present Red Express.

BRT Alternative 2 could be termed the Modified Red Express-Southfield. The Modified Red Express-Southfield starts service at the same points as the Red Express but enters the BRT line-haul at Grand River and Southfield rather than at Wyoming.

In coordination with Alternative 2, there is the BRT Alternative 3 which is termed the Green Express. The Green Express will start at Southfield and Grand River and enter the Jeffries Freeway at Wyoming. If it is determined that more frequent service needs to be offered to areas west of Southfield, the Green Express could start at Evergreen.

BRT Alternative 4 is identical to the present Blue Express. It operates local from Schaefer to West Grand Boulevard and then goes express to the CBD via Grand River.

BRT Alternative 5 could be termed the Modified Blue Express. Rather than beginning its trips at Schaefer, it would start at Southfield. The buses would go local from Southfield to West Grand Boulevard and then go express to the CBD.

BRT Alternative 6, which is illustrated in Figure 3-15, applies to the Schoolcraft Express. It is recommended that the Schoolcraft Express be divided into two parts. The first part starts at Dale, proceeds east on Schoolcraft to Southfield, then takes the Southfield Freeway to the Jeffries. The second part of the route begins at Southfield, proceeds east on Schoolcraft to Wyoming, then enters the Jeffries reserved lane at

Table 3-9 Frequency of Existing Service on Grand River

ROUTE NAME	TYPE OF SERVICE	ROUTE NO.	POINT OF ORIGIN	POINT OF TERMINATION	NUMBER OF BUSES ARRIVING IN THE CBD IN THE A.M.						
					7:00-7:29	7:30-7:59	8:00-8:29	8:30-8:59	9:00-9:29	9:30-10:00	TOTAL
Grand River	Local	21	7 Mile	Capitol Park	2	2	2	2	2	2	12
			Southfield	Capital Park	2	2	2	2	2	2	12
			TOTAL		4	4	4	4	4	4	24
Grand River	Red Express	74	Farmington	Beaubian & Larned		1	1	1			3
			Inkster			1	1	1	1	1	5
			7 Mile		3	6	3	2			14
			TOTAL		3	8	5	4	1	1	22
Grand River	Blue Express	74	Schoolcraft & Dale	Beaubian & Larned		1	1	1			3
			Schaefer & Grand River		1	1	1	2	1	1	7
			TOTAL		1	2	2	3	1	1	10

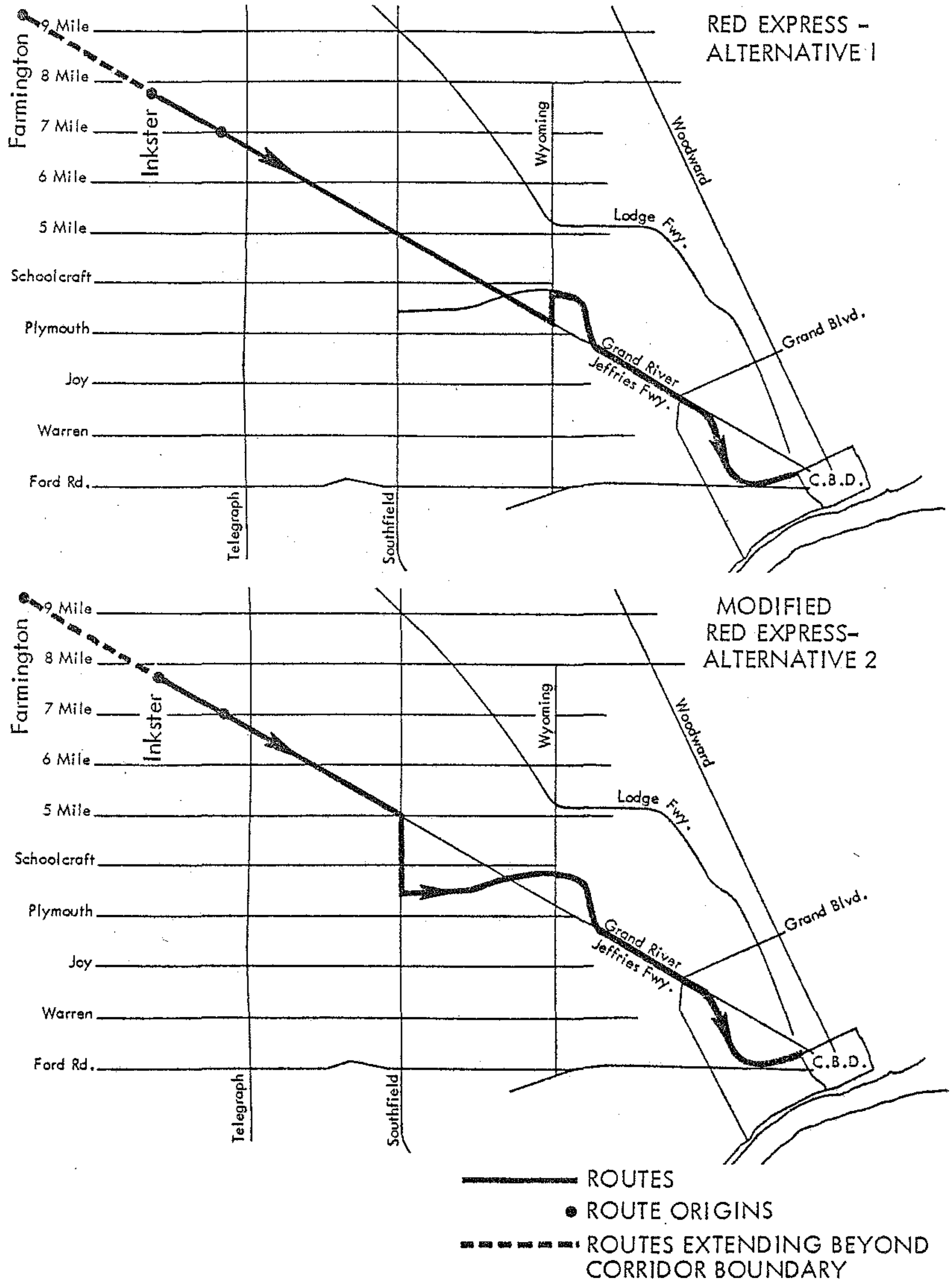


Figure 3-15 Sketch of Alternative BRT Routes on Grand River and Schoolcraft (Sheet 1 of 3)

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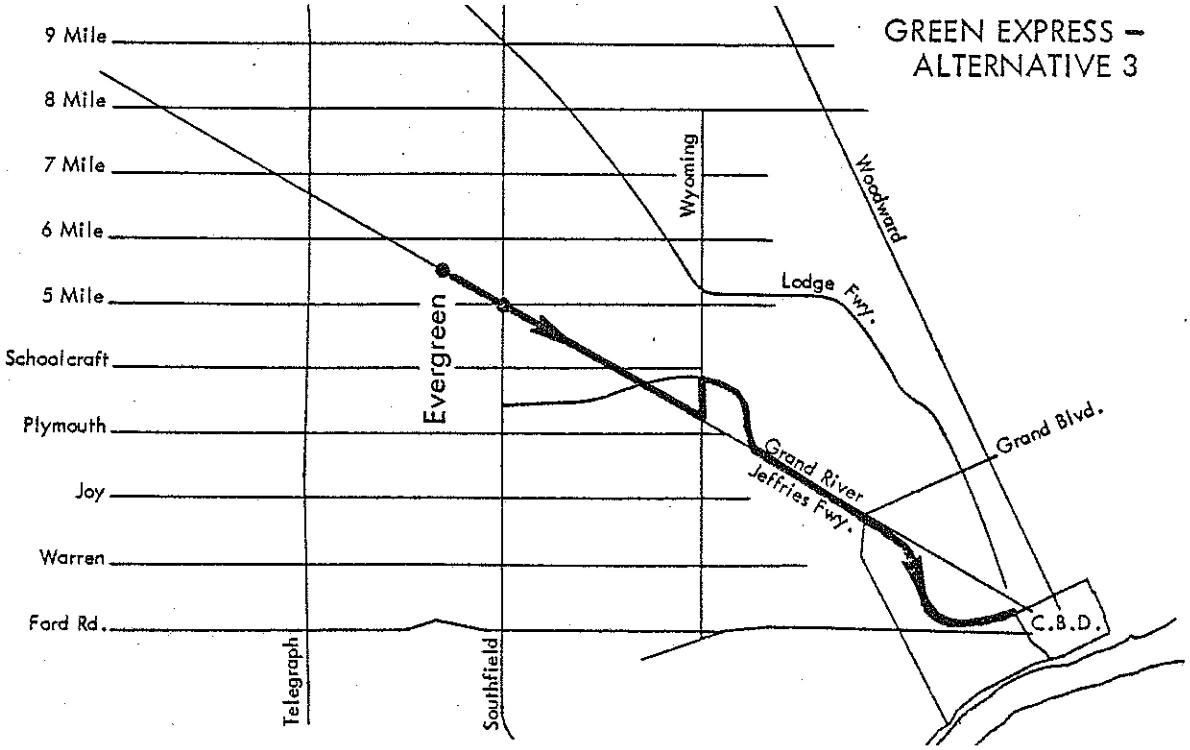


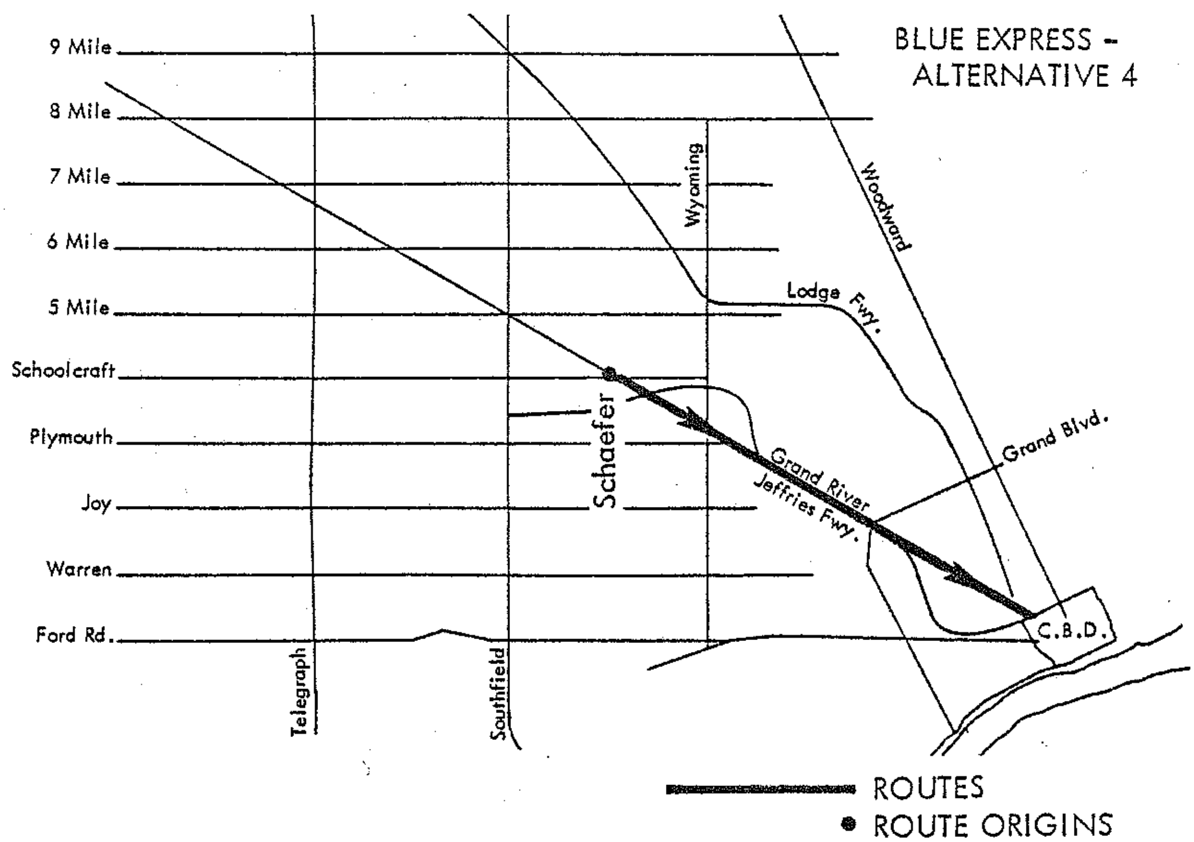


Figure 3-15 Sketch of Alternative BRT Routes on Grand River and Schoolcraft (Sheet 2 of 3)

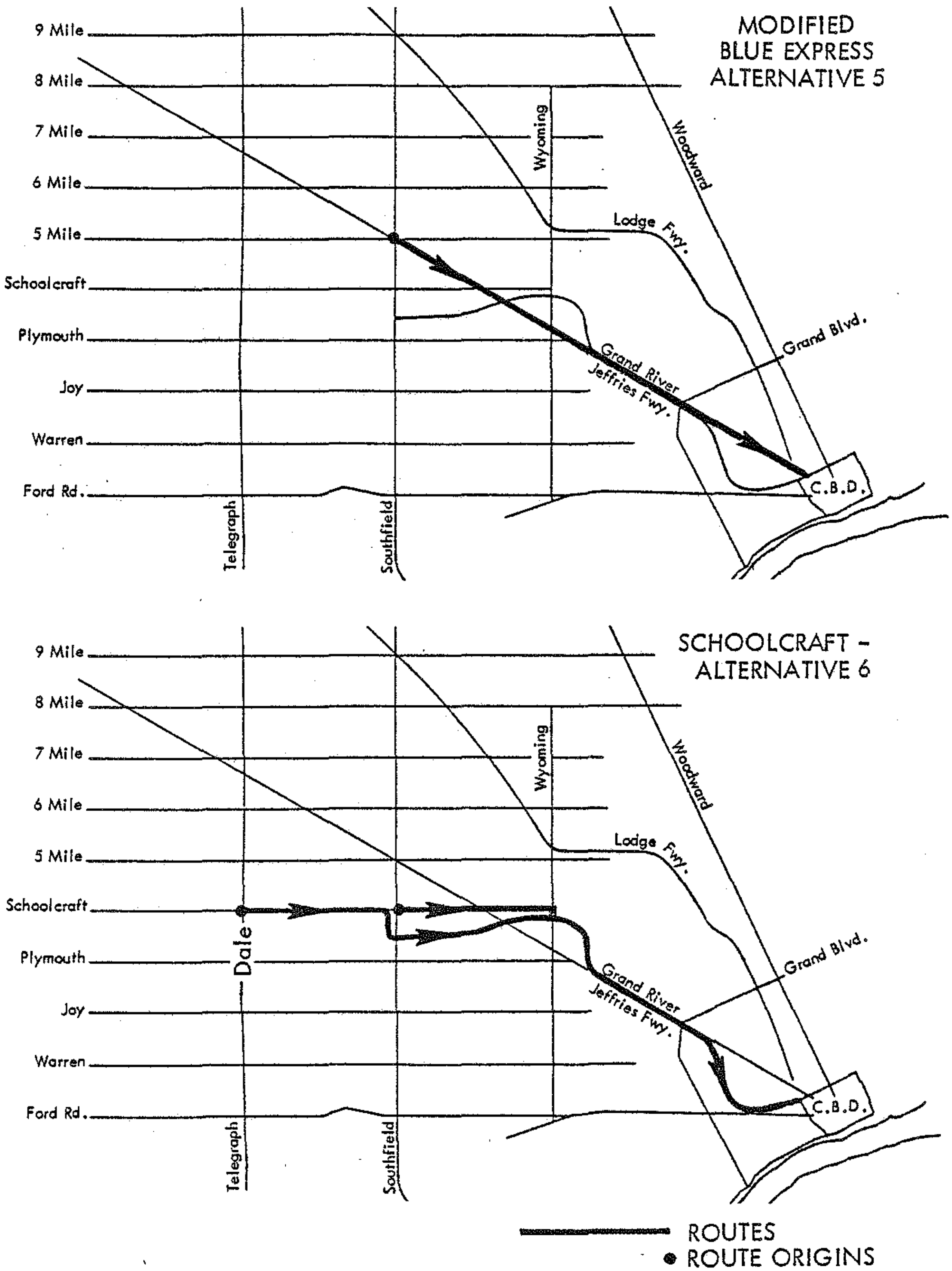


Figure 3-15 Sketch of Alternative BRT Routes on Grand River and Schoolcraft (Sheet 3 of 3)

Wyoming. The estimated demand for these collection routes, as presented in Section 3.6, is sufficient to support peak-hour headways of about 20 minutes for the Schoolcraft-Southfield-Jeffries route and about 30 minutes for the route which begins at Southfield. If this level of demand does not materialize, or if it is determined that headways should be reduced at the expense of trip time, then the two Schoolcraft routes can be combined.

The travel time to the CBD for each of the BRT alternatives is shown in Figure 3-16. Table 3-10 presents a summary of the BRT alternatives for Grand River. These alternatives must be combined to provide continuous BRT service along Grand River from Farmington to Oakman. Case I as shown in Table 3-11 is similar to the service presently being offered to people in Detroit. The Red Express provides express bus collection between Farmington and Wyoming and the Blue Express provides express bus collection between Schaefer and West Grand Boulevard.

Case II combines the Modified Red Express-Southfield, the Green Express, and Blue Express into a system. The Modified Red Express-Southfield collects between Farmington Road and Southfield, the Green Express collects between Southfield and Wyoming, and the Blue Express collects between Schaefer and West Grand Boulevard. The advantage of Case II over Case I is that people between Farmington Road and Southfield save 5 to 6 minutes in travel time on the Modified Red Express-Southfield over the Red Express.

The travel time for people between Southfield and Schaefer is about 3 minutes longer than the present Red Express which enters the freeway at Schaefer. The travel time for the Green Express could be reduced to that of the existing Red Express by routing it along the Jeffries Service Drive between Schaefer and Wyoming. However, since the route starts at Southfield, the extended collection route on Grand River between Schaefer and Wyoming may be necessary to fill the buses before they enter the reserved lane at Wyoming.

Another disadvantage of Case II over the existing service is the increase in headways. For example, the peak hour headways which can be supported by the demand estimates presented in Section 3.6 are 15 minutes for the Modified Red Express-Southfield and 20 minutes for the Green Express. The service area of the Blue Express is predominately outside the corridor as defined for this study, and demand was not estimated for this route.

Case III combines the Modified Red Express-Southfield with the Modified Blue Express. The Modified Red Express provides collection between Farmington Road and Southfield, and the Modified Blue Express provides collection between Southfield and West Grand Boulevard. As in Case II, the people between Farmington Road and Southfield save 5 to 6 minutes on the Modified Red Express over the Red Express. However, the disadvantage of Case III is the 10 to 11 minute increase in travel time for those people living between Southfield and Schaefer who must now ride the Modified Blue Express. The Modified Blue Express has a longer travel time than the Red Express because it does not utilize the Jeffries Freeway for its line haul.

The alternatives listed under Case II are recommended for integration of the Grand River routes into the BRT system. Although peak-period headways are increased by splitting the Red Express route, a significant time savings--5 to 6 minutes--is achieved for riders of the Modified Red Express.

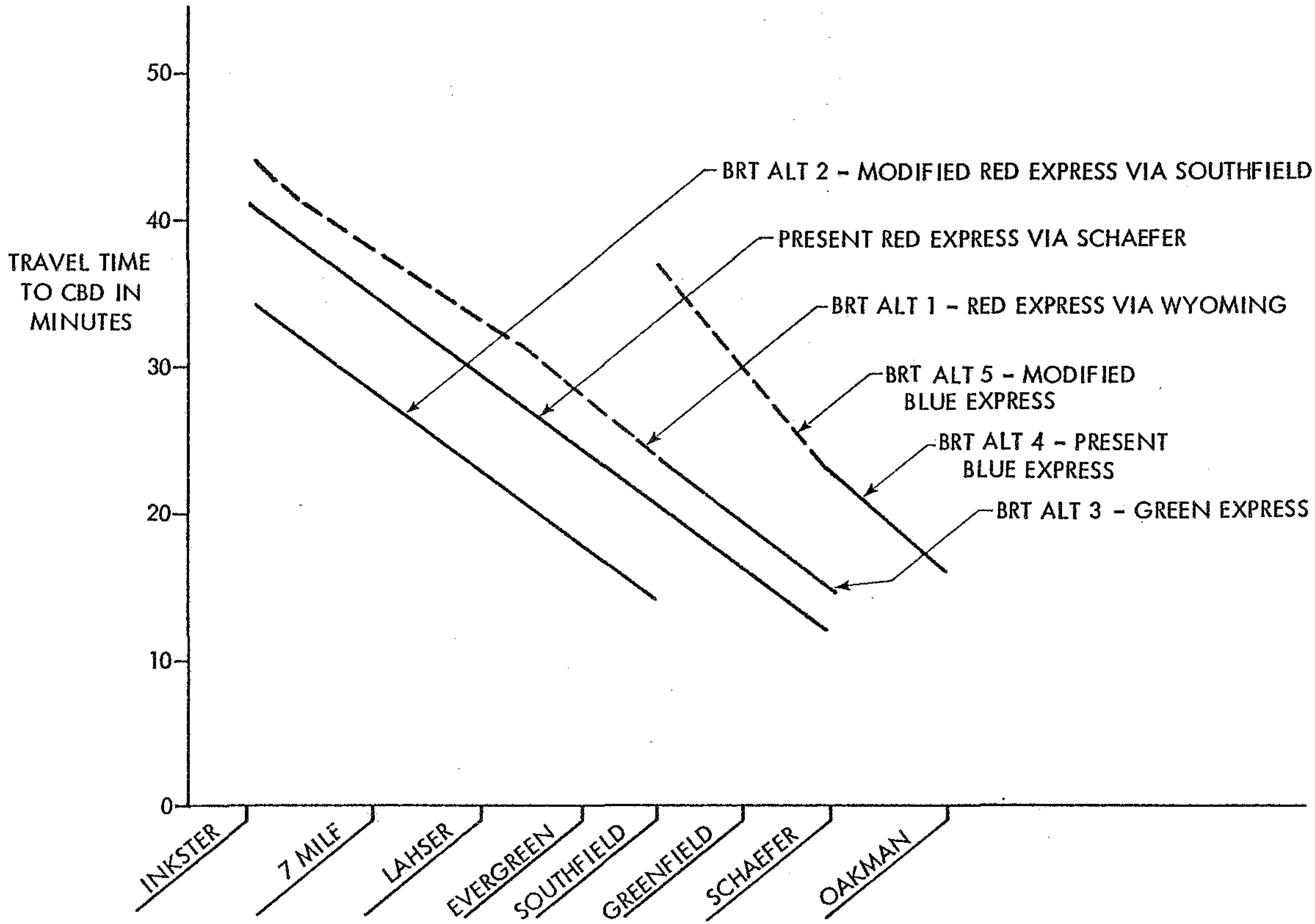


Figure 3-16 Travel Time Comparisons for Grand River
(Not Including CBD Distribution Time)

Table 3-10 Summary of BRT Alternatives for Grand River and Schoolcraft

NAME	COLLECTION	LINE-HAUL	EVALUATION
1) Red Express - Wyoming	a. SE on Grand River from Farmington to 7 Mile via local collection; from 7 Mile to Wyoming the bus stops only at major cross streets. b. SE on Grand River from Inkster or 7 Mile to Wyoming via local collection.	Enters line-haul at Wyoming Enters line-haul at Wyoming	Travel time about 3 minutes longer than present Red Express that enters at Schaefer
2) Modified Red Express - Southfield	a. SE on Grand River from Farmington to 7 Mile via local collection; from 7 Mile to Southfield the bus stops only at major cross streets. b. SE on Grand River from Inkster on 7 Mile to Southfield via local collection.	Enters line-haul at Southfield Enters line-haul at Southfield	5 to 6 min time savings over present Red Express
3) Green Express	a. SE on Grand River from Southfield to Wyoming via local collection. b. SE on Grand River from Evergreen to Wyoming via local collection.	Enters line-haul at Wyoming Enters line-haul at Wyoming	Travel time 3 minutes longer than present Red Express
4) Blue Express	SE on Grand River from Schaefer to West Grand Boulevard via local collection	Nonstop along Gr. River from W. Gr. Blvd. to CBD	Identical to present Blue Express
5) Modified Blue Express	SE on Grand River from Southfield to Oakman via local collection	Same as Blue Express	For people living between Southfield & Schaefer along Gr. River, travel on Modified Blue Express is about 10-11 min greater than travel on present Blue Express
6) Schoolcraft Express	E on Schoolcraft from Dale to Southfield E on Schoolcraft from Southfield to Wyoming	Via Southfield Via Wyoming	

Table 3-11 Combinations of BRT Alternatives for Grand River

CASE	ALTERNATIVE	NAME	COLLECTION
Case I	1 4	Red Express Blue Express	Farmington Road to Wyoming Wyoming to W. Grand Boulevard
Case II	2 3 4	Modified Red Express--Southfield Green Express Blue Express	Farmington Road to Southfield Southfield to Wyoming (or Evergreen to Wyoming) Schaefer to W. Grand Boulevard
Case III	2 5	Modified Red Express--Southfield Modified Blue Express	Farmington Road to Southfield Southfield to W. Gr. Boulevard

Case II is recommended even though it violates one of the ground rules adopted for integrating existing bus service into the BRT system; i.e., the travel time for some patrons (those accessing the system on Grand River between Southfield and Schaefer) is increased by 3 minutes over the existing Red Express. If this increase in travel time is determined to be unacceptable, the Green Express can be routed along the Jeffries Service Drive from Schaefer to Wyoming instead of along Grand River. This routing results in no increase in travel time relative to the existing Red Express for patrons boarding between Southfield and Schaefer. In either case, service on Grand River between Schaefer and Wyoming would continue to be provided by the Blue Express.

Both Modified Red Express and Green Express patrons are afforded shorter trip times for outbound trips as a result of using the Jeffries reserved bus lane.

3.3.1.5 Joy Road

Joy Road is presently served by the Joy Road Local and the Joy Road Express. Figure 3-17 shows the route of each of the above lines. The Joy Road Local originates at either Farmington Road or Telegraph and goes east on Joy Road to Beechwood. The buses go south on Beechwood and West Grand Boulevard to Lafayette. The buses then go east on Lafayette and Fort Street to the CBD, terminating at Cadillac Square. The Joy Road Express also originates at either Farmington Road or Telegraph, goes east on Joy Road to Wyoming, south on Wyoming to Michigan. At Michigan and Wyoming, it begins the nonstop portion of the route to the CBD. The first CBD stop is on Michigan at Third. The bus goes down Third to Lafayette, to Cass, to Fort, to Cadillac Square.

Table 3-12 shows the frequency of service along Joy Road. For the local service east of Telegraph, headways range from 8 to 17 minutes with most of the buses running about 12 minutes apart. The express headways from Farmington Road range from 5 to 26 minutes, with most of the buses running 12 to 13 minutes apart.

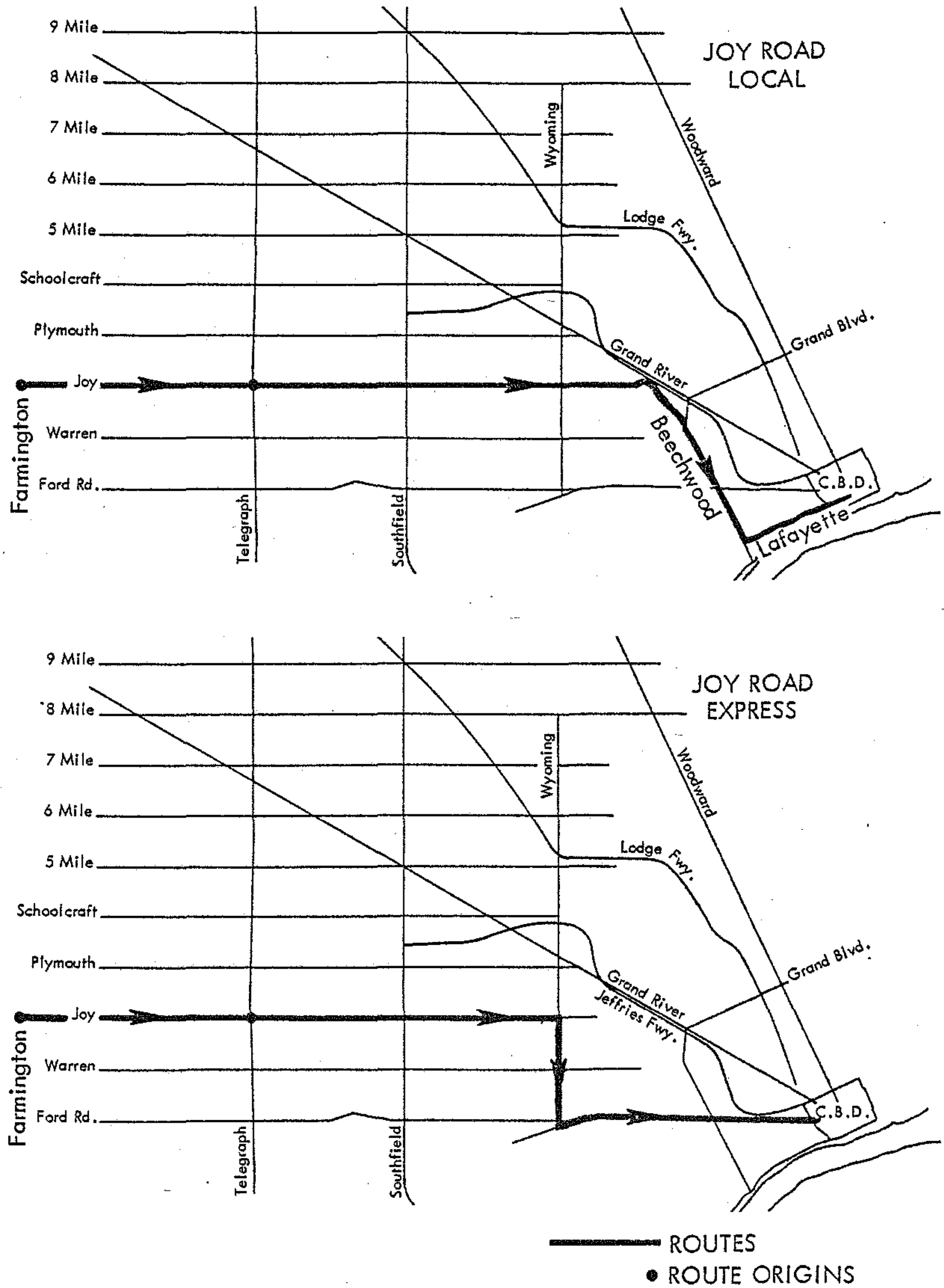


Figure 3-17 Sketch of Existing Express Routes on Joy Road

Table 3-12 Frequency of Existing Service on Joy Road

ROUTE NAME	TYPE OF SERVICE	ROUTE NO.	POINT OF ORIGIN	POINT OF TERMINATION	NUMBER OF BUSES ARRIVING IN THE CBD IN THE A.M.						
					7:00-7:29	7:30-7:59	8:00-8:29	8:30-8:59	9:00-9:29	9:30-10:00	TOTAL
Joy Rd	Local	27	Farmington Road	Cadillac Sq.		1		1	2	2	6
			Telegraph	Cadillac Sq.	2	2	2	1			7
			Schaefer	Cadillac Sq.	1						1
			Total		3	3	2	2	2	2	14
Joy Rd	Express	80	Farmington	Cadillac Sq.	1	2	2	1	2		8
			Telegraph	Cadillac Sq.	1	2		1			4
			Total		2	4	2	2	2	0	12

The five alternative BRT treatments which have been developed for serving Joy Road are illustrated in Figure 3-18. The first alternative is to start the buses at either Farmington Road or Telegraph and run them to Livernois. The buses would then go north on Livernois to the Jeffries Freeway. The second alternative is similar to the first except buses would access the Jeffries at Wyoming rather than at Livernois. The third alternative also has the buses starting at either Farmington Road or Telegraph. The buses would proceed to Southfield and go north on Southfield to the Jeffries. The fourth alternative would have buses start at Southfield, run to Livernois, and go north on Livernois to the Jeffries Freeway. The fifth alternative would also have the buses start at Southfield, run to Wyoming, and go north on Wyoming to the Jeffries entrance. Alternatives 4 and 5 could be used in conjunction with Alternative 3. In Alternative 3, local collection ends at Southfield, while for Alternatives 4 and 5, collection begins at that point.

Note that the BRT alternatives do not provide service to Wyoming between Joy Road and Michigan Avenue. The present Joy Road Express follows this route to get to Michigan Avenue, the road which is used for the line haul, non-stop portion of the express route. In order to provide service to Wyoming, one could add a north-bound BRT collection bus on Wyoming. However, there is probably not sufficient demand to warrant this. Furthermore, the people along this section of Wyoming have many good alternatives still available if the Joy Road Express is rerouted.

1. The Wyoming Local has 12- to 15-minute headways. People along Wyoming could take the local to an intermediate stop at Wyoming and Jeffries.
2. Riders could take the Wyoming Local to Michigan Avenue Express or Local.
3. The Tireman Local has about 20-minute headways in the peak period. People could take this east-west bus to the CBD.
4. The Warren Local and Crosstown Express provide frequent service, and both intersect the Woodward bus to provide a link to the CBD.

Therefore, it is concluded that it will not be necessary to add service to this area when the Joy Road Express is diverted to the Jeffries. The travel time to the CBD from selected intersections along Joy Road for the present Joy Road Express and the Joy Road BRT alternatives is shown in Figure 3-19, and the summary of the evaluation of the alternative is shown in Table 3-13.

There are many possible ways of combining the alternatives that have been considered into service plans which provide some type of BRT collection to each segment of Joy Road presently being served by the express bus service. One set of service plans is associated with buses entering the Jeffries at Wyoming and another set of service plans is associated with buses entering at Livernois. Table 3-14 shows a set of service plans associated with a Wyoming entrance. Case I, which is similar to the present Joy Road Express, has buses starting at either Farmington Road or Telegraph Road and running to Wyoming. At Wyoming, they go north to the Jeffries as illustrated in Figure 3-18. People riding this configuration have a travel time of about 1 minute less than the present Joy Road Express. Case II is the same as Case I, except that the buses that started at Farmington Road are diverted north at Southfield Road. The advantage of Case II

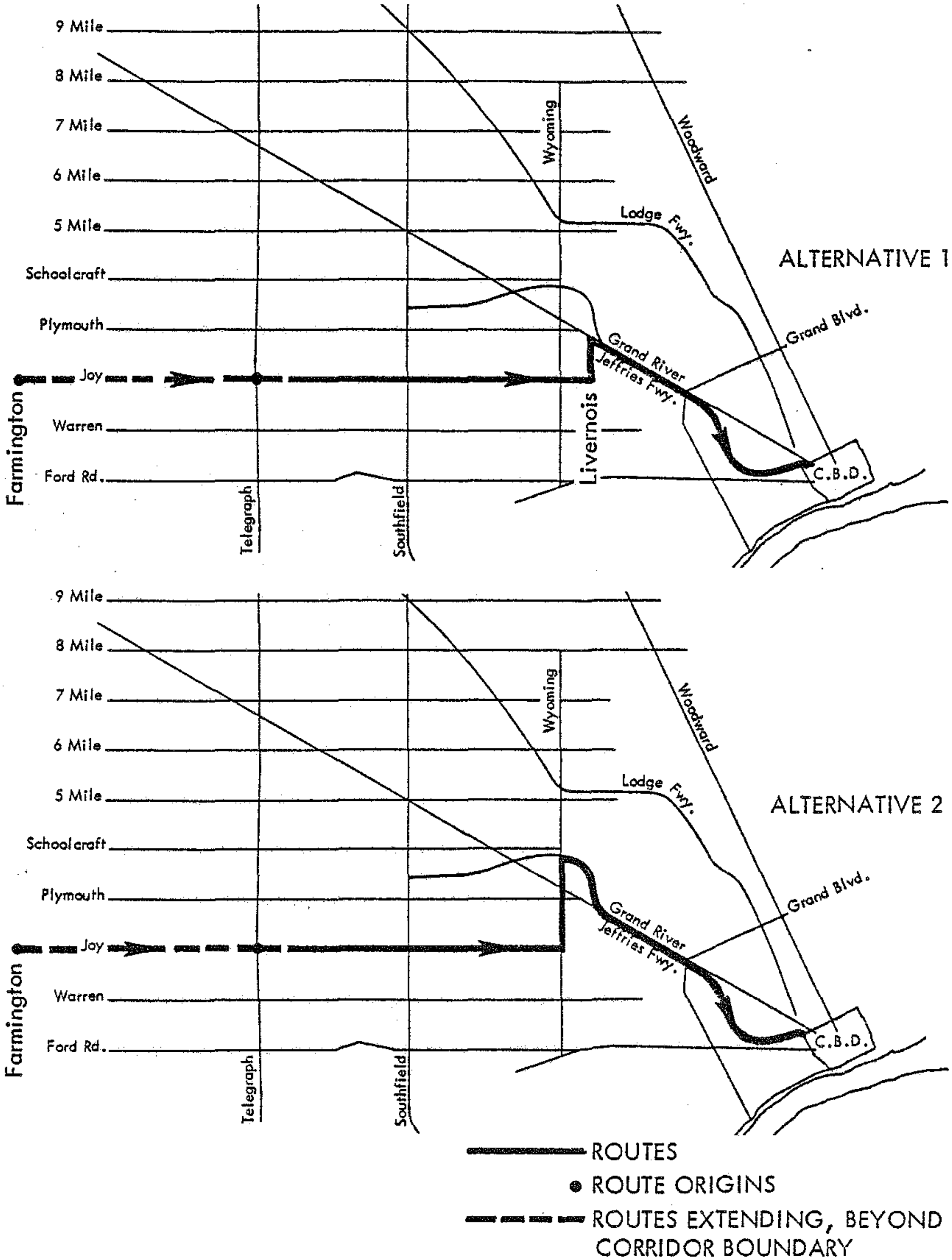


Figure 3-18 Sketch of Alternative BRT Routes on Joy Road (Sheet 1 of 3)

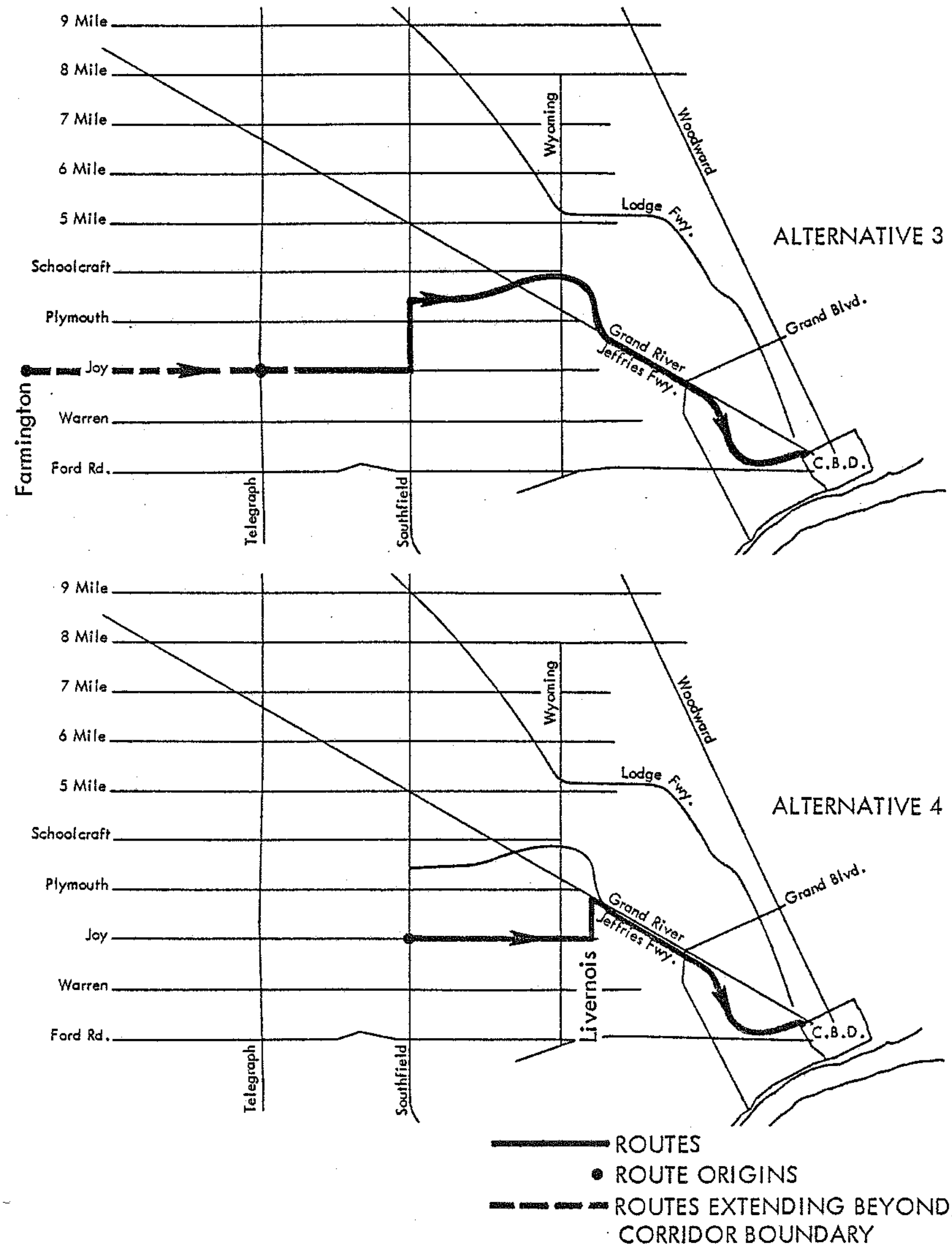


Figure 3-18 Sketch of Alternative BRT Routes on Joy Road (Sheet 2 of 3)

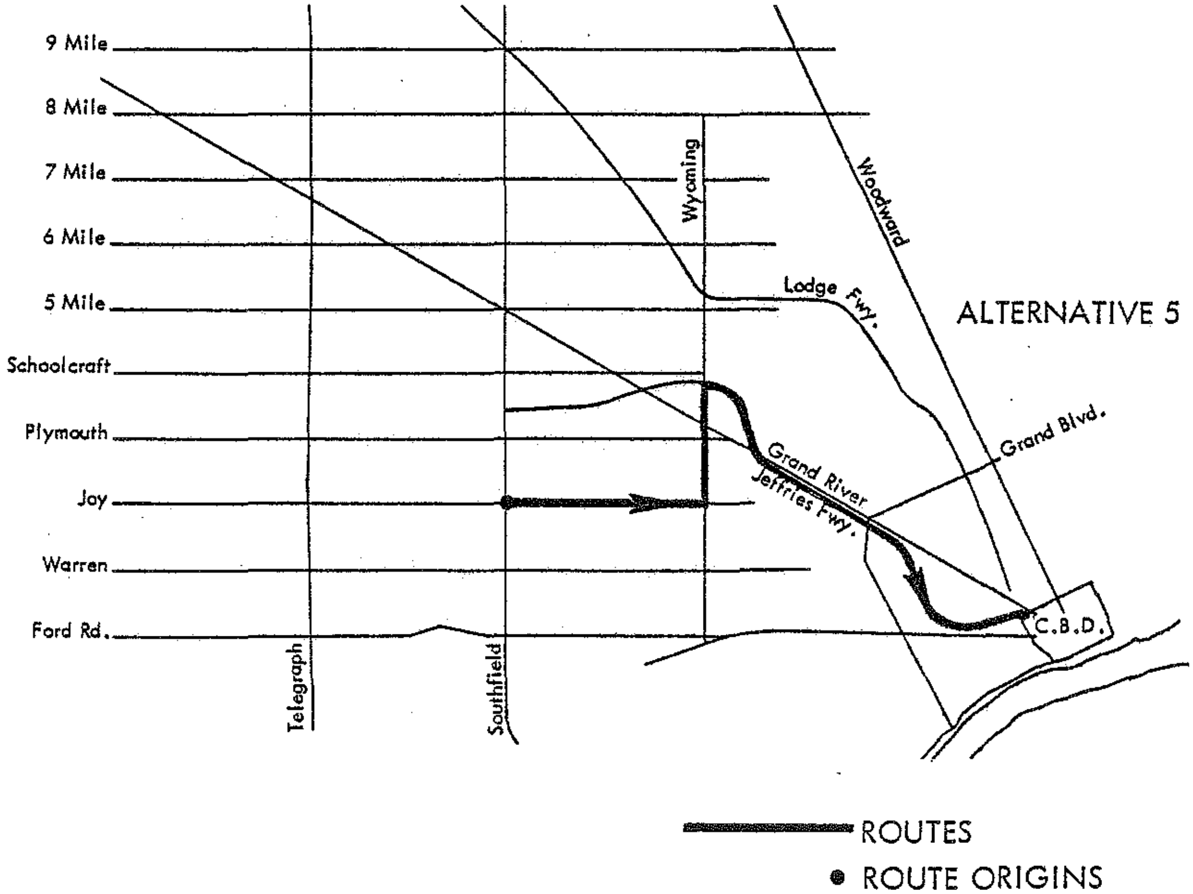


Figure 3-18 Sketch of Alternative BRT Routes on Joy Road
(Sheet 3 of 3)

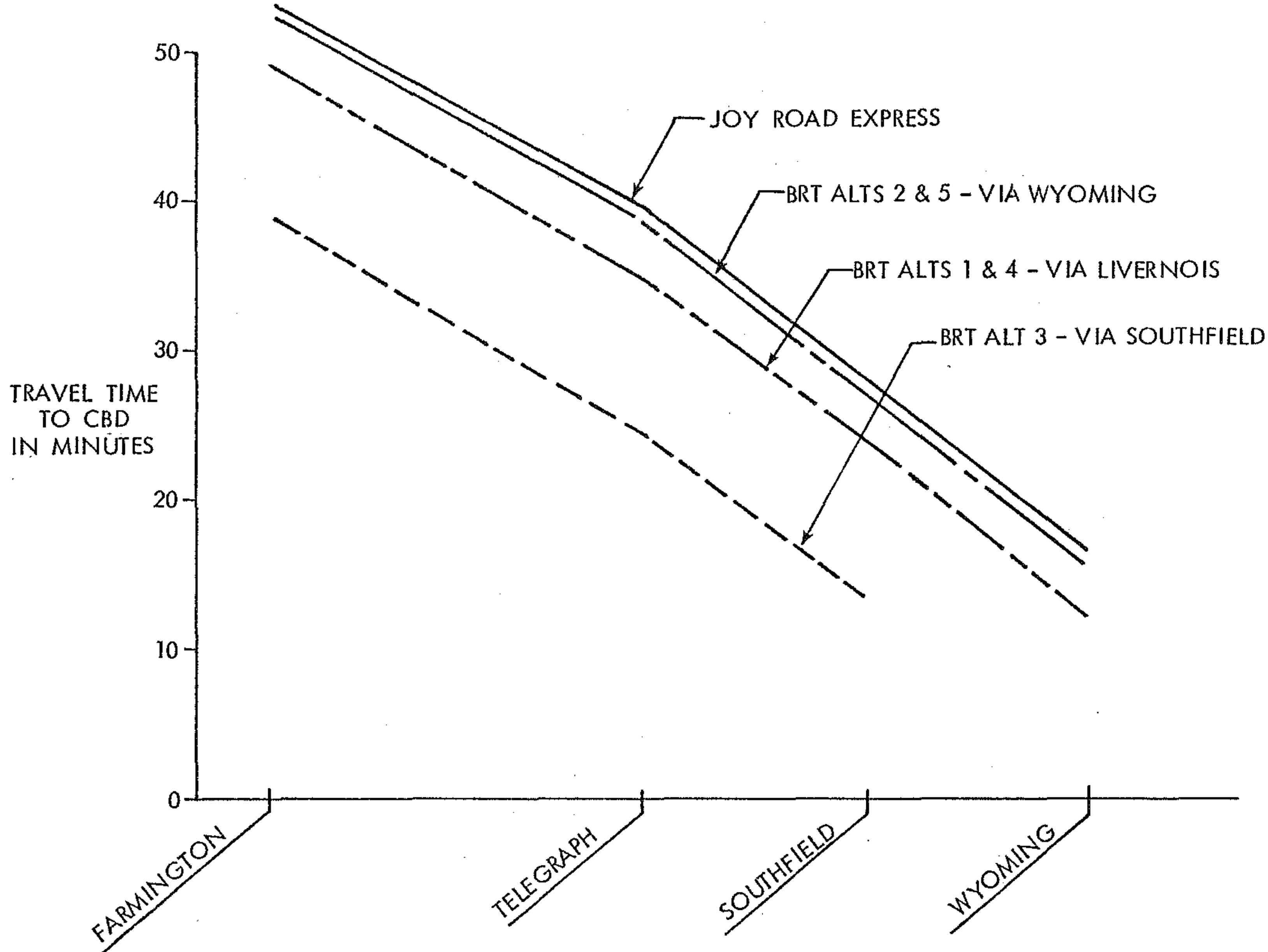


Figure 3-19 Travel Time Comparisons for Joy Road

Table 3-13 Summary of BRT Alternatives for Joy Road

COLLECTION	LINE-HAUL	EVALUATION
BRT Alt 1 - E on Joy Rd from Farmington Rd to Livernois E on Joy Rd from Telegraph Rd to to Livernois	Enters Jeffries line-haul at Livernois	Travel time is 4-5 minutes less than the present Joy Rd Express
BRT Alt 2 - E on Joy Rd from Farmington Rd to Wyoming E on Joy Rd from Telegraph to Wyoming	Enters Jeffries line-haul at Wyoming	Travel time is about 1 minute less than the present Joy Road Express
BRT Alt 3 - E on Joy Rd from Farmington Rd to Southfield E on Joy Rd from Telegraph to Southfield	Enter Southfield at Joy Rd, N on Southfield to Jeffries	Travel time is 14-15 minutes less than the present Joy Road Express
BRT Alt 4 - E on Joy Rd from Southfield to Livernois	Enter Jeffries line-haul at Livernois	Travel time is 4-5 minutes less than the present Joy Road Express
BRT Alt 5 - E on Joy Road from Southfield to Wyoming	Enter Jeffries line-haul at Wyoming	Travel time is about 1 minute less

Table 3-14 Combinations of Alternatives for Joy Road and Wyoming Access

BRT ALTERNATIVES		EVALUATION
Case I	• Buses start at either Farmington Rd or Telegraph Rd & access the Jeffries via Wyoming (Alt 2)	• Travel time is about 1 minute less than the present Joy Rd Express
Case II	• Buses start at Farmington Rd and access the Jeffries via Southfield Rd (Alt 3)	• Travel time is 14-15 minutes less than the present Joy Rd Express
	• Buses start at Telegraph Rd and access the Jeffries via Wyoming (Alt 2)	• Travel time is about 1 minute less than the present Joy Rd Express • People between Southfield & Wyoming see less frequent service Ave. headways from 13-19 min
Case III	• Buses start at Farmington Rd and access the Jeffries via Southfield Rd (Alt 3)	• Travel time is 14-15 minutes less than the present Joy Rd Express
	• Buses start at Telegraph Rd & access Jeffries via Wyoming (Alt 2)	• Travel time is about 1 minute less than the present Joy Rd Express
	• Buses start at Southfield Rd & access Jeffries via Wyoming (Alt 5)	• Travel time is about 1 minute less than the present Joy Rd Express

relative to Case I is that the travel time of buses using the Joy Road/Southfield/Jeffries route is significantly less (14 to 15 minutes less) than the present Joy Road Express. The disadvantage is that persons living east of Southfield see less frequent service because some buses have been diverted to the Southfield Freeway. However, if transit demand increases due to the improved BRT service, then additional buses can be justified to approximately maintain current headways. Case III addresses this eventuality. This combination of alternatives is the same as Case II except that additional buses are started at Southfield to compensate for those buses which are diverted to Southfield.

Table 3-15 summarizes the combinations of alternatives for integrating the Joy Road Express into the BRT system using Livernois to access the Jeffries. The advantage of entering the Jeffries at Livernois is that 3 to 4 minutes of travel time can be saved relative to the alternatives which use Wyoming to access the reserved lane. However, without an exclusive bus ramp at Livernois, buses would have to weave across two lanes of traffic to access the reserved median lane. If the time required for this maneuver were taken into account, it is likely that the net time saved relative to accessing the Jeffries at Wyoming would be insignificant. An exclusive ramp at Livernois could be constructed to provide access directly to the reserved lane on the Jeffries. However, it is doubtful that the expense of constructing such a ramp could be justified since a total of only 21 buses in the three-hour peak period from three routes (Joy, West Chicago, and Plymouth) would benefit from a Livernois access alternative. Finally, the opportunity to interface with the Wyoming transfer station and the New Center shuttle service which originates there would be lost.

The combination of alternatives which is recommended for the integration of Joy Road express service into the BRT system is Case III with access to the Jeffries via Wyoming. Buses which originate at Farmington Road and use Southfield to access the Jeffries save 14 to 15 minutes over the present Joy Road Express. Buses which enter the Jeffries at Wyoming save about one minute over the present express service. Furthermore, headways along the route remain essentially unchanged because additional buses start at Southfield.

For the purposes of demand analysis, system sizing, and cost estimating, only two starting points for buses were assumed. All buses west of Southfield were assumed to start at the corridor boundary, Hazelton, and follow the route which accesses the Jeffries at Southfield. The estimated BRT demand, as reported in Section 3.6, is sufficient to support 4 bus trips in the peak hour and 5 trips during the remainder of the peak period on this route. The rest of the BRT buses on Joy Road were assumed to start at Southfield and access the Jeffries at Wyoming. The demand estimates support 5 bus trips on this route in the peak hour and 5 trips during the remainder of the peak period.

3.3.1.6 West Chicago

West Chicago (2 1/2 Mile Road) is served by the Chicago-Davison local and the Rouge Express. The Chicago-Davison local does not go to the CBD. It originates at West Chicago and Burt (Rouge Park) and goes across West Chicago to Oakman, to Davison, to

Table 3-15 Combinations of Alternatives for Joy Road and Livernois Access

BRT ALTERNATIVES		EVALUATION
Case I	• Buses start at either Farmington Rd or Telegraph Rd & access the Jeffries via Livernois (Alt 1)	• Travel time is about 4-5 minutes less than present Joy Rd Express
Case II	• Buses start at Farmington Rd and access the Jeffries via Southfield Rd (Alt 3)	• Travel time is 14-15 minutes less than the present Joy Rd Express
	• Buses start at Telegraph Rd. and access the Jeffries via Livernois (Alt 1)	• Travel time is about 4-5 minutes less than the present Joy Rd Express • People between Southfield & Livernois see less frequent service Ave. headways from 13-19 min
Case III	• Buses start at Farmington Rd and access the Jeffries via Southfield Rd (Alt 3)	• Travel time is 14-15 minutes less than the present Joy Rd Express
	• Buses start at Telegraph Rd & access Jeffries via Livernois (Alt 1)	• Travel time is about 4-5 minutes less than the present Joy Rd Express
	• Buses start at Southfield Rd & access Jeffries via Livernois (Alt 4)	• Travel time is about 4-5 minutes less than present Joy Rd Express

Conant. It terminates at Davison and Conant. The Rouge Express originates at West Chicago and Burt and follows West Chicago to Livernois, to Joy Road, to Grand River. It expresses to the CBD via Grand River with an intermediate stop at West Grand Boulevard. These existing West Chicago routes are illustrated in Figure 3-20. Table 3-16 shows the frequency of service along West Chicago. Note that there are only three Rouge Express buses. They run at 20-minute headways.

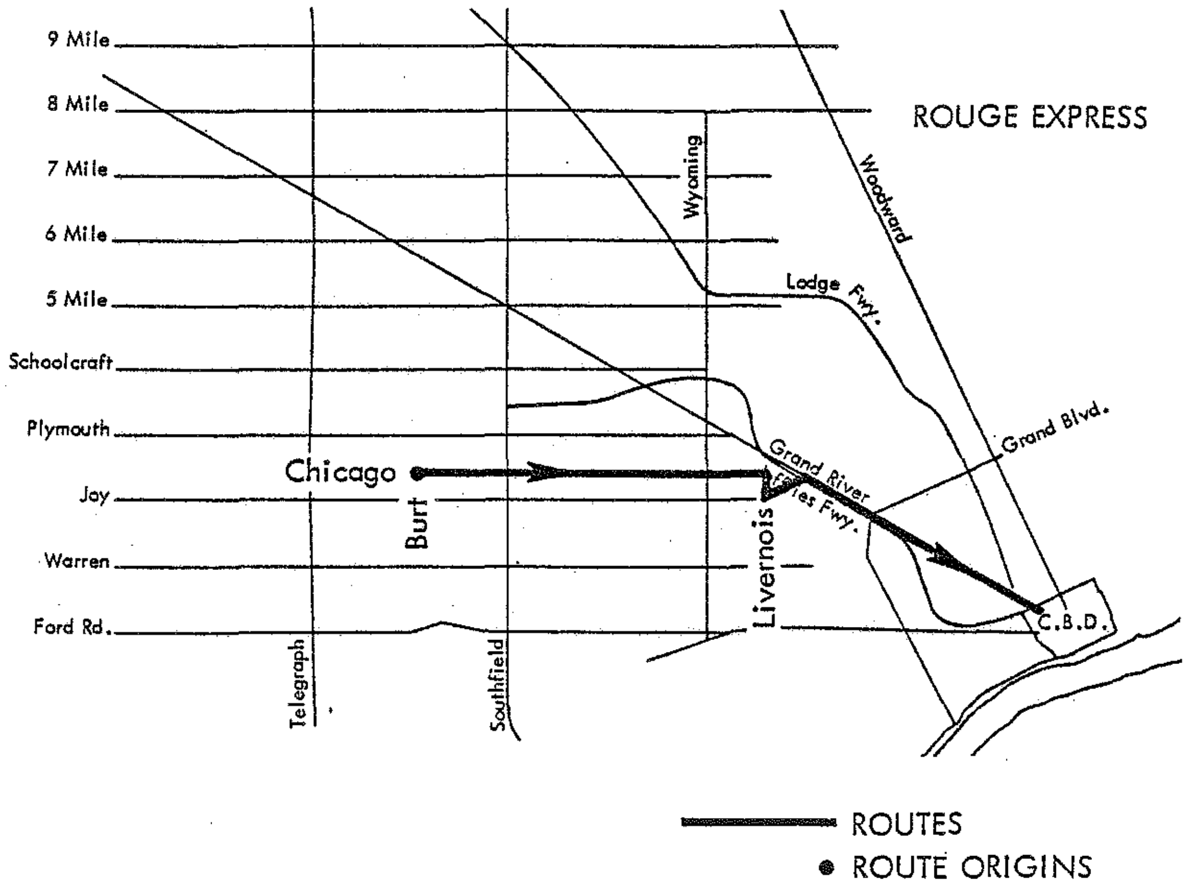


Figure 3-20 Sketch of Existing Express Routes on West Chicago

Table 3-16 Frequency of Existing Service on West Chicago

ROUTE NAME	TYPE OF SERVICE	ROUTE NO.	POINT OF ORIGIN	POINT OF TERMINATION	NUMBER OF BUSES ARRIVING IN THE CBD IN THE A.M.						
					7:00-7:29	7:30-7:59	8:00-8:29	8:30-8:59	9:00-9:29	9:30-10:00	TOTAL
Chicago Davison	Local	15	Burt-Orangelawn	Mt. Elliott & Nevada	1	1	1	1	1		5
			W. Chicago-Schaefer	(Does not terminate at CBD)		1	1	1	1		4
			Grand River-Oakman							1	1
					1	2	2	2	2	1	10
Chicago Davison	Rouge Express	83	Burt-Orangelawn	Blue Cross		1	2				

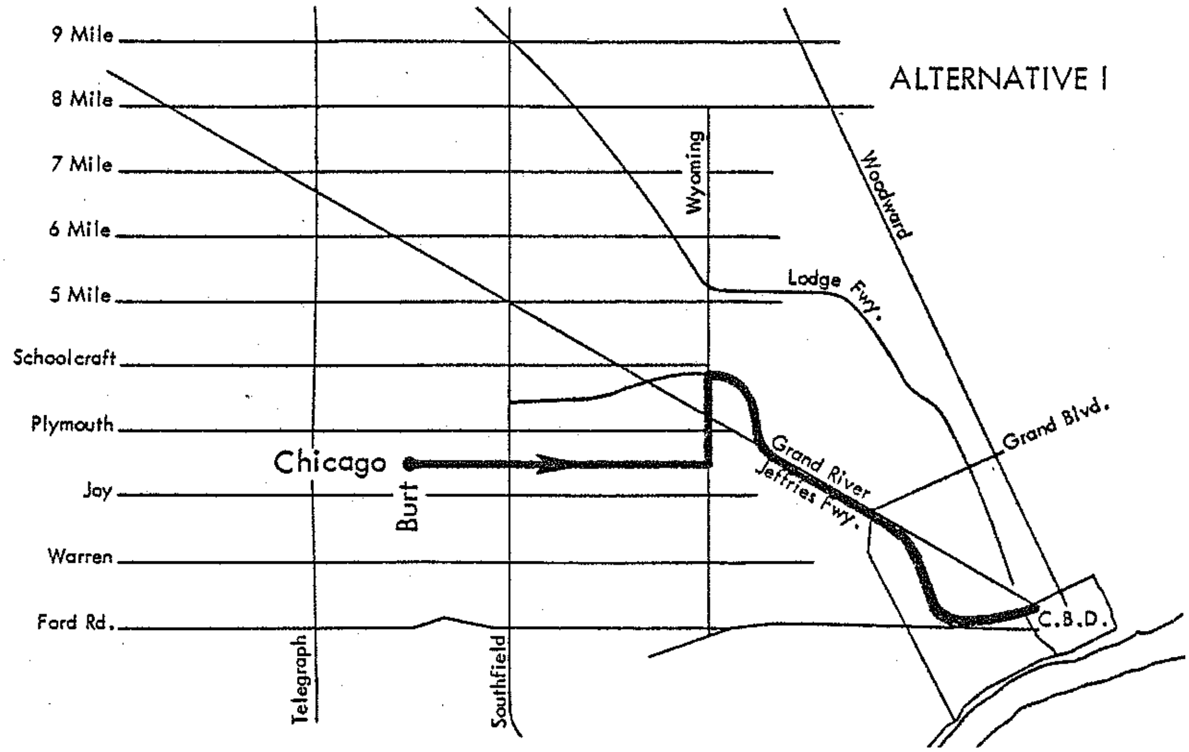
Two BRT treatments have been developed for serving West Chicago as illustrated in Figure 3-21. The first alternative is to start the buses at Burt and West Chicago and run them to Wyoming and then north to the Jeffries. The second alternative starts the buses at the same point and runs them to Livernois to the Jeffries. Figure 3-22 shows the comparison of travel times to the CBD for the existing Rouge Express and the two BRT alternatives. Table 3-17 summarizes the evaluation of the BRT alternatives for West Chicago. An alternative which would have the buses go north on Southfield at West Chicago was not considered for two reasons. First, there is no entrance to the Southfield Freeway at West Chicago, and, second, the collection route would only be one and one-half miles long. The demand would not be sufficient to fill the bus.

It is recommended that the West Chicago BRT buses enter the Jeffries at Wyoming. This will save about 2 to 3 minutes in travel time over the present Rouge express. Note that 3 to 4 more minutes could be saved by routing the buses on at Livernois. However, this alternative is not recommended for the reasons expressed previously in the discussion of the Joy Road alternative. People between Wyoming and Livernois will no longer be served by the Rouge express, but they can access the bus as it goes up Wyoming or access the Grand River Blue Express.

Since West Chicago is essentially a half-mile road and tends to bisect the TALUS zones used in the demand analysis, the BRT demand for the Chicago-Davison Express was not estimated. Although the existing level of service, three buses in the peak period, is included in the system cost estimates, the demand for this line was not considered in sizing the other BRT lines.

Table 3-17 Summary of BRT Alternatives for West Chicago

COLLECTION	LINE HAUL	EVALUATION - TRAVEL TIME IN COMPARISON TO ROUGE EXPRESS
BRT Alt 1 - E on W Chicago from Burt to Livernois	Enter Jeffries line-haul at Livernois	6 minutes less travel time
BRT Alt 2 - E on W Chicago from Burt to Wyoming	Enter Jeffries line-haul at Wyoming	2-3 minutes less travel time



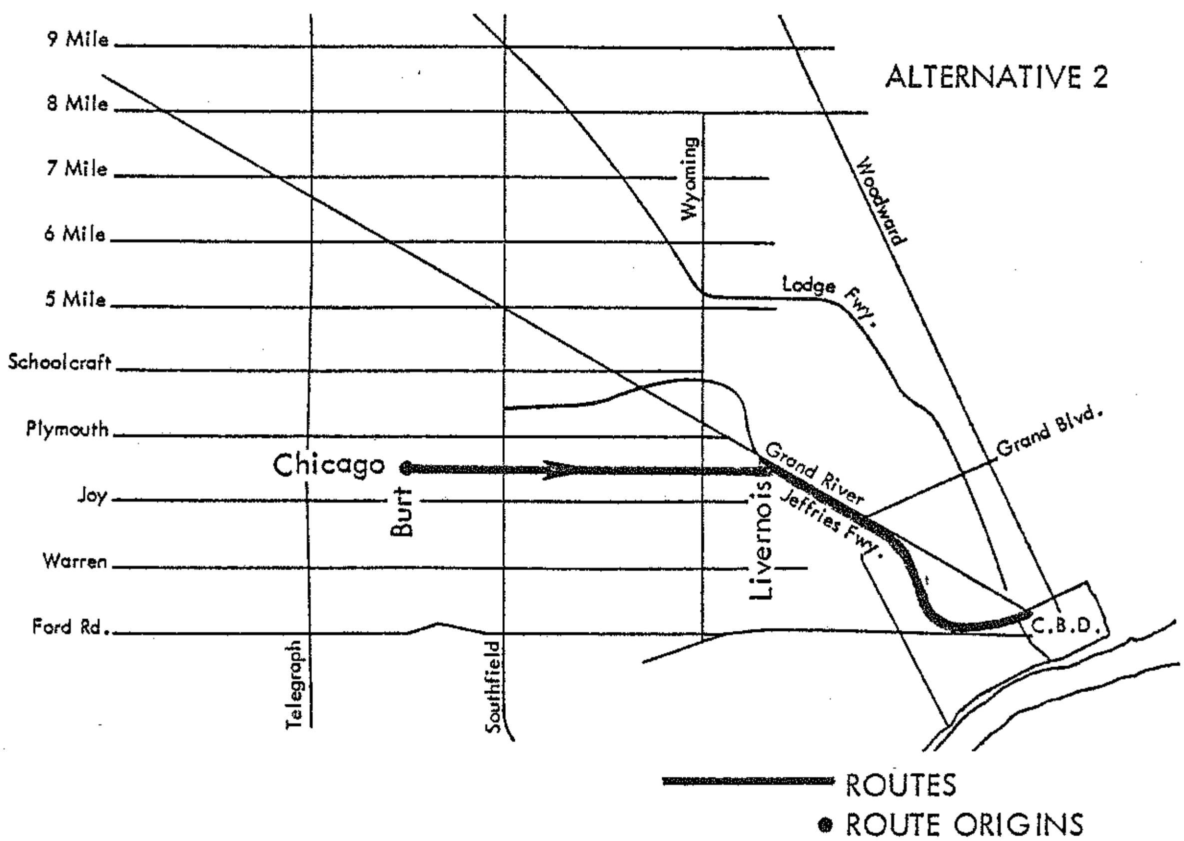


Figure 3-21 Sketch of Alternative BRT Routes on West Chicago

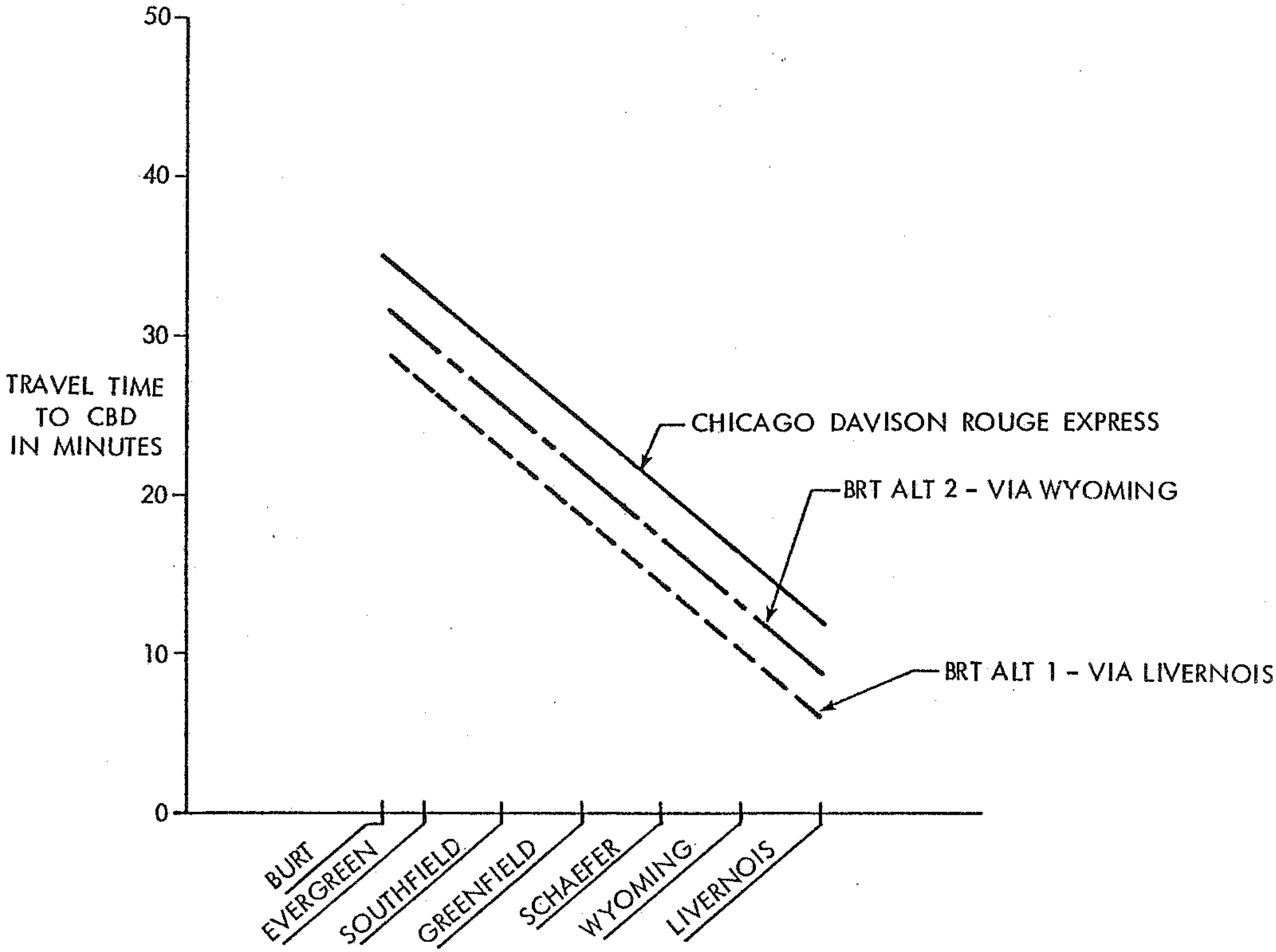


Figure 3-22 Travel Time Comparisons for West Chicago

3.3.1.7 Plymouth Road

Plymouth Road is presently served by essentially two express bus routes. One goes to the CBD via the Lodge Freeway and the other via Grand River. Figure 3-23 shows the route of each of the lines. The Plymouth-Lodge Express has buses originating at Ann Arbor Trail, Farmington Road, Wonderland Shopping Center (just west of Middlebelt), GM Fisher Body (west of Inkster Road), Telegraph, and Outer Drive. The Plymouth-Grand River Express originates at Farmington Road, Wonderland Shopping Center, and Outer Drive. Both lines follow the same basic downtown distribution route. They take State to Griswold to East Jefferson.

Table 3-18 shows the frequency of service along Plymouth Road. With the two routes, combined headways between Wonderland Shopping Center and Grand River range from 2 to 12 minutes. The Plymouth-Grand River line has 10- to 15-minute headways, and the Plymouth-Lodge line has 12- to 18-minute headways.

It appears most practical to integrate the Plymouth-Grand River Express into the Jeffries BRT system and to leave the Plymouth-Lodge service as it is. The five BRT alternative treatments developed for Plymouth Road between Ann Arbor Trail and Grand River are very similar to the alternatives developed for Joy Road. The alternatives for Plymouth Road are illustrated in Figure 3-24 and summarized in Table 3-18. The first alternative is to start the buses at Outer Drive or one of the many points of origin west of Outer Drive, and run them to Grand River, to Livernois, to the Jeffries. The second alternative would have these same buses in Alternative 1 access the Jeffries via Wyoming rather than via Livernois. The third alternative is to have the buses starting west of Outer Drive access the Jeffries via Southfield. The fourth alternatives is to start buses at Southfield, go east on Plymouth, and access the Jeffries via Livernois. The fifth alternative is to have the buses which started at Southfield access the Jeffries via Wyoming. The travel time to the CBD (not including distribution time) for the Plymouth-Grand River Express and the BRT alternatives is shown in Figure 3-25 and the evaluation of the alternatives is summarized in Table 3-19.

The approach taken to combine the BRT alternatives for Plymouth Road into a service plan is very similar to the service plans for Joy Road. Therefore, the service plans for Plymouth Road will not be discussed in detail. Table 3-20 shows the Plymouth Road service plans in coordination with access to the Jeffries via Wyoming and Table 3-21 for the service plans accessing the Jeffries via Livernois.

Case III with access to the Jeffries via Wyoming is the recommended service plan for Plymouth Road. People west of Southfield Road who take buses that access the Jeffries via Southfield save 12 to 13 minutes over the present Plymouth-Grand River Express, and people who take buses which access the Jeffries via Wyoming save about 2 minutes. Furthermore, headways along the route remain essentially unchanged because additional buses start at Plymouth and Southfield Roads. Even though an additional minute could be saved if the buses entered the Jeffries at Livernois rather than at Wyoming, this alternative was not selected for the reasons cited in the discussion of Joy Road alternatives.

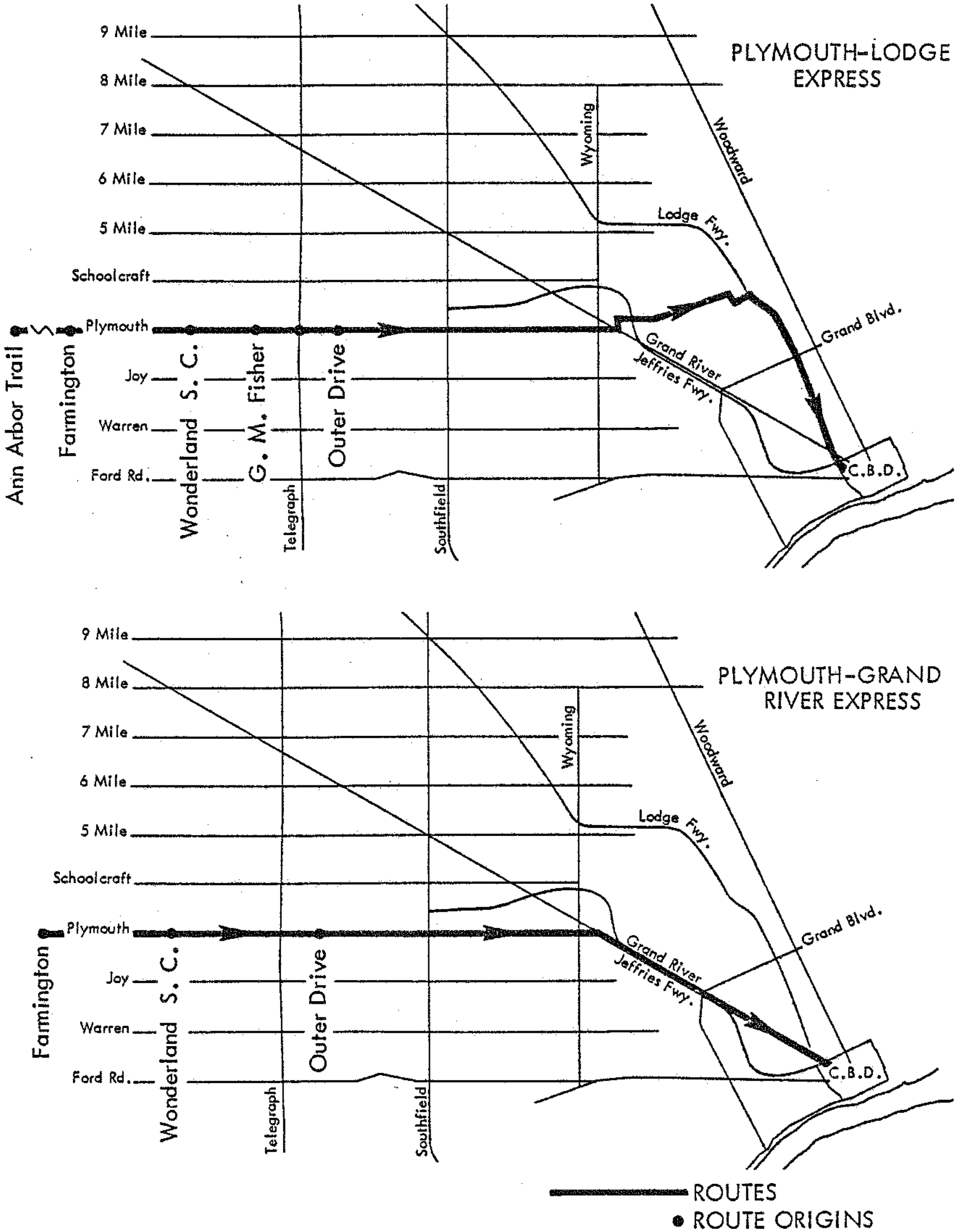


Figure 3-23 Sketch of Existing Express Routes on Plymouth Road

Table 3-18 Frequency of Existing Service on Plymouth Road

ROUTE NAME	TYPE OF SERVICE	ROUTE NO.	POINT OF ORIGIN	POINT OF TERMINATION	NUMBER OF BUSES ARRIVING THE CBD IN THE A.M.						
					7:00-7:29	7:30-7:59	8:00-8:29	8:30-8:59	9:00-9:29	9:30 10:00	TOTAL
Plymouth	Express via Lodge	38	Ann Arbor Tr	Griswold & Jefferson		1			1	1	3
			Farmington	"	1						1
			Wonderland	"		1		1		1	3
			GM	"				2	1		3
			Telegraph	"			2				2
			Outer Drive	"	1						1
			TOTAL		2	2	2	3	2	2	13
Plymouth	Express via Grand River	82	Farmington	Griswold & Jefferson			1				1
			Wonderland	"	1	2	1	1			5
			Outer Drive	"		1					1
			TOTAL		1	3	2	1			7

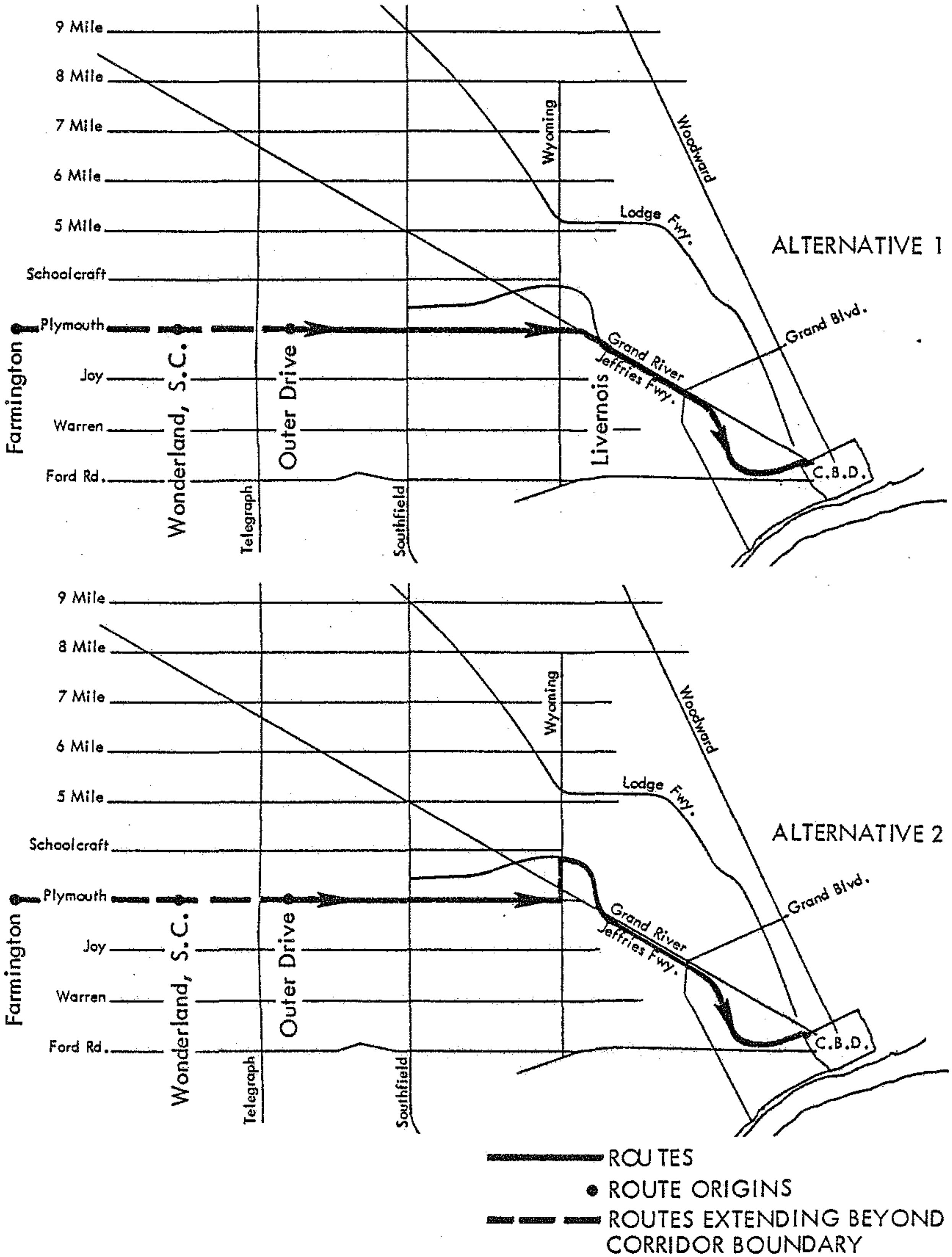


Figure 3-24 Sketch of Alternative BRT Routes on Plymouth Road (Sheet 1 of 3)

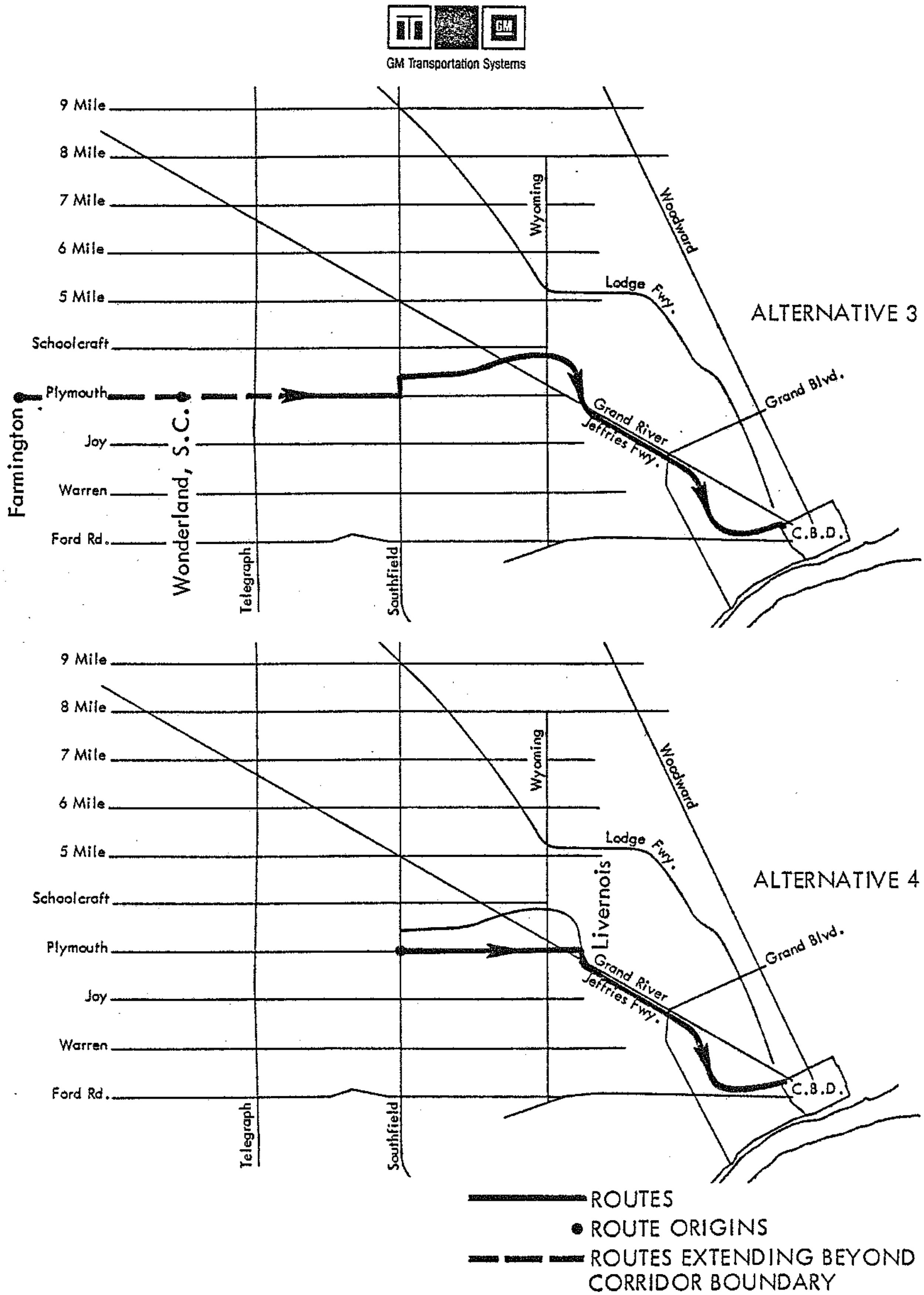


Figure 3-24 Sketch of Alternative BRT Routes on Plymouth Road (Sheet 2 of 3)

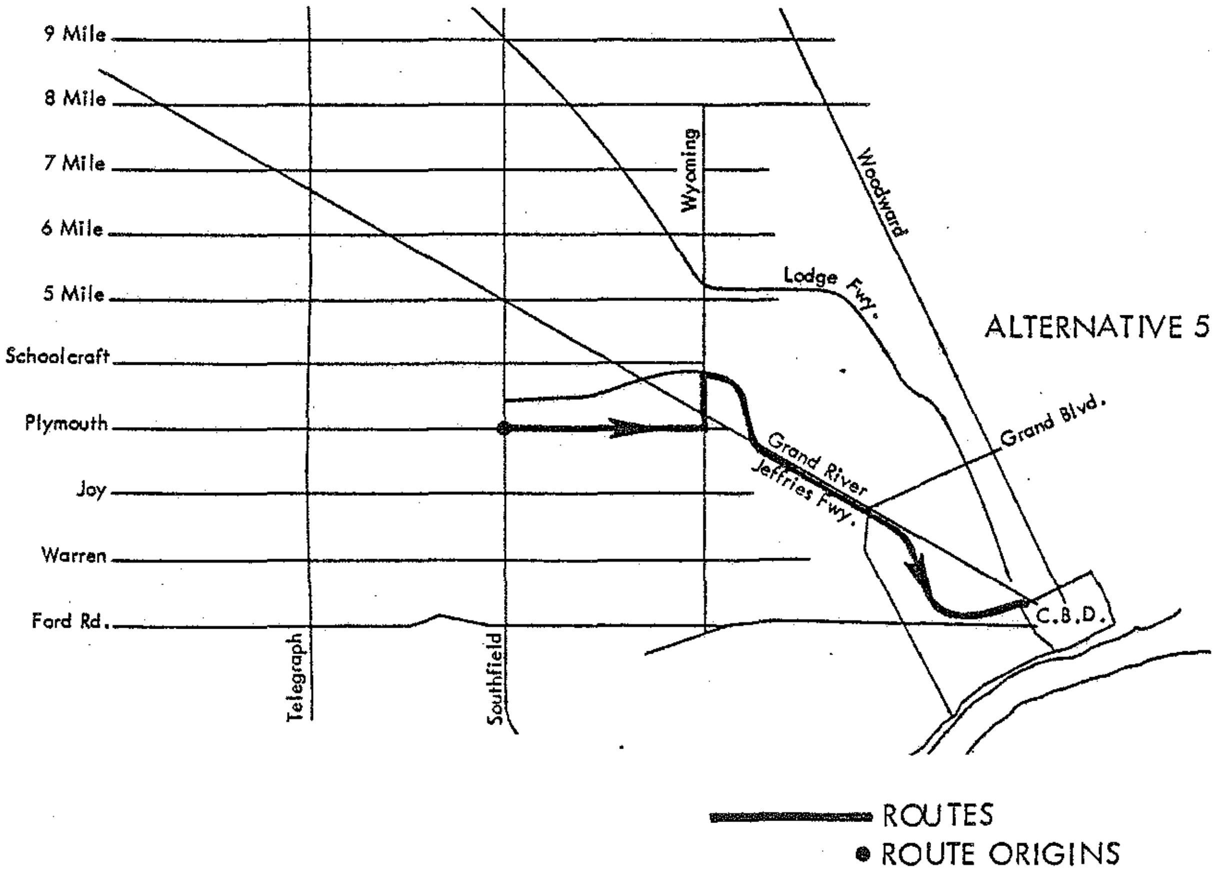


Figure 3-24 Sketch of Alternative BRT Routes on Plymouth Road
(Sheet 3 of 3)

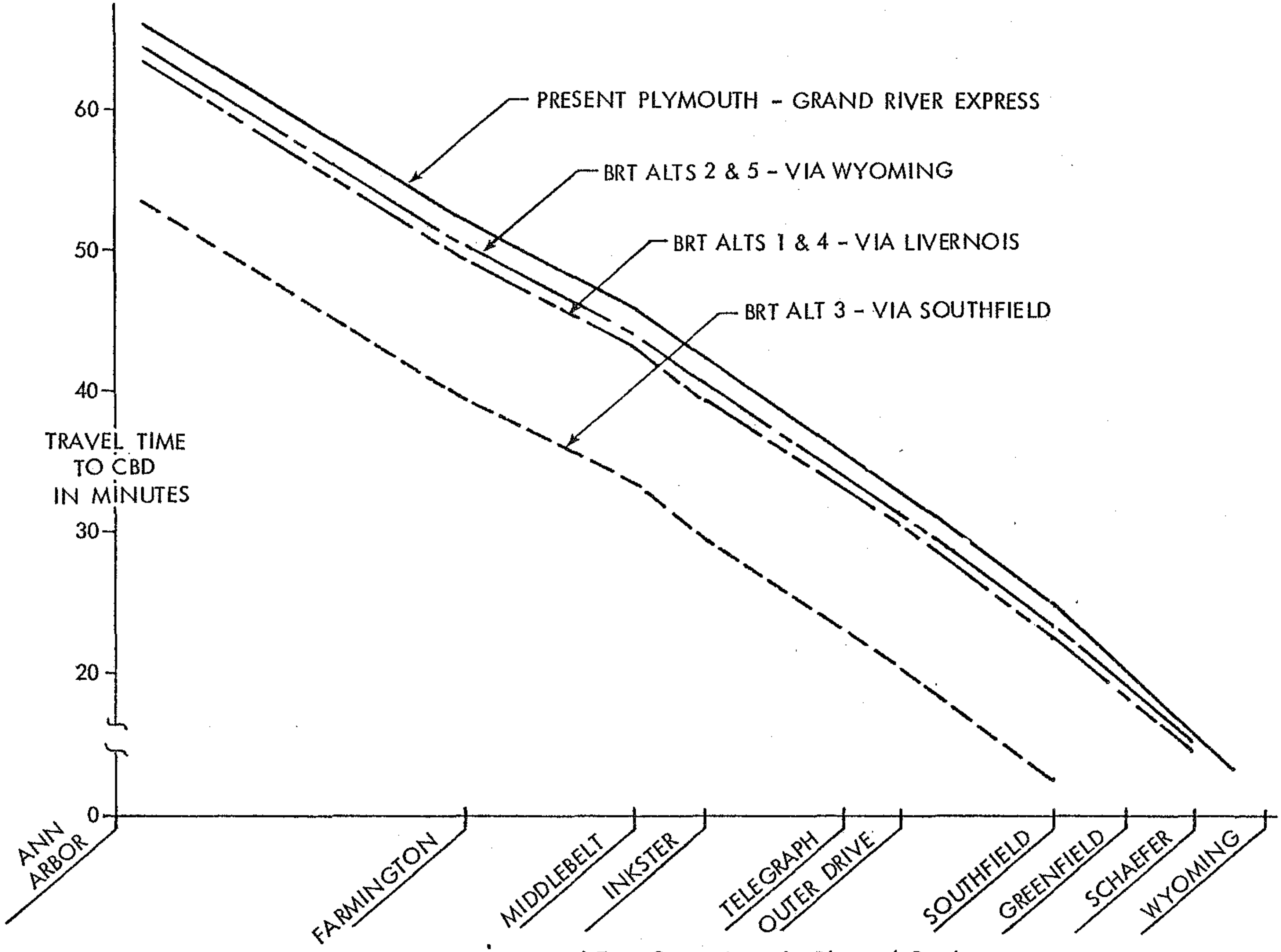


Figure 3-25 Travel Time Comparisons for Plymouth Road

Table 3-19 Summary of BRT Alternatives for Plymouth Road

COLLECTION	LINE HAUL	EVALUATION
BRT Alt 1 - E on Plymouth Rd from Outer Dr or points of origin W of Outer Dr to Livernois	Enters Jeffries line-haul at Livernois	Travel time is 3 minutes less than the present Plymouth-Grand River Express
BRT Alt 2 - E on Plymouth Rd from Outer Dr or points of origin W of Outer Dr to Wyoming	Enter Jeffries line-haul at Wyoming	Travel time is 2 minutes less than the present Plymouth-Grand River Express
BRT Alt 3 E on Plymouth Rd from points of origin W of Outer Dr to Southfield	Enter Southfield at Plymouth Rd, N on Southfield to Jeffries	Travel time is 12-13 minutes less than the present Plymouth-Grand River Express
BRT Alt 4 - E on Plymouth Rd from Southfield to Livernois	Enter Jeffries line-haul at Livernois	Travel time is 3 minutes less than the present Plymouth-Grand River Express
BRT Alt 5 - E on Plymouth Rd from Southfield to Wyoming	Enter Jeffries line-haul at Wyoming	Travel time is 2 minutes less than the present Plymouth-Grand River Express

Table 3-20 Combinations of Alternatives for Plymouth Road, Wyoming Access

CASE	BRT ALTERNATIVES	TRAVEL TIME AS COMPARED TO PRESENT PLYMOUTH-GRAND RIVER EXPRESS
Case I	• Buses start at Outer Drive or points W of Outer Dr & access the Jeffries via Wyoming (Alt 2)	2 minutes less travel time
Case II	• Buses start at origins W of Outer Dr & access the Jeffries via Southfield (Alt 3)	12-13 minutes less travel time
	• Buses start at Outer Dr or points W of Outer Dr & access the Jeffries via Wyoming (Alt 2)	2 minutes less travel time (people between Southfield & Wyoming may see less frequent service)
Case III	• Buses start at origins W of Outer Dr & access the Jeffries via Southfield (Alt 3)	12-13 minutes less travel time
	• Buses start at Outer Dr or points W of Outer Dr & access the Jeffries via Wyoming (Alt 2)	2 minutes less travel time
	• Buses start at Southfield Rd & access the Jeffries via Wyoming (Alt 5)	2 minutes less travel time

Table 3-21 Combinations of Alternatives for Plymouth Road, Livernois Access

CASE	BRT ALTERNATIVES	TRAVEL TIME AS COMPARED TO PRESENT PLYMOUTH-GRAND RIVER EXPRESS
Case I	• Buses start at Outer Dr or points W of Outer Dr and access the Jeffries via Livernois (Alt 1)	3 minutes less travel time
Case II	• Buses start at origins W of Outer Drive & access the Jeffries via Southfield (Alt 3)	12-13 minutes less travel time
	• Buses start at Outer Dr or points W of Outer Dr & access the Jeffries via Livernois (Alt 1)	3 minutes less travel time (People between Southfield & Livernois may see less frequent service)
Case III	• Buses start at origins W of Outer Drive & access the Jeffries via Southfield (Alt 3)	12-13 minutes less travel time
	• Buses start at Outer Dr or points W of Outer Dr & access the Jeffries via Livernois (Alt 1)	3 minutes less travel time
	• Buses start at Southfield Rd and access the Jeffries via Livernois (Alt 4)	3 minutes less travel time

Presently, there are seven Plymouth-Grand River Expresses and 13 Plymouth-Lodge Expresses in the peak period. For the purpose of the demand analysis, it was assumed that all transit passengers which originate within the corridor boundary and are destined to either the CBD or New Center become BRT patrons. If this in fact turns out to be the case, then some Plymouth-Lodge Express bus trips should be eliminated. However, it would not be desirable to significantly increase the headway of the service between Grand River and the John Lodge Expressway which is currently being provided by the Plymouth-Lodge Express.

As with Joy Road, the number of buses which can be diverted to the Jeffries via Southfield will depend upon whether or not one can fill the buses by that point. The demand analysis reported in Section 3.6 suggests that four bus trips in the peak hour and four trips in the remainder of the peak period can be diverted to the Jeffries via the Southfield Freeway. In addition, four bus trips would be started at Southfield to access the Jeffries via Wyoming in the peak hour, and the route would be served by five trips during the remainder of the peak period.

3.3.1.8 Existing DDOT Feeder Service

The frequency of existing local service on the major east-west arterials has been presented in the previous sections. The structure of the BRT collection routes minimizes the utility of these local buses in providing feeder service to the BRT system. However, the local buses operating on north-south streets in Detroit can perform an important feeder function by linking the BRT collection routes. The number of local buses operating on the major north-south streets in the corridor during the morning peak period is summarized in Table 3-22.

3.3.2 Summary of SEMTA Service

The service which is currently being provided by SEMTA in the Oakland County portion of the corridor was analyzed to determine the extent to which existing service can be integrated into the BRT system. Routes which serve the corridor and terminate in the Detroit CBD during the morning peak period were considered for possible integration as BRT collection and line-haul routes. In addition, routes which provide service to Northland during the morning peak period were considered as possible feeders to the BRT system.

A survey of the routes and schedules of existing SEMTA service in the corridor resulted in the identification of three sets of routes which provide service to the Detroit CBD or to Northland Center in the morning peak period. A brief description of these routes along with the number of buses arriving at Northland and the CBD in the morning peak period is presented in Table 3-23.

Table 3-22 Frequency of Local Service on North-South Streets of Detroit

ROUTE NAME	ROUTE NO.	POINT OF ORIGIN IN CORRIDOR	DIRECTION OF TRAVEL	NUMBER OF BUSES LEAVING POINT OF ORIGIN IN A.M. PEAK PERIOD						
				7:00-7:29	7:30-7:59	8:00-8:29	8:30-8:59	9:00-9:29	9:30-10:00	TOTAL
Lahser	None	8 Mile & Evergreen	S	1	2	1	1	1		6
Southfield	46	8 Mile	S		1	1	1	1	1	5
		Grand River	S	1						1
		Joy Road	N	1	2	2	1	1	1	8
Greenfield	22	Northland	S	3	2	3	2	2	2	14
		Fenkell (5 Mile)	S	1						1
		Warren	N	4	3	3	2	2	3	17
Schaefer	41	11 Mile	S	1	1	1	1	1	1	6
		8 Mile	S	1	1	1				3
		Tireman	N	2	2	2	2	2	2	12
Meyers-Northlawn	33	8 Mile & Meyers	S	1	1	1	1	1		5
		Grand River & Oakman	N		1	1	1	1		5
Wyoming	54	8 Mile	S	3	2	2	2	1	1	11
		Tireman	N	3	2	3	2	2	2	14
Livernois	30	8 Mile	S	2	2	2	1	1	1	9
		Tireman	N	3	2	2	2		2	11

Table 3-23 Existing SEMTA Service to Northland and the Detroit CBD

ROUTE DESIGNATION	SERVICE AREA	NUMBER OF BUSES ARRIVING IN A.M. PEAK PERIOD	
		CBD	NORTHLAND
G-1	Pontiac, Birmingham, Royal Oak, & Detroit via Woodward Avenue	8	0
G-2	Birmingham, Northland, Berkley, Royal Oak, & Detroit	7	2
G-3	Northland, Orchard Ridge, & Farmington Hills	1	1

Figure 3-26 shows a schematic of the existing SEMTA routes in the corridor which provide service to the Detroit CBD in the morning peak period. The figure also shows the assumed boundary of the Southfield-Jeffries corridor. Note that all of the routes use Woodward Avenue for the line-haul portion of the trip. As a result of using Woodward Avenue, substantial portions of the routes are outside the corridor. In addition, SEMTA buses operate in a quasi-express mode serving numerous potential intermediate destinations along Woodward from Birmingham to the Detroit CBD. For these reasons, it is recommended that the service on these routes be continued and that BRT collection routes be initiated as new service in the corridor. The proposed structure of this new service is described in Section 3.4.3.

The SEMTA routes which currently provide morning peak period service to Northland Center are shown schematically in Figure 3-27. Service from Birmingham to Northland is also provided by Route G-3, shown in Figure 3-26. Although this service appears to cover a significant part of the corridor, very few buses (namely, three) are scheduled on these routes during the morning peak period. The existing service cannot be considered to be a significant base upon which to design a feeder service for the BRT system. Therefore, although the existing service can be used to access the BRT system, it was not considered in the analysis of feeder system requirements for the BRT system. The feeder system proposed for Oakland County is described in Section 3.4.3.

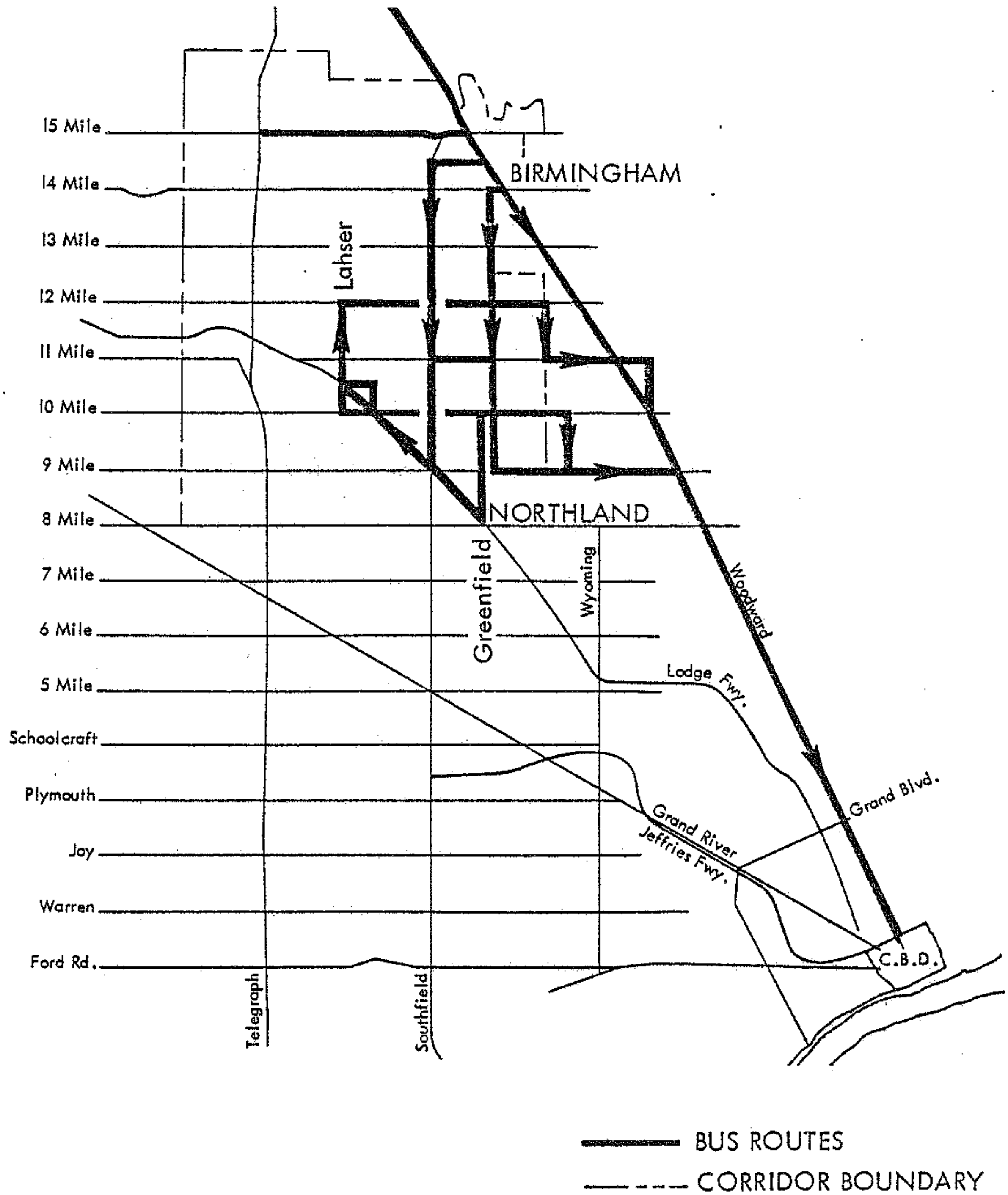


Figure 3-26 SEMTA Routes Serving Detroit in the Morning Peak Period

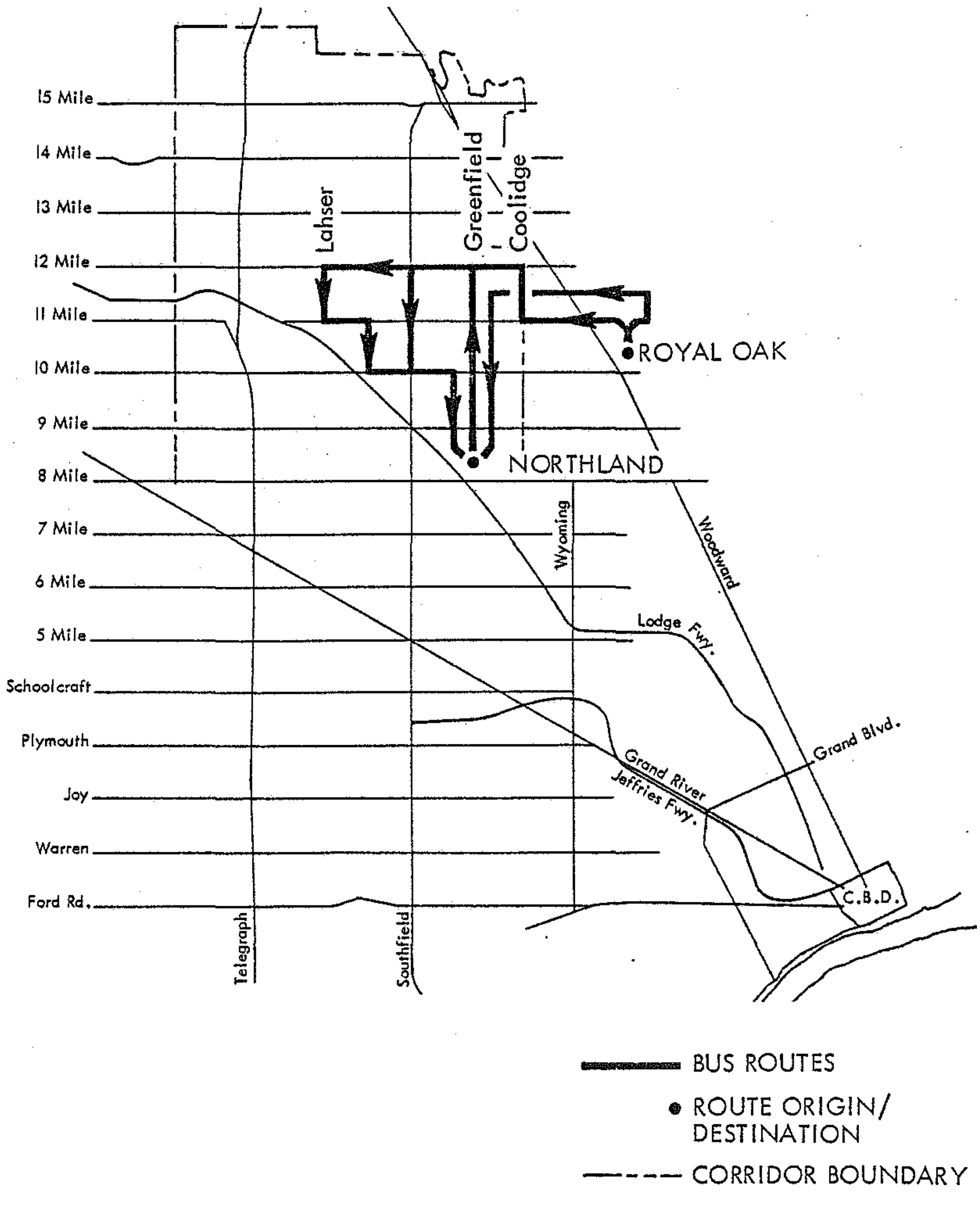


Figure 3-27 SEMTA Routes Serving Northland in the Morning Peak Period

3.4 BRT System Synthesis

The purpose of this section is to describe the service options and the BRT system design alternatives which were considered in the evolutionary development of the proposed BRT system. The rationale which supports the recommended BRT collection routes in Detroit was described in detail in the previous section. A review of that route structure is presented in this section. Then, the considerations leading to the proposed BRT collection routes and feeder system in Oakland County are delineated. The rationale for the recommentation of fixed-route feeder service in Stage II rather than dial-a-bus service as proposed in Stage I is presented. The importance of the Wyoming transfer station to the BRT concept is discussed. Two New Center service alternatives were considered during the course of the BRT system design. The trade-off between shuttle service to the New Center and direct service including New Center collection service is evaluated. Then, changes in the CBD and New Center distribution routes from those proposed in Stage I are described. Finally, the need for off-peak BRT service is discussed, and the proposed off-peak service policy is presented.

3.4.1 BRT Collection in Detroit

The structure of the peak-period BRT collection routes in Detroit has been presented in detail in the previous section. In summary, collection routes operate on all of the mile roads in Detroit plus Grand River and West Chicago. As illustrated in Figure 3-28, all of the routes which start west of Southfield except the Eight Mile and West Chicago routes use the Southfield Freeway to access the Jeffries Freeway. The Eight Mile Road buses take the Lodge Freeway to Wyoming and access the Jeffries at Wyoming. The West Chicago buses continue past Southfield to Wyoming and then run north on Wyoming to the Jeffries. Although these routes may actually start at the various starting points of existing express bus service, for the purposes of demand analysis, system sizing, and cost estimating, it is assumed that they all start at the Detroit City Limits, the western boundary of the corridor. Complementing these routes in Detroit are additional BRT collection routes which start at Southfield, run east to Wyoming, and finally access the Jeffries at Wyoming. These routes are illustrated in Figure 3-29. The Oakland County routes shown in this figure are discussed later in this section.

All of the BRT buses on these collection routes stop at the Wyoming transfer station to drop off New Center passengers before entering the Jeffries reserved lane for the express line haul trip to the CBD. Frequent service to the New Center is provided by New Center shuttle buses which operate between the Wyoming transfer station and the New Center.

3.4.2 Park-and-Ride in Detroit

Currently, there are no formalized park-and-ride facilities coordinated with the present express bus service in Detroit. Potential park-and-ride sites within the Southfield/Jeffries

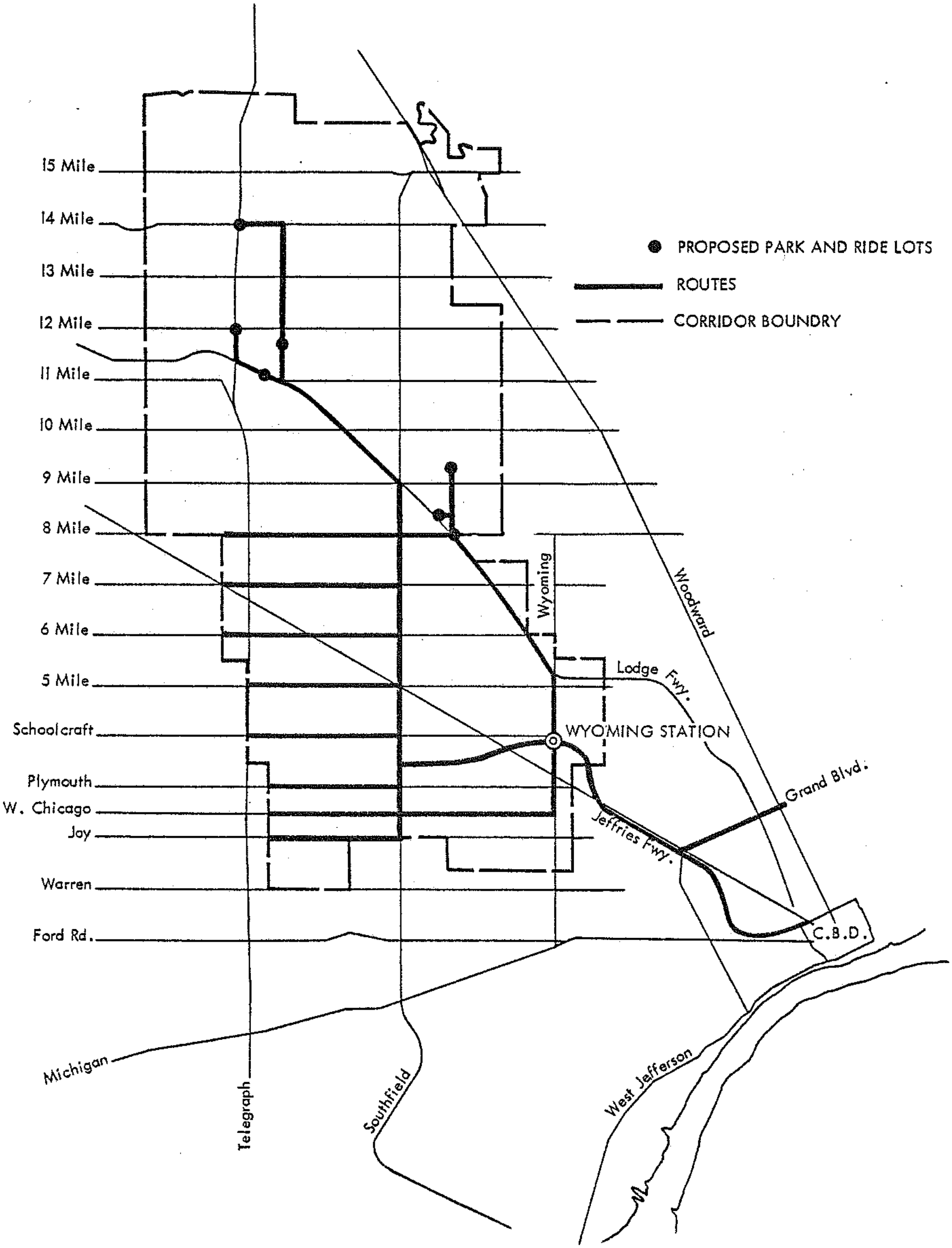


Figure 3-28 BRT Routes - Oakland County and Detroit, West of Southfield

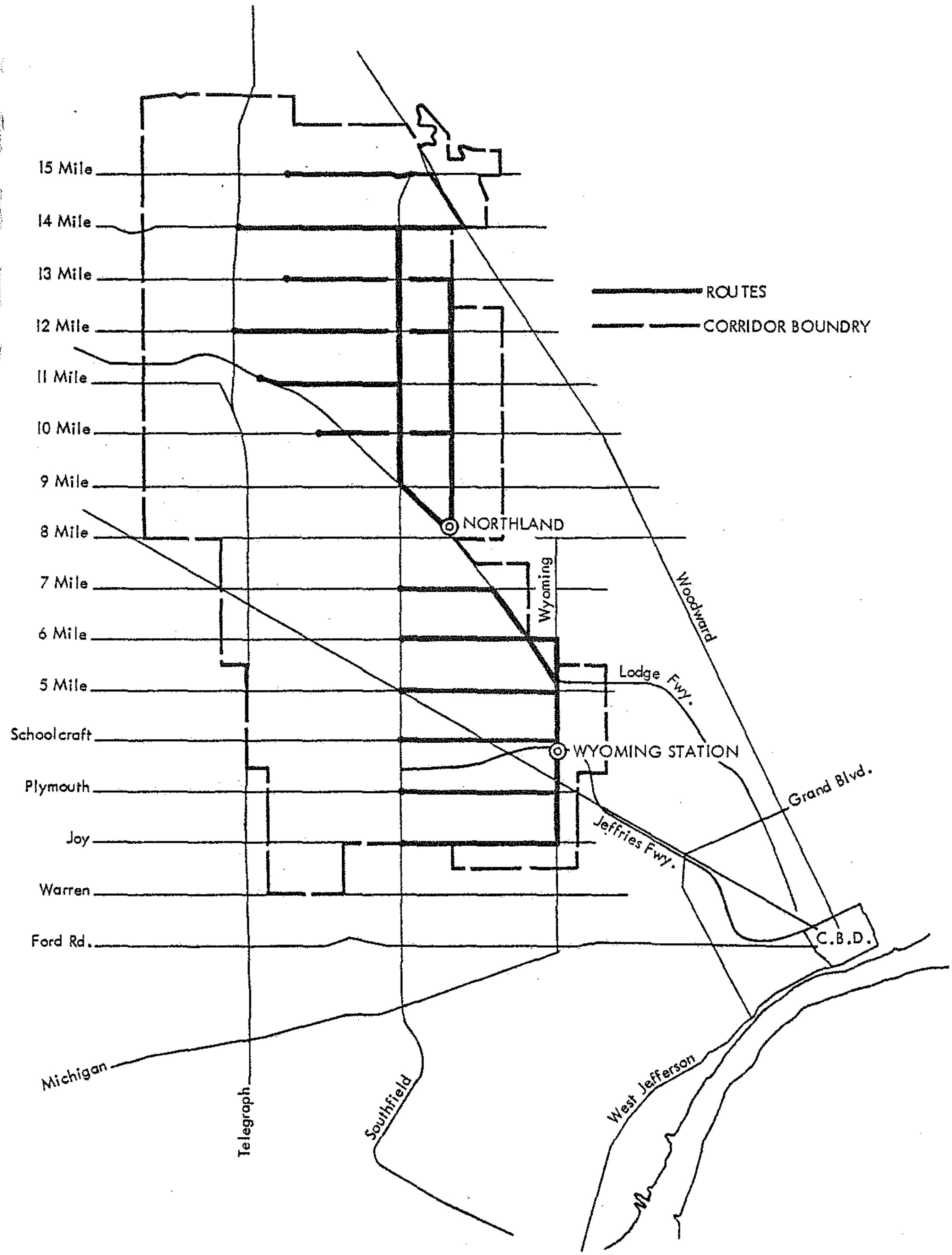


Figure 3-29 BRT Routes - Oakland County Feeder and Detroit Collection, East of Southfield

corridor were identified and surveyed as to suitability (but not availability) by SEMTA, et al, in their earlier work on the Jeffries reserved lane project.[1]

Due to the relatively close spacing of BRT collection routes and the availability of adequate feeder service in Detroit, neither the availability of nor the demand for park-and-ride facilities within Detroit have been addressed in this study. However, the effect of park-and-ride service in Detroit on BRT demand should be evaluated in subsequent detailed design of BRT operations. If warranted, park-and-ride facilities could be located along the collection routes near the line-haul access points. It is expected that park-and-ride lots so located would have little effect on the structure of BRT collection routes in Detroit.

3.4.3 Park-and-Ride in Oakland County

Because of the high rate of auto ownership and the apparent lack of transit orientation among Oakland County residents, BRT passengers who originate in this part of the corridor will probably access the system by the most time-efficient mode available. Therefore, it is expected that most Oakland County patrons will access the BRT system by automobile at designated park-and-ride facilities. Automobile access includes park-and-ride, kiss-and-ride, and carpool-and-ride.

A list of existing parking lots in Oakland County which offer some potential for use as park-and-ride facilities was presented in the Jeffries report published by SEMTA.[1] From these and other potential sites identified as part of this study, seven lots were selected as BRT park-and-ride facilities. The location of these lots and the number of spaces which are assumed to be allocated to park-and-ride are listed in Table 3-24. In general, it was assumed that the following proportions of available parking spaces can be negotiated for park-and-ride use: church/synagogue (50 percent), shopping center (5 percent), theater (no matinee) (50 percent).

The availability of spaces at these particular parking lots has not been formally established, nor has the maneuverability of buses in and around the lots been determined. In fact, subsequent discussions with SEMTA staff have revealed that both Tel-Twelve Mall and Green-8 Shopping Center are probably unsuitable for park-and-ride use due to a lack of available spaces and a lot configuration which limits bus maneuverability. On the other hand, SEMTA indicated that a parcel of state-owned land at Lahser and Northwestern Highway is currently being prepared to serve as a 200-space SEMTA park-and-ride lot. In addition, SEMTA has already negotiated a park-and-ride agreement with St. Ives Church (Lahser, north of Twelve Mile) for the use of 200 spaces. SEMTA also indicated that park-and-ride spaces at Northland Center may not be available. While Northland is not an essential BRT park-and-ride facility, it is highly desirable, and every effort should be employed in securing a park-and-ride agreement with Northland Center. Northland is situated in a prime location in the southeast corner of the Oakland County portion of the corridor, and it is a natural terminal for the BRT feeder system in Oakland

[1] "Feasibility Study of Reserved Bus-Carpool Lanes for Jeffries Freeway (I-96)," Michigan State Highway Commission; Southeastern Michigan Transportation Authority; City of Detroit, Department of Transportation; and Southeast Michigan Council of Governments; June 1975.

Table 3-24 Selected Park-and-Ride Sites in Oakland County

LOCATION	PARKING SPACES (Estimated)	PARK-AND-RIDE LOTS (Estimated)	LIGHTING	OWNER
Fourteen Mile, Telegraph	600	300	yes	Temple Beth El
Twelve Mile, Telegraph	5,000	200	yes	Tel-Twelve Mall
Lahser, south of Twelve Mile	375	200	yes	Highland Park Baptist
Eleven Mile, west of Lahser	400	200	yes	Congregation Shaarey Zedek
Providence Drive, Greenfield	800	400	yes	Americana Theater
Eight Mile, Greenfield	1,500	100	yes	Green-8 Shopping Center
Eight Mile, Greenfield	10,000	500	yes	Northland Center
TOTAL		1,900		

County. In addition, Northland is the proposed northern terminus of the Greenfield Intermediate Service described in Section 4.0 of this report.

The park-and-ride lots listed in Table 3-24 were selected primarily to illustrate the proposed BRT collection concept in Oakland County. Although these specific lot locations are assumed to be BRT access points in the demand analysis and are used for bus mileage and operating time calculations in the cost analysis, the BRT concept does not depend on the availability of these particular lots. Other facilities can be substituted with no change in the BRT concept and probably little change in overall system sizing and cost estimates.

An analysis of preliminary demand data indicated that in order to maintain relatively short headways during the peak period, BRT collection routes should be structured so that each one serves at least two park-and-ride lots. Figure 3-28 shows the proposed BRT collection and line-haul routes designed to serve the selected park-and-ride lots in Oakland County. One of the four routes starts at Temple Beth El (Fourteen Mile and Telegraph), runs east on Fourteen Mile to Lahser, and then proceeds south on Lahser to the Highland Park Baptist Church (Lahser, south of Twelve Mile). After serving the second park-and-ride lot, the collection bus continues south on Lahser, follows Northwestern Highway to Southfield, runs south on Southfield Freeway to the Jeffries, and then takes the Jeffries to the CBD, making an intermediate stop at the Wyoming transfer station. The buses on this route operate in a local collection mode on surface streets before starting the line-haul portion of the trip at Northwestern Highway. A second route begins at Tel-Twelve Mall, runs south on Telegraph to Eleven Mile, then proceeds in an easterly direction on Eleven Mile to Congregation Shaarey Zedek. After serving the second park-and-ride lot, the route runs east on Eleven Mile to Lahser, enters Northwestern Highway, and then follows the previously described route to the Detroit CBD, also making an intermediate stop at the Wyoming transfer station. A third BRT collection route starts at the Americana Theater (Greenfield and Providence Drive), runs south on Greenfield to Eight Mile where it serves Green-8 Shopping Center, proceeds west on Eight Mile to Southfield, then follows the Southfield-Jeffries route to the CBD with an intermediate stop at Wyoming. The fourth route provides direct service to the Wyoming station and the CBD from Northland via Eight Mile, Southfield, and Jeffries. The estimated BRT demand accessing the system at Northland is sufficient to support direct service because Northland is assumed to be both the largest park-and-ride facility in the corridor and the transfer point between Oakland County feeders and the BRT system.

The Lodge Freeway to Wyoming to the Jeffries Freeway represents a viable alternative route for BRT buses which originate in Oakland County, since the Lodge is generally not heavily congested north of Wyoming. Bus travel times between Northland and the Wyoming station and between the intersection of Northwestern Highway and Southfield and the Wyoming station were estimated for the proposed BRT routes using Southfield and the alternative route using the Lodge Freeway. Comparison of estimated travel times from Northland indicates that the alternative route using the Lodge Freeway results in a potential travel time saving of about 3 minutes. Comparison of estimated travel times from Northwestern Highway and Southfield indicates that both routes result in about the same travel time. A disadvantage of selecting the Lodge Freeway route over the Southfield route is that fewer BRT vehicles would use the Jeffries reserved bus lane between Southfield and Wyoming. This reduced bus usage may lead to a more severe enforcement problem. Although for the purposes of this study the Southfield route is assumed to be the BRT line-haul route from Oakland County, the final choice can be made later after the Jeffries has been opened to Southfield and traffic has reacted by approaching its new equilibrium point.

In what may be considered a prelude to the BRT system, SEMTA is planning to initiate park-and-ride service from Oakland County to the Detroit CBD on April 26, 1976. The new service will include two routes. The first route starts at Orchard Mall, runs southeast on Northwestern Highway to the new state-owned park-and-ride facility near Lahser and Northwestern Highway, then continues southeast on Northwestern Highway to the Lodge to Wyoming to the Jeffries, and finally to the CBD. The second route starts at Maple and Lahser, runs south on Lahser to St. Ives Church (where 200 park-and-ride spaces have been allocated), serves another park-and-ride lot (Travelers Tower), then enters Northwestern Highway at Ten Mile Road and follows the same route to the CBD as the first new route. When the Jeffries Freeway is opened to Southfield, these new routes can use Southfield to access the Jeffries if travel time can be improved.

3.4.4 Feeder System in Oakland County

As indicated above, park-and-ride is expected to be the dominant BRT access mode in Oakland County. However, this mode of access assumes the availability of an automobile. Since the concept of a transit system which is designed to provide service only to those who have automobiles available to access the system is not socially sound, it is considered necessary to provide a feeder system in Oakland County even though the system may not be justified on the basis of demand alone.

Consideration of the anticipated light demand for the Oakland County feeder system and the practical requirement that the transfer to a BRT line-haul vehicle be relatively quick and convenient leads to the conclusion that the feeder system should be focused on a single transfer point. In this way, the feeder demand is concentrated, and the transfer point can be served with a maximum number of BRT line-haul buses, thus reducing the average headway and the average transfer time. Since Northland Center is the largest potential park-and-ride facility and is conveniently located in the southeastern corner of the Oakland County portion of the corridor, it is the natural choice for the transfer point. Therefore, a local bus system focused on Northland was postulated to feed the BRT system. If park-and-ride spaces are not available at Northland, it may be desirable to designate another location as the feeder system transfer point or to configure a BRT collection route which links a major park-and-ride facility with the feeder bus terminal at Northland. The postulated feeder system consisted of routes running across the corridor on each of the east-west "mile" roads and then south using both Southfield and Greenfield to access Northland--the assumed transfer point.

In order to evaluate the postulated feeder system, the potential demand for the system as a feeder service to the BRT was estimated. First, submodal split estimates were made for each zone in the Oakland County portion of the corridor as described in Section 3.6. Based on these submodal split estimates and the Stage I BRT demand estimates, the potential feeder system demand for each zone was estimated. The demand for each zone was then assigned to one or more feeder routes to indicate potential load profiles. The analysis revealed that a large part of the potential feeder demand is produced in zones along Greenfield Road and that almost none is produced in zones west of Lahser. As a result, the postulated feeder system was modified by moving the starting point of all of the routes to Lahser except those on Fourteen Mile and Twelve Mile Roads, which are extended to Telegraph to interface with park-and-ride lots. Due to the difficulty of maneuvering a transit coach on residential streets, it may not be possible to implement a feeder route on Fourteen Mile Road. If this is the case, the potential park-and-ride lot at Fourteen Mile and Telegraph could be served by extending the Thirteen Mile Road route north on Lahser and then west on Fourteen Mile to Telegraph. The estimated load profiles also revealed that very little potential feeder system demand exists for the Nine Mile Road route. Therefore, this route was deleted.

The feeder system for Oakland County which is proposed on the basis of the foregoing analysis is shown schematically in Figure 3-29. The feeder system will not only serve the BRT system, but it will also serve the Greenfield Intermediate Service which operates between Northland and Fairlane. Based on the demand analysis performed during Stage II, the estimated peak-period demand for each feeder route (including demand for Greenfield Intermediate Service as well as for BRT service) is tabulated in Table 3-25. Also listed in the table is the number of buses required in the peak period to provide a policy headway of about 22 minutes on each route.

Table 3-25 Estimated Peak-Period Demand for Oakland County Feeder System

ROUTE	PEAK-PERIOD DEMAND	NUMBER OF BUSES REQUIRED
Fifteen Mile	233	4
Fourteen Mile	98	3
Thirteen Mile	216	3
Twelve Mile	263	3
Eleven Mile	71	2
Ten Mile	119	2
TOTAL	1000	17

In Stage I a dial-a-ride (DAR) system was proposed to provide feeder service in Oakland County. This recommendation was based on an analysis of fixed-route and DAR feeder service in areas of low demand density which was presented in the Phase I report.[1] According to that analysis, DAR represents a lower cost feeder alternative for this area than a fixed-route alternative operating at 12-minute headways on a one-mile grid. This

[1] "Michigan Bus Rapid Transit Demonstration Program, Phase I, Final Report," GM TSD, Report No. EP-750012, May 1975.

high level of service is the same as that originally proposed for suburban feeder service in the Regional 1990 Transit Plan. However, it is not obvious that this high level of feeder service can be justified in an area which is characterized by an apparent lack of transit dependence and absence of potential feeder system demand. Therefore, the limited fixed-route feeder system, which requires 17 buses in the peak period, is recommended in lieu of the more pervasive DAR system, which requires 30 buses as indicated in Section 4.5.2 in the Stage I section of this report.

3.4.5. Wyoming Transfer Station

The Wyoming transfer station is a vital element in the BRT system concept. It performs two important system functions. First, it provides access from Wyoming to the reserved bus lane on the Jeffries Freeway for more than half of the BRT vehicles in the system. Second, it provides the flexibility necessary to serve the New Center area with high quality BRT service. As indicated earlier in this report, the demand for the New Center, although significant, is much lower than the demand for the CBD. The transfer facility at Wyoming provides New Center patrons with the opportunity to access the BRT system using CBD collection buses which operate at much closer headways than the headways at which direct New Center collection buses could operate. Since New Center demand is concentrated at one point, the number of New Center-bound buses which serve the transfer station can be maximized without sacrificing average load factors on New Center buses.

The design concept of the station is described in detail in Section 3.5. In general, the station is a relatively well-isolated structure located at surface street grade over the median of the Jeffries Freeway with bus only access ramps to and from the Service Drives and the Jeffries reserved bus lanes. There are several distinct advantages associated with this configuration — not the least of which is the strong public image which can be associated with the structure to enhance the transit identity of the Jeffries exclusive bus lane and the entire BRT system. The fact that the bus ramps between the station and the Jeffries reserved lanes are isolated from automobile traffic on Wyoming eliminates potential BRT delays and minimizes interference to automobile traffic by buses. Finally, the location of the station away from the automobile access ramps and the strong transit identity of the station discourages use of the exclusive entrance ramps by non-BRT vehicles.

3.4.6 Alternative New Center Service

Two alternative types of New Center service were evaluated during the BRT system design process. The first type, direct New Center service, is similar to the concept proposed in Stage I. New Center collection and line-haul buses operate on the same routes and in parallel with the CBD service, providing direct, no-transfer service to the New Center. Since the New Center demand is not as great as the CBD demand, the New Center collection buses must operate at significantly longer headways than the CBD buses. However, since all buses have access to the Wyoming station, New Center patrons have the option of accessing the system on a CBD collection bus and then transfering to a New Center bus at Wyoming. If all direct New Center buses make an intermediate stop at the Wyoming station, the headway for New Center service, and therefore the average transfer time, is minimized. The advantage of this service concept is that no-transfer service is provided to New Center patrons who wish to take advantage of it.

In the second type of New Center service that was considered, all New Center passengers transfer to New Center shuttle buses, which operate only between the Wyoming station and the New Center. All BRT collection buses make an intermediate stop at the Wyoming transfer station and then proceed to the CBD. The disadvantages of this alternative are that no direct, no-transfer service to the New Center is provided, and that all BRT trips to the CBD are required to make one stop en route, i.e., the Wyoming transfer station. However, the alternative has several advantages. First, all BRT collection buses have the same ultimate destination, thus eliminating any potential confusion by passengers. Second, the dead-head time of New Center buses is substantially reduced. The third and most important advantage of this alternative is that peak-period service comparable to that provided by the first alternative (except for the required transfer) can be provided, with a saving of nearly 10 percent in the number of buses required and a saving of about 5 percent in the number of bus operating hours and operating miles per day. Therefore, the second alternative, utilizing the New Center shuttle, is proposed for the BRT system.

3.4.7 CBD and New Center Distribution

As originally conceived, both the CBD and New Center distribution networks were configured as closed loops, with buses operating in exclusive lanes around the loop. For most of the route miles, the buses were to operate contraflow on one-way streets. Representatives of the Detroit Department of Transportation (DDOT), when asked to comment on these planned implementations, expressed opposition to the recommended contraflow treatments. The DDOT representatives stated that traffic moves freely in both locations and that the BRT vehicles can operate free-flow in mixed traffic without sacrificing scheduling schedule reliability or average vehicle speed.

Several times runs were made over each of the distribution routes to verify these observations. These runs were made by auto during the hours of peak transit demand, 7:30 to 8:30 a.m. and 4:00 to 5:00 p.m. Because these timed runs were made by auto, not bus, care was taken to drive purposely slowly to simulate bus travel times. The results of these runs are summarized in Table 3-26 and 3-27. These runs indicated that the contraflow treatments were, in fact, unnecessary, and suitable speed and schedule reliability can be achieved by running free-flow with mixed traffic.

Except for the direction of travel around the loop, the basic CBD distribution route has not been altered from the Stage I recommendation. The BRT vehicles enter the loop by proceeding down Grand River after exiting the Fisher Freeway via the exclusive bus ramp at Third Street. The buses proceed along Grand River, making stops as indicated in Figure 3-30. At Madison, the buses turn east on Madison for two blocks and then south on Beaubien. At the Beaubien/Congress intersection, the buses turn west onto Congress and travel west on Congress to Cass. The final link of the loop is along Cass north to

Table 3-26 Times Runs on Modified CBD Distribution Route

DATE	TIME	AVG. SPEED	COMMENTS
12/2/75	4:10:00–4:20:00 10 min	12 mi/h	Traffic light – Streets dry – Driving slowly
12/3/75	7:33:30–7:42:40 9 min 10 s	13.1 mi/h	Traffic light – Streets dry – Driving slowly
12/3/75	4:06:30–4:18:30 12 min	10 mi/h	Traffic moderate – Streets dry – driving slowly – Beaubien, Congress, & Cass lights synchronized
12/3/75	4:18:30–4:28:20 9 min 50 s	12.2 mi/h	
12/3/75	4:28:20–4:39:00 10 min 40 s	11.3 mi/h	
12/4/75	7:52:40–8:02:20 9 min 40 s	12.4 mi/h	Overcast – Streets wet, not slippery traffic light on Beaubien and Cass, moderate on Congress and Grand River
12/4/75	8:02:30–8:12:30 10 min	12 mi/h	Congress to Cass very sharp corner for buses
12/4/75	8:12:30–8:24:20 11 min 50 s	10.1 mi/h	Autos queuing to enter parking lot on Congress east of Cass
1/14/76	4:22:40–4:35:40 13 min	9.2 mi/h	7 in of snow on 1/13/76. Some snow on streets but not enough to hinder travel Followed semi-trailer on Grand River, Beaubien and Congress to Brush.
1/14/76	4:35:40–4:46:10 10 min 30 s	11.4 mi/h	Most heavily traveled link on the route appears to be on Congress.
1/14/76	4:47:00–4:59:10 12 min 10 s	9.9 mi/h	Used Washington Boulevard instead of Cass to northbound line. Auto triple parked in front of Sheraton Cadillac Hotel – this was a bottleneck

Table 3-27 Timed Runs on New Center Distribution Route

DATE	TIME	AVG. SPEED	COMMENTS
12/2/75	4:25:20-4:38:20 13 min	18.5 mi/h	Traffic light - roads dry - driving slowly
12/2/75	4:38:20-4:53:20 15 min	16 mi/h	Passed by bus on John R.
12/3/75	7:54:10-8:07:50 13 min 40 s	17.6 mi/h	Traffic light - roads dry - driving slowly
12/3/75	4:49:50-5:02:00 12 min 10 s	19.7 mi/h	Traffic light except for John R which was moderate
12/3/75	5:02;00-5:16:00 14 min	17.1 mi/h	Traffic moderate — no delays
12/4/75	8:33:20-8:46:20 13 min	18.5 mi/h	Followed bus down John R. It took 5 minutes to travel length of John R. Alexandrine and Second very light.

Grand River. Before the Third Street ramp is completed, BRT vehicles will enter/exit the CBD loop via Michigan Avenue. Only one temporary addition to the route is necessary to accommodate the Michigan Avenue entry point. A link is added on Park Place between Michigan Avenue and Grand River.

Figure 3-31 shows the areas served by the CBD distribution loop. Each large circle on the figure represents a 1000-foot radius circle circumscribed around each proposed BRT stop. The route was configured to provide service to the areas of largest predicted demand. As the demand in the CBD shifts, for example, when the Renaissance Center opens, the route will be restructured to meet the new demand.

Assuming an average bus speed of 8 miles per hour, 15 minutes are required to complete one circuit of the 2-mile loop.

The New Center distribution route was altered somewhat from the route defined in Stage I and reported in Section 4.2.1. The BRT vehicles now travel along the route free-flow with mixed traffic, not contraflow. As illustrated in Figure 3-32, one link of the loop was re-routed from John R to Cass in order to serve the areas of peak demand more quickly. That is, Wayne State passengers are not required to ride around approximately 75 percent of the route before exiting. The new Wayne State stop is approximately 25 percent into the route. All major New Center destinations are served by the time the Medical Center stop is completed.

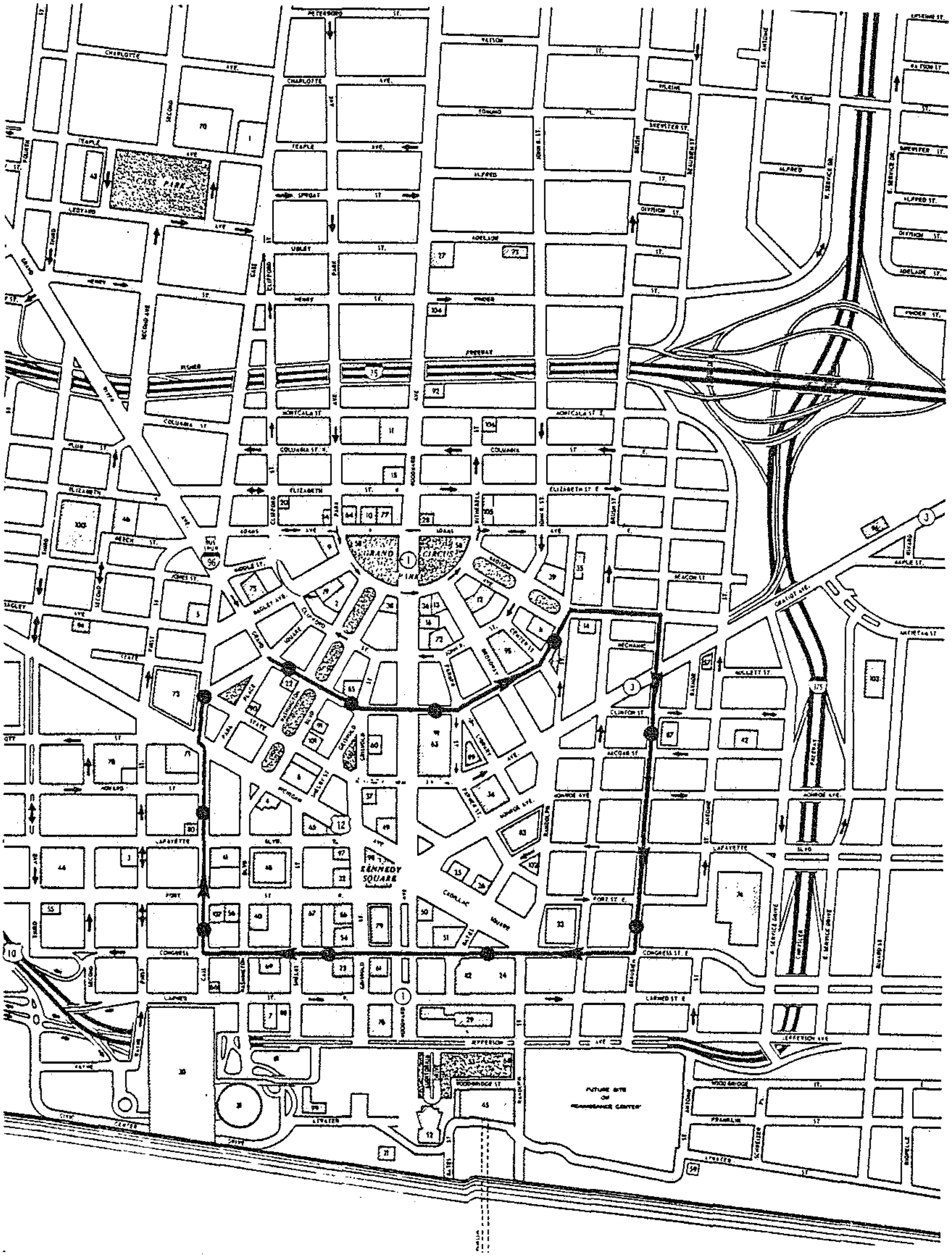


Figure 3-30 CBD Distribution Loop

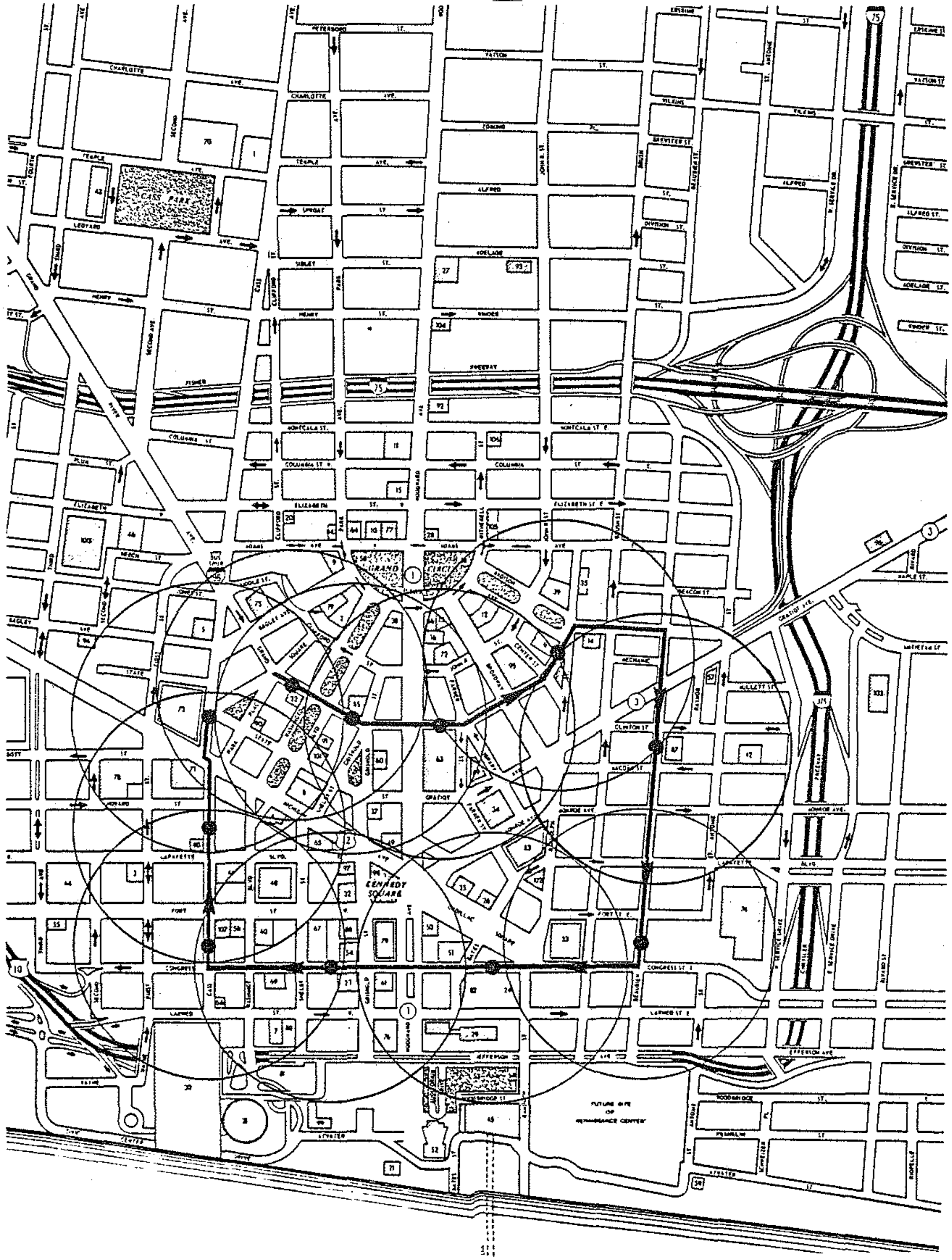


Figure 3-31 Area Coverage of CBD Distribution Loop

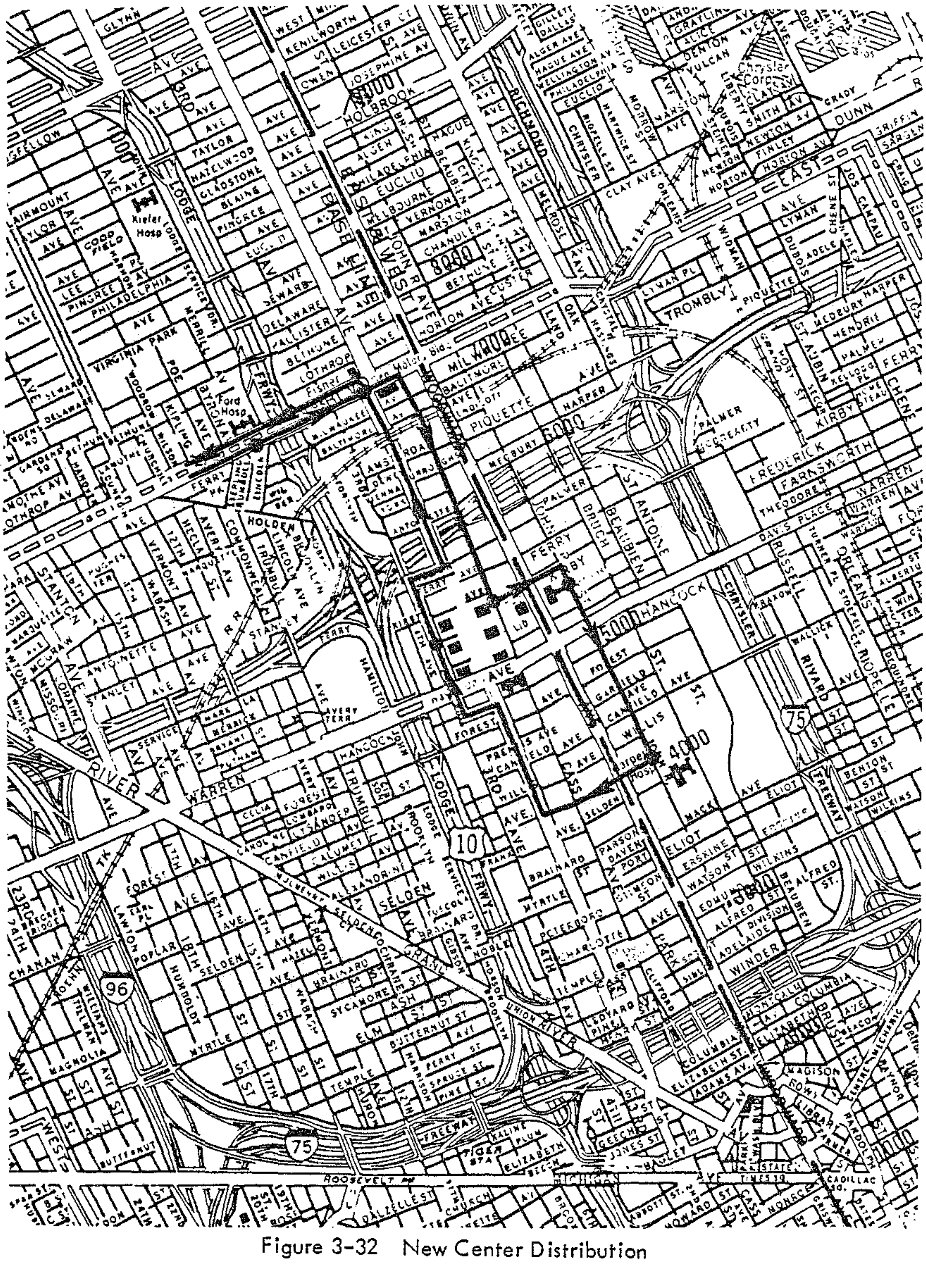


Figure 3-32 New Center Distribution

The new distribution route is structured as follows: New Center shuttle buses exit the exclusive lanes at the Scotten bus ramp and proceed east on Grand Boulevard, stopping at Ford Hospital. The next stop is at Second Avenue on Grand Boulevard to serve the Fisher and General Motors Buildings. The buses then turn south on Cass and stop at Kirby to serve Wayne State. After the Wayne State stop, the buses turn east on Kirby (which is made one-way east-bound between Cass and Woodward) to John R, where they turn south onto John R, stopping at the Cultural Center. The buses then proceed south on John R to Alexandrine where they stop to serve the Medical Center. For the return trip to Grand Boulevard, the buses turn north from Alexandrine onto Second. If demand is sufficient, another stop will be made at Wayne State. The buses turn west onto Grand Boulevard to return to the Jeffries. In the evening, the stops at Ford Hospital and the Fisher Building will be made on the north side of Grand Boulevard.

Timed runs were made during the peak periods over the modified New Center distribution loop. The results are provided in Table 3-28. The route, without stops, takes approximately 7 minutes to traverse from the Fisher Building to the Medical Center.

If necessary, new major trip attractors in the New Center area could be provided service with minor changes in route layout.

It would take approximately 10 minutes to travel from the Ford Hospital stop to the Medical Center stop on the route. Assuming an average bus speed of 10 miles per hour, approximately 25 minutes is required to complete the 4.1-mile loop.

3.4.8 Off-Peak Service Policy

An important part of the BRT system and of its ultimate acceptance by the commuting public is the existence of adequate transit alternatives for persons who must return to their points of origin in the corridor during the business day or after the evening peak period. As indicated in Section 4.5.4 in the Stage I portion of this report, the corridor is well-served by existing DDOT local buses and by the Imperial Express during the day between the peak periods. Since the Imperial Express has already been recommended for integration into the BRT system during peak periods, it is recommended that a modified Imperial Express route be used to provide off-peak BRT service. The modified route starts in the CBD, follows the CBD distribution route, runs to the Wyoming station via the Fisher and Jeffries Freeways, runs north on Wyoming to James Couzens, northwest on James Couzens to Northland, then south on Greenfield to Seven Mile, and finally west on Seven Mile Road to Five Points, the western boundary of the corridor. The inbound trip would follow the same route, including the deviation to Northland. Local buses on Plymouth, West Chicago, and Joy Roads provide off-peak service from the CBD to the part of the corridor south of the Jeffries Freeway. It is also recommended that the New Center shuttle be operated during the off-peak period.

Based on ride checks conducted by DDOT, the average off-peak ridership on the current Imperial Express is estimated to be 125 passengers per hour. Since this demand easily supports the 30-minute headway that is currently provided, it is assumed that the additional New Center demand (especially to Wayne State University) will be sufficient to justify a headway of approximately 20 minutes for the modified Imperial Express during the mid-day period. Only three Modified Imperial Express buses are assumed to leave the CBD in the post-peak period from 6:00 to 8:00 p.m.

Off-peak New Center shuttle service is assumed to operate on 30-minute headways during the mid-day period and 40-minute headways during the post-peak period from 6:00 to 8:00 p.m. The local service currently provided in Detroit by DDOT provides adequate feeder service during off-peak periods. In Oakland County, it is recommended that the feeder system proposed for the peak periods be operated during the off-peak periods (between the peak periods and for two hours after the evening peak) but at somewhat longer headway (30 to 40 minutes) for economy. This feeder system serves not only the off-peak BRT system but also the Greenfield Intermediate Service.

Table 3-28 Timed Runs on Modified New Center Distribution Route

DATE	TIME	AVG. SPEED	COMMENTS
1/22/76	8:05:40–8:18:40 13 min	19 mi/h	Roads wet – some snow had fallen
1/22/76	8:18:40–8:35:00 16 min 20 s	15 mi/h	Followed bus down Cass making same stops as bus. This increased travel time.
1/22/76	8:35:00–8:49:00 14 min	17.7 mi/h	Reached Medical Center at Alexandrine at 8:42:00 – 7 minutes
1/22/76	4:00:10–4:14:40 14 min 30 s	17 mi/h	Medical Center at 4:07:10
1/22/76	4:14:40–4:30:10 15 min 30 s	15.9 mi/h	Medical Center at 4:22:30
1/22/76	4:30:10–4:43:50 12 min 40 s	18 mi/h	Medical Center at 4:36:20
1/22/76	4:43:50–4:59:00 15 min 10 s	16.2 mi/h	Medical Center at 4:52:40 Entrance to Kirby congested. Traffic heavy on John R.

3.5 Physical Design

During the physical design effort of the BRT program, the freeway lane on the Jeffries to be dedicated to exclusive use by BRT vehicles was selected, and exclusive access facilities for BRT vehicles were studied. Several of the proposed capital improvements for the BRT system were designated the responsibility of the Michigan Department of State Highways and Transportation. The Michigan Department of State Highways and Transportation effort will be discussed in detail later in this section of the report.

3.5.1 Davison Bottleneck

East of the Wyoming overpass at the junction with Davison, the transition between the dual-dual and single-dual sections of the Jeffries occurs. The outer dual roadways in this transition section are only two lanes wide. These sections of roadway are too narrow to allow one lane to be dedicated for exclusive use by BRT vehicles. Only one lane would remain for use by other traffic.

On the other hand, the inner dual roadways in this section are a full three lanes throughout. The inner dual roadways are not presently in use. No weaving would be required of the BRT vehicles to make the transition from the median lanes of the inner duals to the median lanes of the single duals. For these reasons, the median lanes of the inner dual roadways and the median lanes of the single dual roadways were selected for exclusive use by BRT vehicles.

3.5.2 Exclusive Access Ramps

A consequence of using the inner dual roadways is the need for exclusive bus ramps at all BRT access points. Initially, it was felt that exclusive BRT access ramps to the exclusive median lanes from the following overpasses would be desirable:

- Greenfield
- Schaefer
- Wyoming
- Livernois
- Scotten/Grand Boulevard

Ramps would be constructed on both sides of the overpasses to allow BRT vehicles on the Jeffries Freeway to make intermediate stops and to provide entrance/exit capability to the exclusive BRT lanes from the above-mentioned streets. However, as the investigation of these ramps progressed and as the final BRT system concept crystallized, it became evident that often there were physical constraints affecting construction of the ramps and a considerable expense would be incurred if the ramps were to be constructed. Of the above-mentioned ramps, only the Scotten ramp is proposed for the final system.

Discussions of each overpass implementation which was considered during system concept evolution follow.

3.5.2.1 Greenfield Overpass

No physical barriers exist which would prevent construction of the ramps. However, the overpass is quite high, approximately 30 feet, becaust it must pass over railroad tracks. The average overpass height on the Jeffries is approximately 18 to 20 feet. The ramp grade, regardless of overpass height, is limited to 6 percent by vehicle performance limitations during inclement weather. Therefore, with a 6 percent grade, vertical curves on the top and bottom of the ramp, and an adequately barriered median in the transition area at the bottom of the ramp, the ramps would be approximately 1,300 feet long. These ramps would be relatively costly.

3.5.2.2 Schaefer Overpass

The Schaefer overpass is 350 feet from the Grand River left turn overpass and approximately 500 feet from the Grand River overpass. There is not adequate space to construct an exclusive ramp on the east side of Schaefer between the Schaefer and Grand River left turn lane overpasses. No obstructions exist to constructing an exclusive ramp on the west side of the Schaefer overpass. Therefore, if exclusive ramps were constructed, one would be constructed on the east of the Schaefer overpass and the other would be constructed on the west side of the Grand River overpass. Two methods could be employed to proceed from ramp to ramp. The service drives could be used or the area between the Schaefer and Grand River overpasses, over the median, could be decked over and exclusive bus lanes constructed on the deck. In the former case, the BRT vehicles would be subject to all the delays of mixed traffic on the service drives and would also be required to negotiate very sharp turns onto the overpasses. In the latter case, the cost would be relatively high and the BRT vehicles would obstruct traffic when crossing the Schaefer and Grand River overpasses. The buses could also be obstructed by mixed traffic on the overpasses. In both cases, the time required to make an intermediate stop could be prohibitive.

3.5.2.3 Wyoming Overpass

There are no constraints to constructing exclusive bus lanes to the Wyoming overpass. No other structures are near enough to the Wyoming overpass to prevent construction. Therefore, Wyoming Avenue was considered to be the best place to build ramps for intermediate stops and for BRT vehicles to enter the exclusive lanes. Later, it was the Wyoming location that was chosen for construction of the transfer station. The Wyoming location provides a very good entry point for BRT vehicles serving Detroit on the mile roads east of the Southfield Freeway.

3.5.2.4 Livernois Overpass

The Livernois overpass cannot be used for the construction of exclusive bus ramps from the Jeffries Freeway median. Approximately 150 feet west of the Livernois overpass is a structure carrying a Jeffries U-turn lane and westbound West Chicago over the Jeffries. On the east side of the Livernois overpass there is a structure, about 150 feet away carrying the eastbound lanes of West Chicago over the freeway. Therefore, exclusive ramps at this location would have to be constructed to the two overpasses carrying West Chicago Road over the freeway. To travel from one ramp to the other, BRT vehicles would have to use the service drives or a deck would have to be built at the same level of the overpasses between the three overpasses, that is, between the westbound West Chicago overpass and the Livernois overpass and the eastbound West Chicago overpass. This would be quite costly and would result in traffic conflicts between BRT vehicles and traffic on the overpasses. Using the service drives would be time consuming. Neither solution was considered practicable.

3.5.2.5 Scotten Overpass

This location was not considered as an intermediate stopping point for BRT vehicles. It is necessary to construct a ramp in this location to provide access to the New Center via Grand Boulevard. There are three overpasses at this location. From west to east, they are the Scotten overpass and two West Grand Boulevard overpasses. There are approximately 350 feet between the Scotten overpass and the westernmost West Grand Boulevard overpass. The entrance/exit ramp is constructed to the Scotten overpass. Buses travel from Scotten on Grand River to Grand Boulevard and then on to the New Center. This ramp is of the same design as the ramps to the Wyoming transfer station.

3.5.3 Capital Improvements

The capital improvements proposed for the final BRT system are presented in this section. Several of these capital improvements are designated the responsibility of the Michigan Department of State Highways and Transportation. The geometrics specialists were to study exclusive BRT ramps at several overpasses on the Jeffries, an exclusive bus exit ramp in the Southfield Freeway/Eight Mile Road area serving Northland, and the exit from the southeast terminus of the Jeffries Freeway. Subsequently, several of the overpass ramps were deleted in favor of a BRT transfer station at Wyoming Avenue. The work done on the exclusive ramps to the overpasses was directly applicable to the ramps to the Wyoming station. In addition, the feasibility of an exclusive ramp from the southbound Southfield/eastbound Jeffries exit ramp to the median between the inner dual roadways of the Jeffries was investigated.

Drawings and cost estimates for the capital improvements were submitted by the Department of State Highways and Transportation.

The following capital improvements are proposed for the final BRT system.

3.5.3.1 Southfield Freeway/Eight Mile Road Proposed Exclusive Bus Ramp

Figure 3-33 decpits the proposed exclusive ramp. The ramp would exit the Southfield Freeway at Winora allowing buses to proceed via Winora to the Northwestern Highway service drive and from there to Northland. This route directs the buses through a residential area.

The cost of the ramp is estimated to be $300,000. There would be a weave conflict between vehicles entering the freeway via the northbound on-ramp and buses existing the freeway on the exclusive bus ramp.

A preferred alternative ramp is also shown in the figure. This route would bypass the residential areas. However, additional right-of-way would have to be acquired for this implementation.

If the Lodge Freeway and Wyoming Avenue route is used for the BRT buses to access the Jeffries Freeway, a ramp will not be constructed at Winora.

3.5.3.2 Wyoming Transfer Station

The Wyoming Transfer Station is a center of activity for the BRT system. All BRT buses stop at the station. These buses access the station either via exclusive ramps from the Jeffries BRT lanes or via exclusive bridges from the service drives to the station. Access to the New Center is via shuttle bus from the station. The estimated cost of the station, ramps, and crossover bridge is $1,356,000.

The station will be constructed approximately 1,000 feet west of the Wyoming overpass. It will be centered over the median between the inner roadways of the Jeffries (see Figure 3-34). The location of the station is dictated by certain physical constraints. For example, the overpass supports are a constraint affecting directly the station location. Roughly 1,000 feet are required to construct the ramps into and out of the station from the median. This 1000-foot length requires use of the center area of the median, not just the outer shoulders adjacent to the median barrier. Therefore, because the Wyoming overpass bridge supports are in the center of the median, the ramp with the associated merge/demerge section must be complete before the bridge supports are encountered.

Adequate clearance between the station crossover bridges from the service drives to the station, and the Jeffries eastbound off-ramp and westbound on-ramp was also necessary. Constructing the station 1,000 feet from the Wyoming overpass eliminates this problem because the crossover bridge is not constructed over the freeway on-off ramps. This is shown in Figure 3-34.

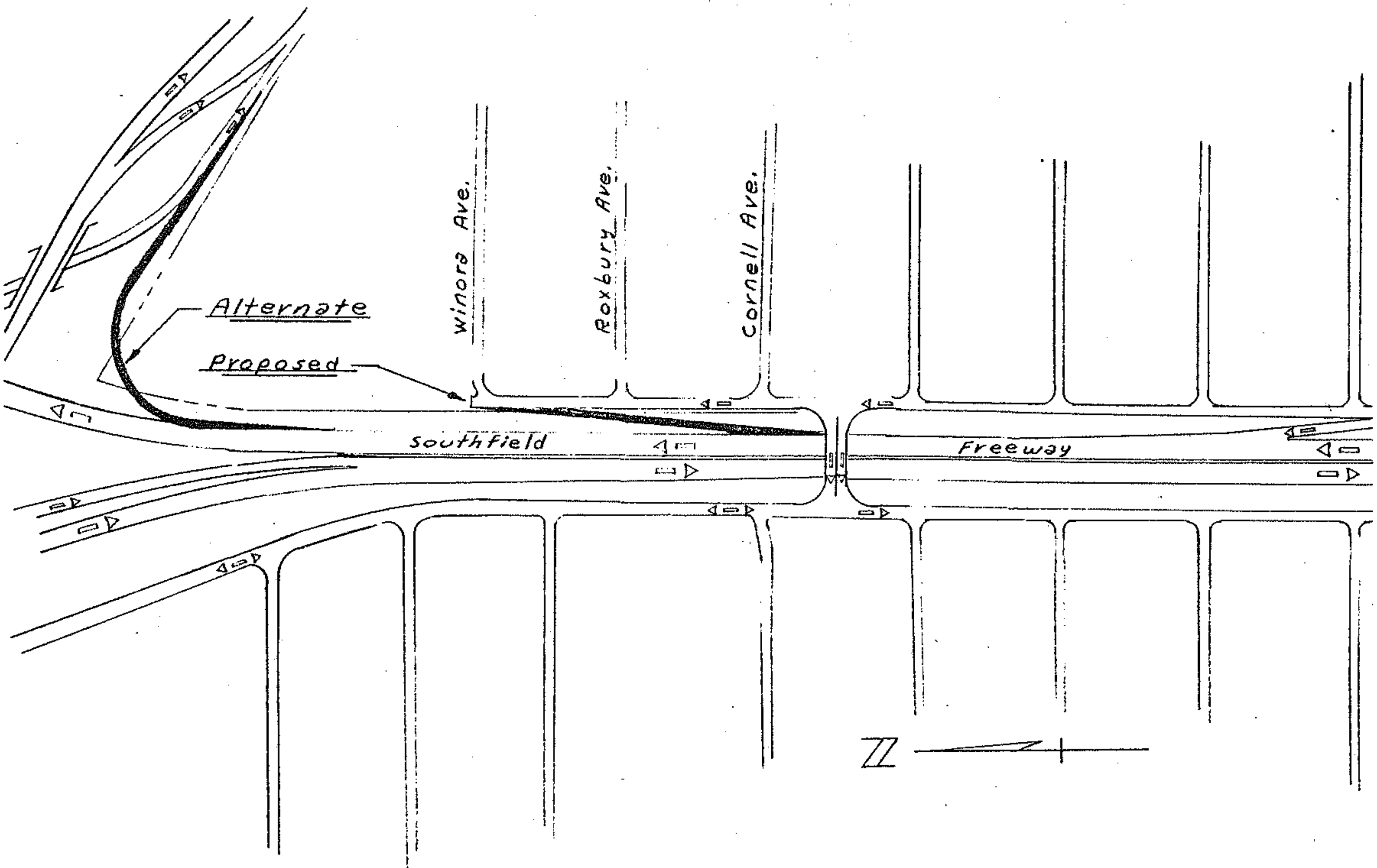


Figure 3-33 Proposed Exclusive Bus Ramp - Southfield Freeway

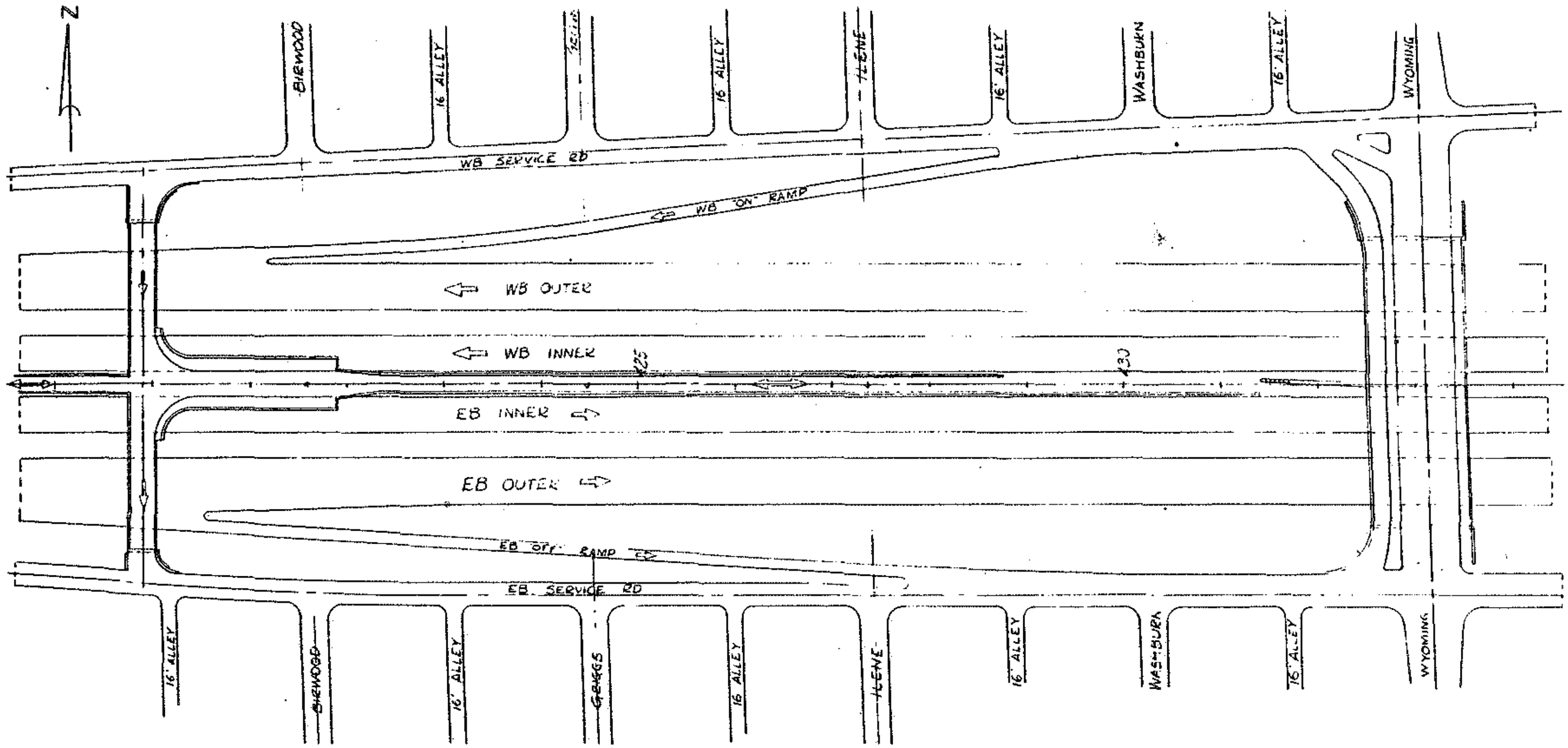


Figure 3-34 Proposed Wyoming Avenue Station

The station concept is depicted in Figures 3-1 (in Section 3.1), 3-34, and 3-35. Figure 3-1 is an artist's rendering of the station concept. In this rendering the station is shown during the evening peak period with BRT vehicles coming out of the city. The Wyoming overpass is shown in the background. Also in evidence, in the foreground, are the sidewalks on the crossover bridges which provide pedestrian access to the station from the service drives. The passenger platforms in the station are enclosed on all sides. Openings in the walls adjacent to the bus stops are provided to allow access to the front and rear bus doors.

Figure 3-35 is a plan view of the station. The passenger platforms are 142 feet long and 12 feet wide. The roadway is 23 feet wide. The 142-foot and 23-foot dimensions were dictated by the desire to provide stopping spaces for three buses at once while allowing any bus to exit the station without waiting for buses ahead to clear. That is, the 23-foot wide roadway allows buses to pull around parked buses ahead. The platform width was determined by expected peak-passenger volumes in the station. The station is cantilevered over the median of the freeway as shown in Section A.A of the figure. No amenities are provided in the station because of the relatively short station wait time for passengers.

The overall plan view of the station, Figure 3-34, shows the crossover bridges to the service drives and the station location. Sidewalks are provided on the crossover bridges for pedestrian access. One exclusive ramp is shown between the station and Wyoming Avenue. An identical ramp is provided on the west side of the station.

These ramps are completely within the median of the freeway. See Figure 3-34 and 3-36. The median is 26 feet wide, too narrow to allow ramps wide enough for two lanes. The roadway on the ramp is 16 feet wide and the ramp grade is 6 percent. In the transition area between the Jeffries exclusive lanes and the ramps, it is necessary to assure that it would not be possible for vehicles to cross from one side of the freeway to the other. That is, the median barriers, while not continuous, overlap such that no gap exists between the roadways. This requires approximately 300 additional feet of length for the ramp implementation, necessary in the interest of safety.

During off-peak periods, two-way traffic will use the station and ramps. The station roadways are wide enough to allow vehicles to pass in both directions. Signals will be provided to eliminate conflicts on the one-lane ramps. Buses will wait in the station until the ramps are clear. Sensors on the exclusive lanes of the Jeffries and in the station will control the signals. During the peak periods, the ramps and station operate in one direction only, eastbound in the morning peak and westbound during the evening peak.

Buses accessing the station from Wyoming will enter/leave the station via the service drive and crossover bridges.

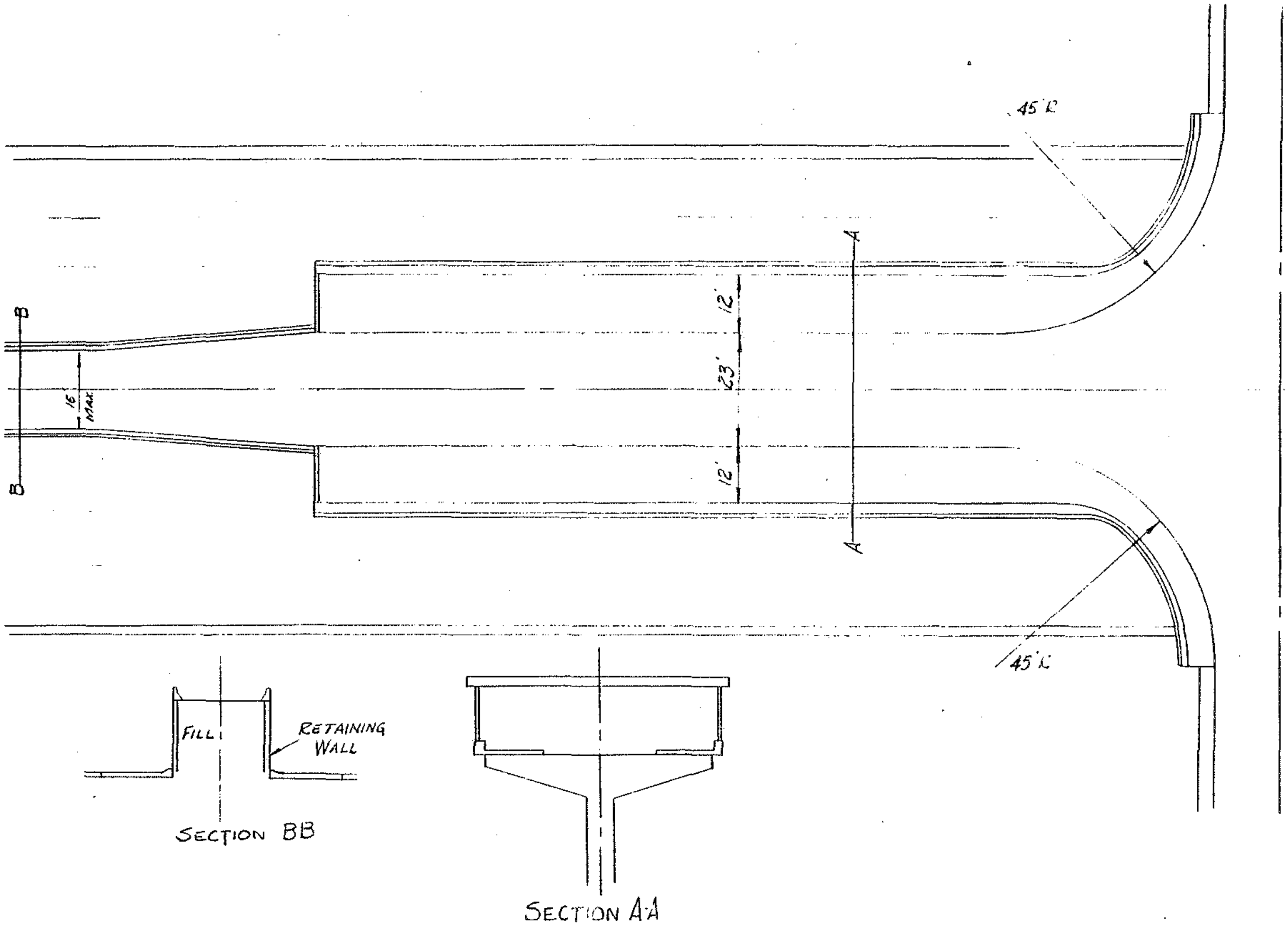


Figure 3-35 Proposed Typical Station Detail

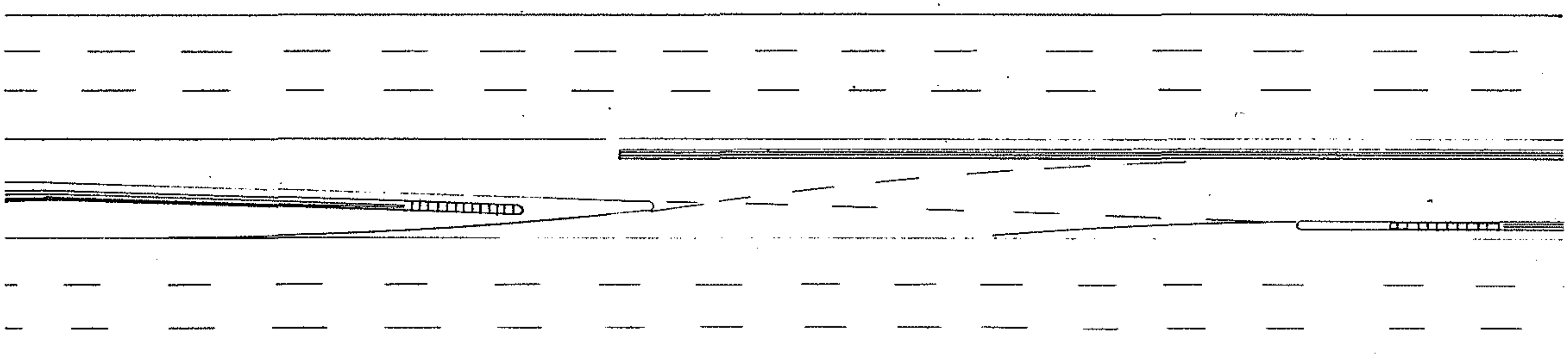


Figure 3-36 Proposed Exclusive Bus On/Off Ramp

During the peak morning hour, 116 buses will use the station, 64 will enter via the exclusive ramp from the Jeffries exclusive lane, and 52 will enter via the crossover bridge from the westbound service drive. Two station berths are required to handle this predicted load. However, the station has been designed with three berths to provide sufficient capacity to handle future system growth.

The estimated peak number of New Center shuttle passengers waiting at the Wyoming station was calculated for the evening peak hour when transfer time is greater. Each BRT route was considered separately. From the peak-hour demands and average headways, the number of New Center passengers waiting to transfer at the station at any one time was determined. This figure, 99 passengers, was increased by 50 percent to account for surges in demand during the peak hour. The total number of passengers waiting at one time in the station, including the surge factor, is 148.

A Level of Service C criterion, as developed by Fruin[1] has been assumed for the station platform queuing areas. This provides for 0.65 to 0.93 square metre per person for queuing area. Using the 0.93-square metre per person figure and a 142-foot platform length, the platform width for 148 passengers would be 10.4 feet. The platform width was increased by 1.6 feet to 12 feet. This will allow a 15 percent increase in passenger volume.

3.5.3.3 Scotten Overpass

The Scotten overpass ramp was discussed previously in Paragraph 3.5.2.5. The station access ramps are the same design as the Scotten overpass ramp. Because these ramps are the same, a separate drawing was not made of the Scotten ramp. The cost of this ramp, as estimated by the Michigan Department of State Highways and Transportation, is $350,000.

3.5.3.4 Southeast Terminus of the Jeffries Freeway

The proposed route between the southeast erminus of the Jeffries and the CBD is via the Fisher Freeway to Third Street and from there to the CBD via Grand River. Exclusive BRT lanes are proposed between the Jeffries Freeway and the Third Street overpass. Figure 3-37 shows the proposed route.

Starting at the Jeffries, a new exclusive BRT roadway would be constructed to the median of the Fisher Freeway in the vicinity of the 14th Street overpass. Two bridges would be constructed to carry this roadway over the existing freeway turn lanes. Between 14th Street and Third Street the median of the Fisher Freeway would be reconfigures to provide two exclusive bus lanes separated by a median barrier. Figure 3-38 shows the changes proposed for the median of the Fisher Freeway. At Third Street an exclusive

[1] Fruin, John J., Pedestrian Planning and Design, Metropolitan Association of Urban Designers and Environmental Planners, Inc., New York 1971.

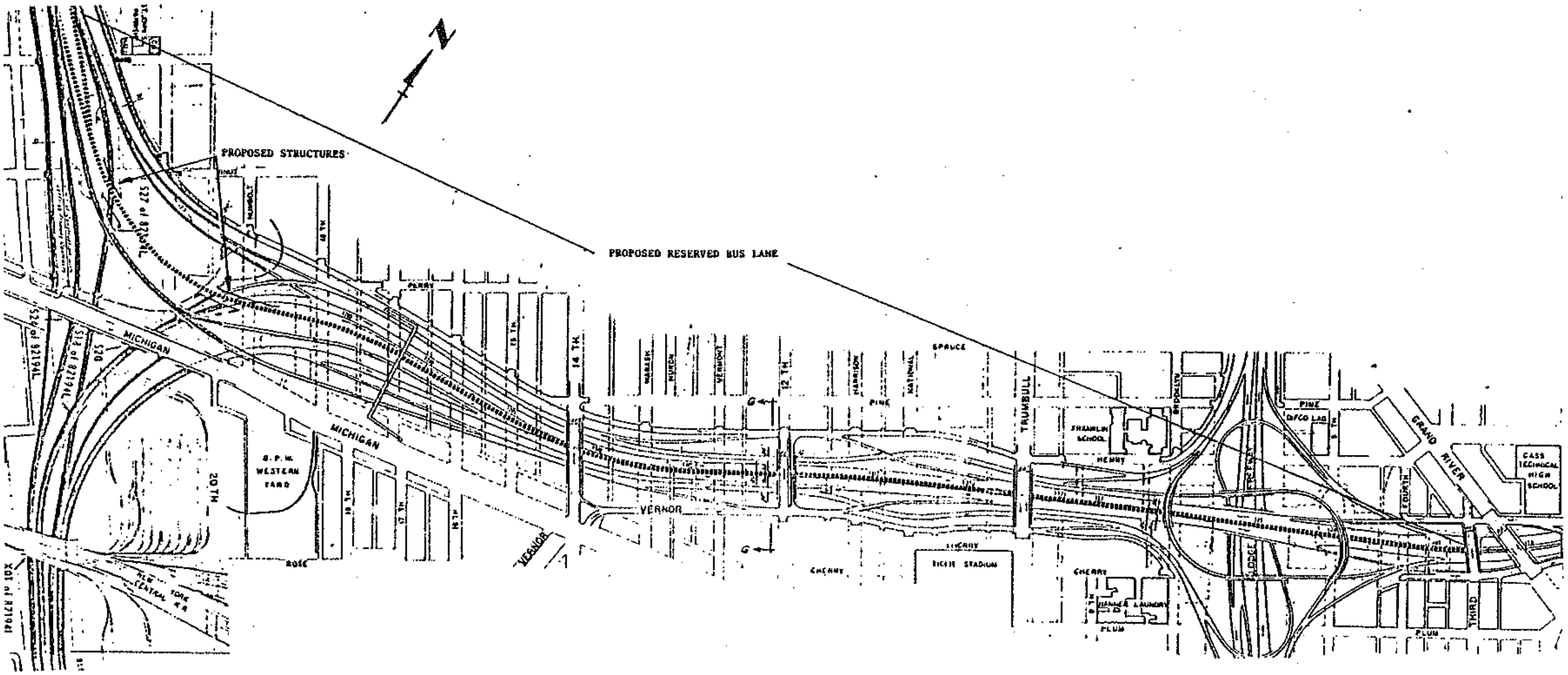


Figure 3-37 Typical Cross Sections - I-75 (Fisher Freeway)

GM Transportation Systems

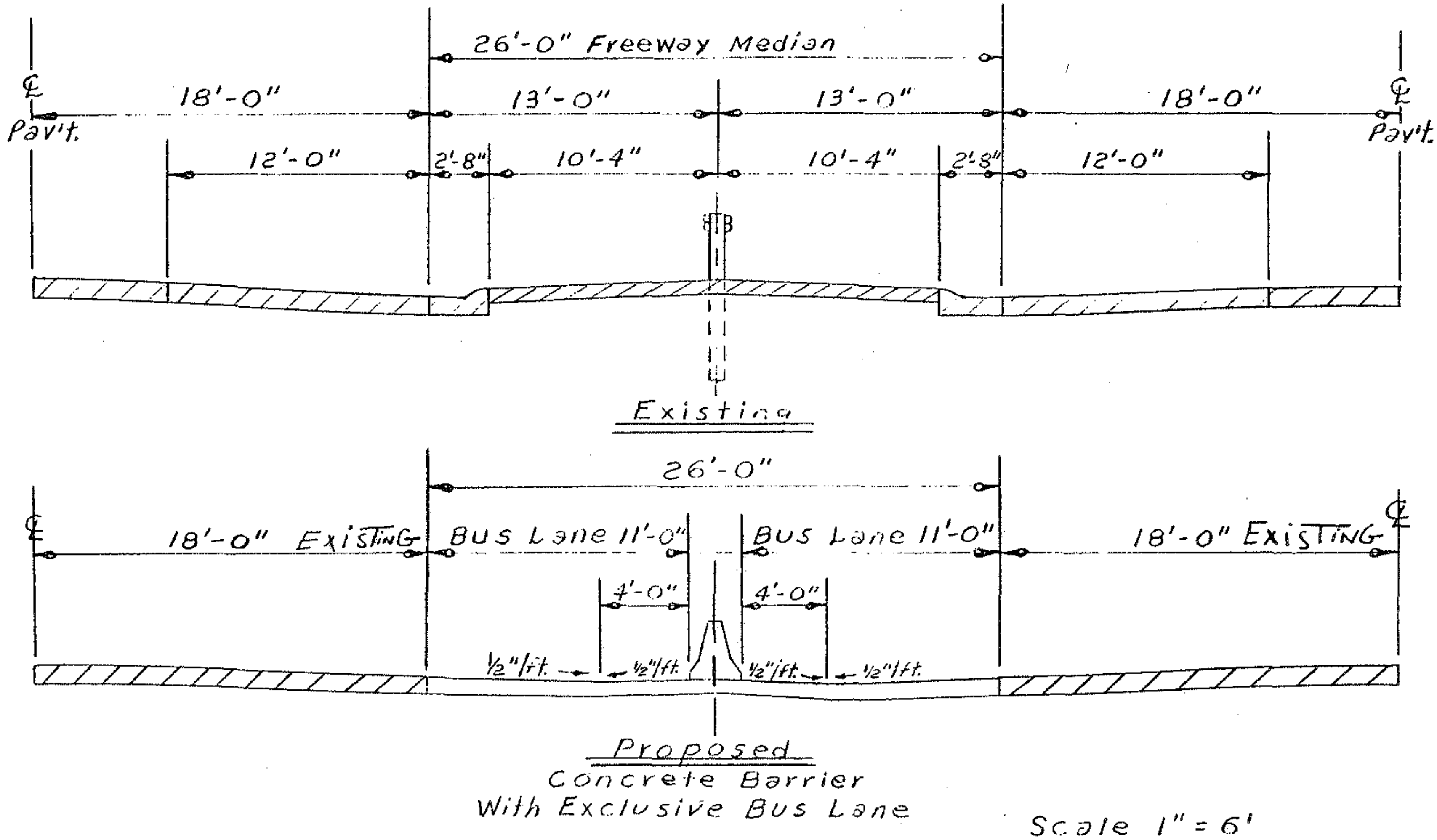


Figure 3-38 City of Detroit - Bus Rapid Transit - Fisher Freeway

ramp would be constructed to allow eastbound buses to exit from the exclusive median lane to the overpass. This ramp is shown in Figure 3-39. The distance between the northbound Lodge to westbound Fisher turning roadway overpass and the Third Street overpass is insufficient to provide access to both median bus lanes without having a gap in the median barrier. As mentioned earlier, approximately 1,000 feet is required to construct a ramp with overlapping barriers in the transition area between the ramp and median. Therefore, with a safe non-discontinuous median barrier, only eastbound BRT vehicles can use the ramp. Westbound BRT vehicles will enter the Fisher Freeway via the existing on-ramp at Third Street and then weave over the exclusive median lane. The estimated cost of the new roadways, structures, and median reconfiguration between the Jeffries Freeway and Third Street is $1,505,000. The Third Street ramp is estimated to cost $350,000 for a $1,855,000 total.

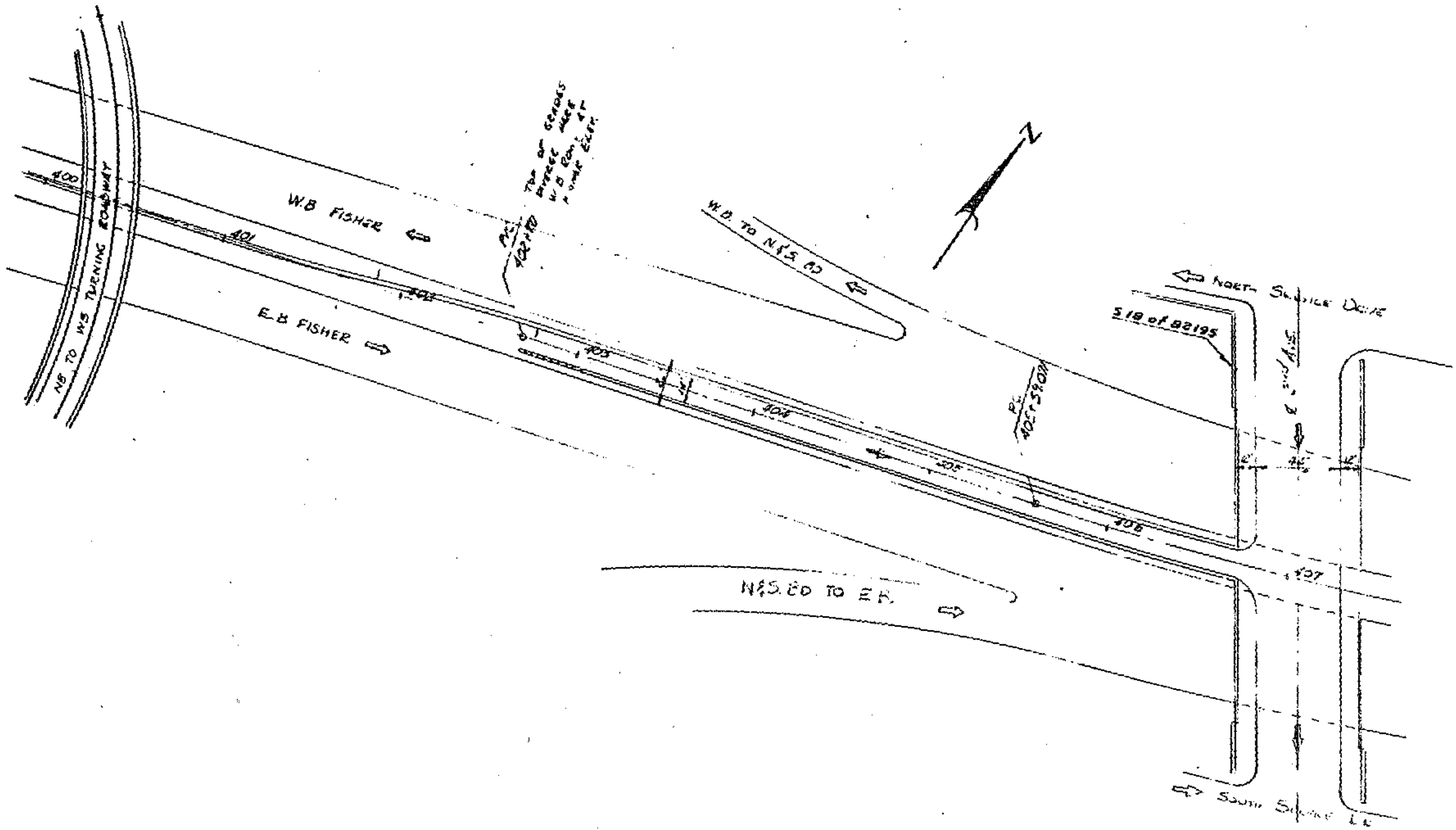


Figure 3-39 Proposed Exclusive Bus Ramp - I-75 at Third Street

3.6 BRT Demand Estimates

Following the synthesis of a BRT service concept for the Southfield/Jeffries corridor, the potential ridership of that system was evaluated. The evaluation process consisted of two parts:

- The total "pool" of trips from which BRT riders could be attracted was estimated.
- The portion of all trips which could potentially be diverted to BRT from other modes was then predicted.

The estimation of total corridor travel demand was accomplished in a manner similar to that of previous BRT analyses. The Southfield/Jeffries corridor was defined as a list of origin zones in Oakland County and northwest Detroit, and a list of destination zones in the Detroit CBD, New Center area, and adjacent to the proposed Wyoming Avenue BRT station. (See Table 3-29 for corridor zone lists.) Next, a 3-hour peak period was selected as the analysis time interval; the period from 7:00 to 10:00 a.m., found in previous analyses to be the peak period, was again chosen. A computer file containing trip records derived from the 1965 TALUS survey was scanned, and trips meeting all of the following criteria were tabulated:

- The trip must originate in one of the corridor's designated origin zones.
- The trip must terminate in a zone identified as a corridor destination.
- The trip must terminate later than the lower boundary of the analysis interval (i.e., after 7:00 a.m.).
- The trip must terminate no later than the upper boundary of the analysis interval (i.e., up to and including 10:00 a.m.).

The resulting trip matrix represents the morning peak-period travel patterns of a typical weekday in 1965. The number of trips from each origin zone was then multiplied by the 1975-to-1965 population ratio (estimated by SEMCOG) of the district containing the zone, with the intention of producing a trip matrix which more closely models 1975 travel patterns.

Next, appropriate input data were assembled, and the BRT modal split program was run. Input data preparation included the following items:

- A list of all TALUS zones in the corridor was assembled. This list also designated a group number for each destination zone (for use in arranging output data summaries).

- Node and link lists were prepared for the auto and transit networks. Average speeds for the various types of links in the auto network were taken from SEMCOG 1990 Network V Average Speeds. Speeds on the transit network are as indicated in Section 3.7-1.

Table 3-29 Southfield/Jeffries Corridor Zone List

TALUS ORIGIN ZONES			TALUS DESTINATION ZONES
0700	0924	2104	0010
0701	0930	2110	0011
0702	0931	2111	0012
0703	0932	2112	0013
0704	0933	2120	0014
0710	0940	2121	0020
0711	0941	2122	0021
0712	0942	2130	0022
0713	0943	2131	0023
0720	0944	2132	0030
0721	0945	2133	0031
0722	0946	2134	0032
0723	0947	2135	0040
0724	0950	2136	0041
0725	0951	2137	0042
0730	0952	2140	0043
0731	0953	2141	0044
0732	0954	2142	0050
0733	0955	2143	0051
0734	0960	2144	0052
0735	0961	2145	0060
0736	0962	2146	0061
0740	0963	2147	0062
0741	0970	2400	0063
0742	0971	2401	0064
0743	0972	2402	0065
0744	0973	2403	0066
0910	2032	2404	0070
0911	2034	2405	0071
0912	2040	2420	0072
0913	2041	2421	0132
0914	2043	2422	0133
0920	2100	2423	0500
0921	2101	2424	0501
0922	2102	2425	0521
0923	2103	2426	0600
			0702
			0731
			0732

- A 1975 morning peak-period trip matrix was generated, as discussed above.

- All non-local destination zones were designated as either "activity center" or "CBD" types.

- A set of submodal weighting factors was chosen for each origin zone. (Section 2.4 discusses the use of these factors in greater detail.) Origin zones in Detroit were assigned weighting factors of unity for the appropriate BRT collection mode; all other factors for those zones were zero. In Oakland County a great deal of overlap was apparent in the proposed feeder bus and park-and-ride service areas. Therefore, these zones could not be readily subdivided (by applying complementary feeder bus and park-and-ride weighting factors) and then analyzed as separate subzones with only one transit mode serving each. Instead, Oakland County was evaluated as if all BRT trips accessed the system by park-and-ride, since that mode would be more widespread and would generally have superior travel times. The BRT demand computed for each origin zone was then subjectively split into feeder bus and park-and-ride components, after consideration of the zone's proximity to proposed feeder routes, auto ownership, population density, and average household income. Table 3-30 lists the proportions into which initital demand estimates were divided to obtain separate figures for feeder bus and park-and-ride.

- A set of modal split parameters, listed in Table 3-31 was defined for each of the corridor's travel modes. Since Oakland County feeder bus characteristics were not used directly in the estimation of BRT modal split, the table includes no parameters for that mode.

- Each of the corridor's zones was placed in one of five classes on the basis of average household income, as projected by SEMCOG for 1975, measured in 1965 dollars. Since the income class boundaries are also expressed in 1965 dollars, a consistency of units is achieved.

- The land area of each traffic analysis zone was obtained from SEMCOG demographic data. These land areas are converted from acres to square miles by the modal split program and used in the computation of trip production and attraction densities.

- A list of x-y coordinates for each traffic analysis zone centroid was obtained. Network node and zone centroid locations are expressed in the same units (miles) and in the same coordinate system, allowing distances between nodes and zone centroids to be computed directly.

- Peak-period diversion curve data were reformatted and made available to the BRT modal split program.

Table 3-30 Oakland County Feeder Bus/Park-and-Ride Proportions

TALUS ORIGIN ZONES	FEEDER BUS FRACTION	PARK-AND-RIDE FRACTION
2032	0.300	0.700
2034	0.400	0.600
2040	0.500	0.500
2041	0.300	0.700
2043	0.400	0.600
2100	0.500	0.500
2101	0.500	0.500
2102	0.100	0.900
2103	0.100	0.900
2104	0.300	0.700
2111	0.500	0.500
2112	0.500	0.500
2120	0.400	0.600
2121	0.300	0.700
2122	0.200	0.800
2130	0.300	0.700
2131	0.400	0.600
2132	0.400	0.600
2133	0.200	0.800
2134	0.400	0.600
2135	0.400	0.600
2136	0.400	0.600
2137	0.300	0.700
2140	0.200	0.800
2141	0.400	0.600
2142	0.000	1.000
2143	0.000	1.000
2144	0.000	1.000
2145	0.000	1.000
2146	0.300	0.700
2147	0.000	1.000
2400	0.400	0.600
2401	0.300	0.700
2402	0.400	0.600
2404	0.200	0.800
2405	0.300	0.700
2420	0.200	0.800
2421	0.000	1.000
2422	0.300	0.700
2423	0.200	0.800
2424	0.000	1.000
2425	0.000	1.000
2426	0.000	1.000

Table 3-31 BRT Modal Split Parameters

	AUTOMOBILE	DETROIT BRT COLLECTION	OAKLAND COUNTY PARK-and-RIDE
Access			
Out-of-vehicle time	1.0 min	10.0 min	6.0 min
Cost policy	GRAD	FLAT	Grad
Cost rate	$0.05/mi	$0.00	$0.05/mi
Additional cost	$0.00	$0.00	$0.55
Travel speed	30.0 mi/h	-	30.0 mi/h
Collection			
Cost policy	GRAD	FLAT	FLAT
Cost rate	$0.05/mi	$0.00	$0.00
Line-haul			
Cost policy	GRAD	FLAT	FLAT
Cost rate	$0.05/mi	$0.45	$0.45
Distribution			
Cost policy	GRAD	FLAT	FLAT
Cost rate	$0.05/mi	$0.00	$0.00
Local Egress			
Out-of-vehicle time	2.0 min	10.0 min	10.0 min
Cost policy	GRAD	FLAT	FLAT
Cost rate	$0.05/mi	$0.00	$0.00
Additional cost	$0.00	$0.00	$0.00
Travel Speed	25.0 mi/h	-	-
Activity Center Egress			
Out-of-vehicle time	3.0 min	5.0 min	5.0 min
Cost policy	GRAD	FLAT	FLAT
Cost rate	$0.05/mi	$0.00	$0.00
Additional cost	$0.50 park	$0.00	$0.00
Travel speed	15.0 mi/h	-	-
CBD Egress			
Out-of-vehicle time	7.0 min	3.0 min	3.0 min
Cost of policy	GRAD	FLAT	FLAT
Cost rate	$0.05/mi	$0.00	$0.00
Additional cost	$1.00 park	$0.00	$0.00
Travel speed	15.0 mi/h	-	-

• A file containing various program run-control parameters was assembled. These parameters include the number of origin zones, the number of destination zones, and, separately for the auto and transit networks, the number of nodes, the maximum node identification number, and the number of links.

• The modal split analysis of the Southfield/Jeffries BRT corridor produced the results discussed below and summarized in Figures 3-40 through 3-43. The intermediate destination zones near the proposed Wyoming Avenue BRT station (i.e., zones 0702, 0731, and 0732) were predicted to attract only 91 of the corridor's peak-period BRT trips; therefore, trips to these zones are not included in the demand estimates discussed hereafter. A total of 10,073 peak-period BRT trips to the Detroit CBD and New Center area was predicted, for an overall modal split of 45.5 percent. The Detroit CBD attracted a majority of the trips (7,861), while the New Center area accounted for the remaining 2,212 trips. Most BRT trips originated in Detroit (6,804) rather than Oakland County (3,269). Of the Oakland County BRT trips, 72.3 percent (2,365 of the 3,269 trips) were estimated to access the system by park-and-ride. Those park-and-ride trips, however, represent only 23.5 percent of the system's total predicted ridership.

Figures 3-40 and 3-41 illustrate peak-period and peak-hour (7:30-8:30) demand patterns for Detroit CBD destinations. Similar information pertaining to New Center trips is shown in Figures 3-42 and 3-43.

The data displayed in these figures were generated by individually assigning the demand estimated for each origin zone to a BRT collection route. The demand produced in some zones was assigned to the Grand River Blue Express, which is not considered part of the BRT system. The demands estimated for a few other zones were deleted because the zones are not directly served by a BRT collection route. Due to these reasons and the effects of round-off, the total number of trips reported in these figures is somewhat lower than the totals reported above. The demand reported in the figures was used to size the BRT system and for the cost/revenue analysis.

The number of bus trips required to serve the estimated demand was determined, assuming standard forty-foot transit coaches seating fifty-three passengers. On the average, the peak load on collection buses operating on routes which use the freeway to access the Wyoming transfer station was limited to the number of seats on each coach (53). The average peak load on non-freeway collection buses was assumed to be 65. Since these collection buses also serve New Center patrons who transfer to another bus at the Wyoming station, it is expected that a seat will be available to all CBD passengers by the time the bus enters the freeway at Wyoming. The number of inbound bus trips completed in the peak hour on each BRT collection route is shown in Figure 3-44 Note that in the peak hour, 97 buses enter the CBD distribution route and 19 New Center Shuttles operate between the Wyoming station and the New Center. Table 3-32 summarizes the demand, the number of bus trips in the peak hour, and the number of bus trips in the peak period by route. The first four are park-and-ride routes originating in Oakland County. The remainder are Detroit collection routes. The "W" associated with many of the routes indicates that the route operates in the local collection mode west of Southfield, then enters the freeway. Those designated by an "E" begin at Southfield and proceed east, ultimately entering the Jeffries at Wyoming.

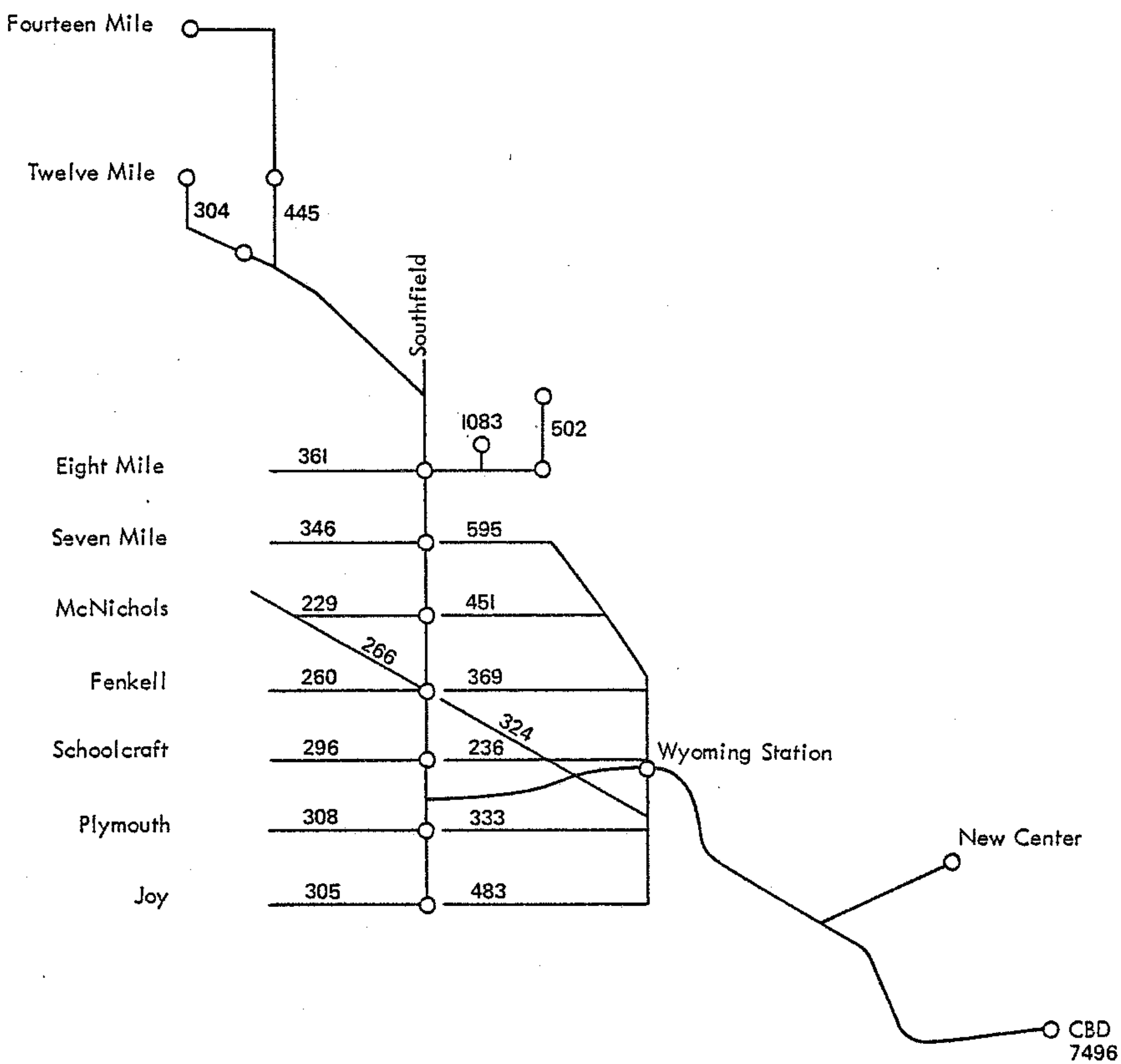


Figure 3-40 Estimated Peak-Period CBD Demand by Route

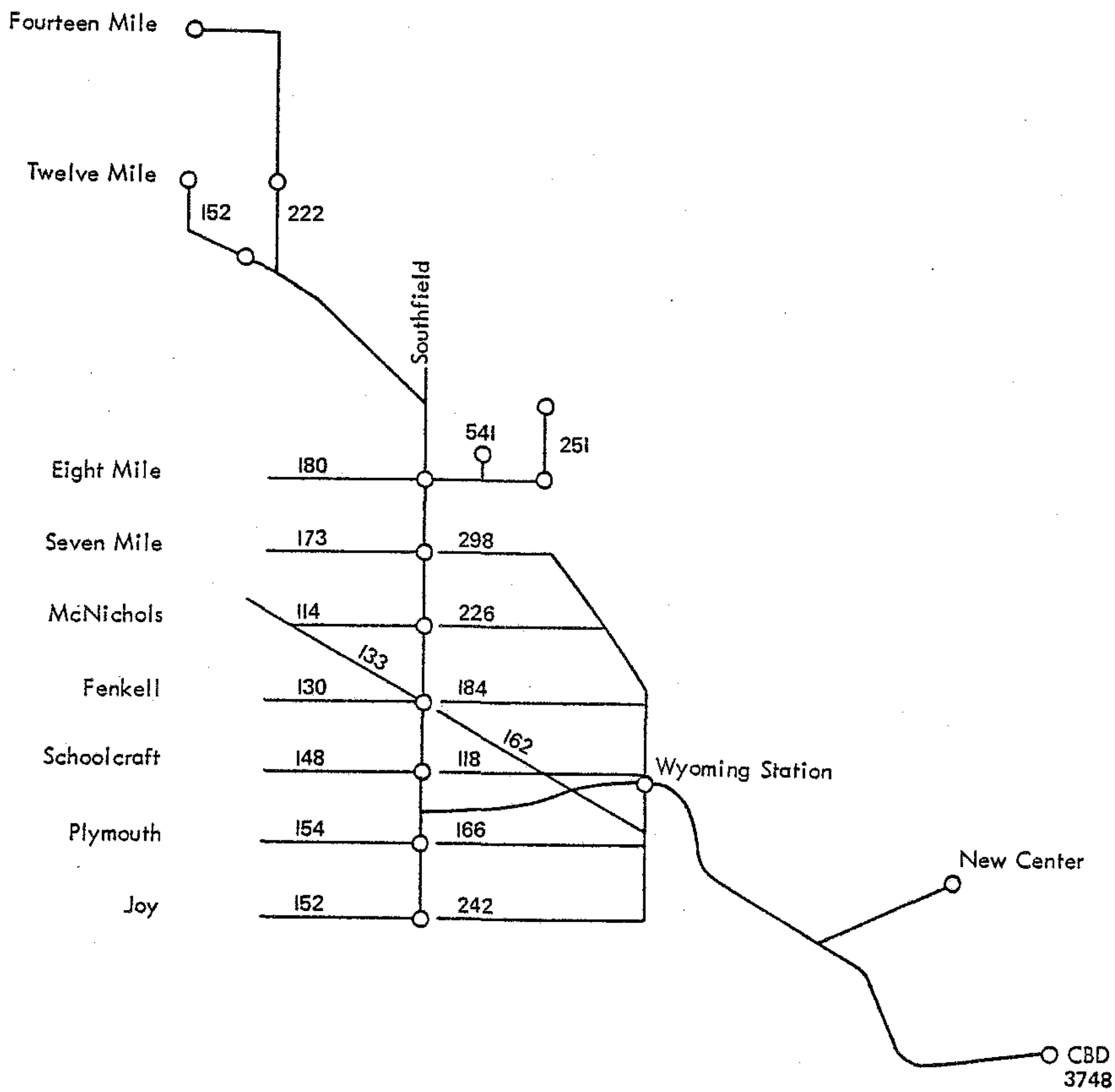


Figure 3-41 Estimated Peak-Hour CBD Demand By Route

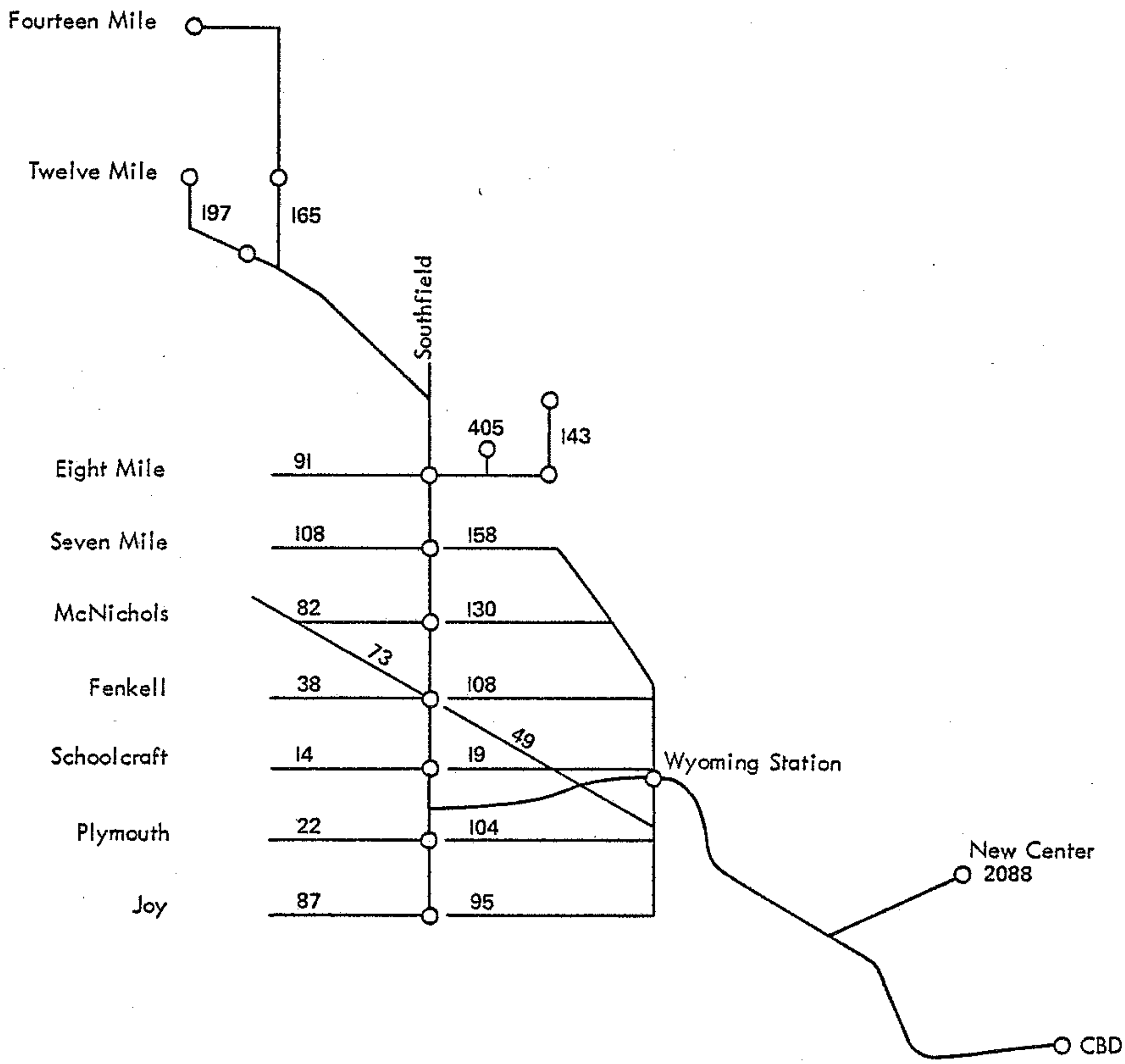


Figure 3-42 Estimated Peak-Period New Center Demand By Route

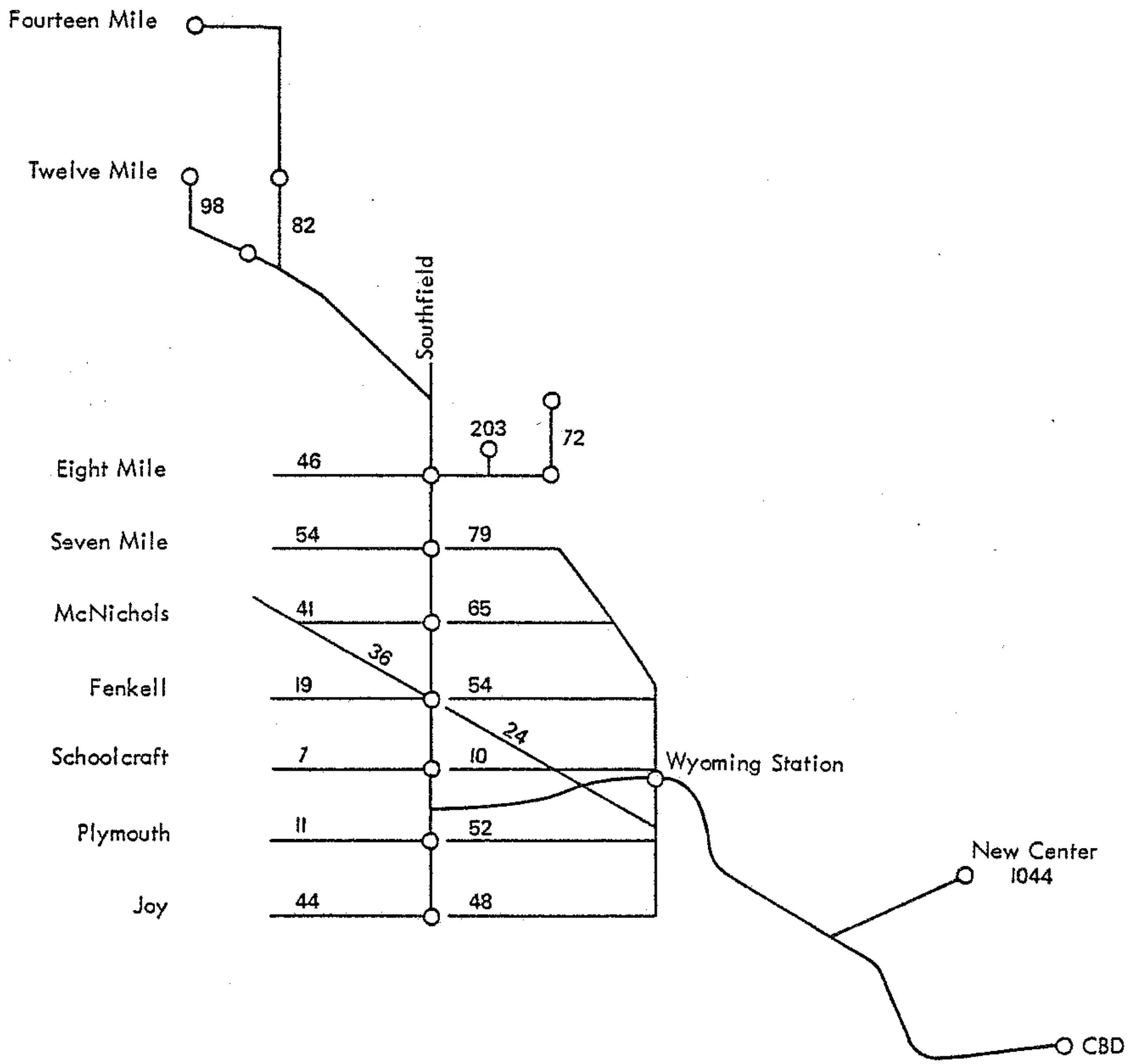


Figure 3-43 Estimated Peak-Hour New Center Demand By Route

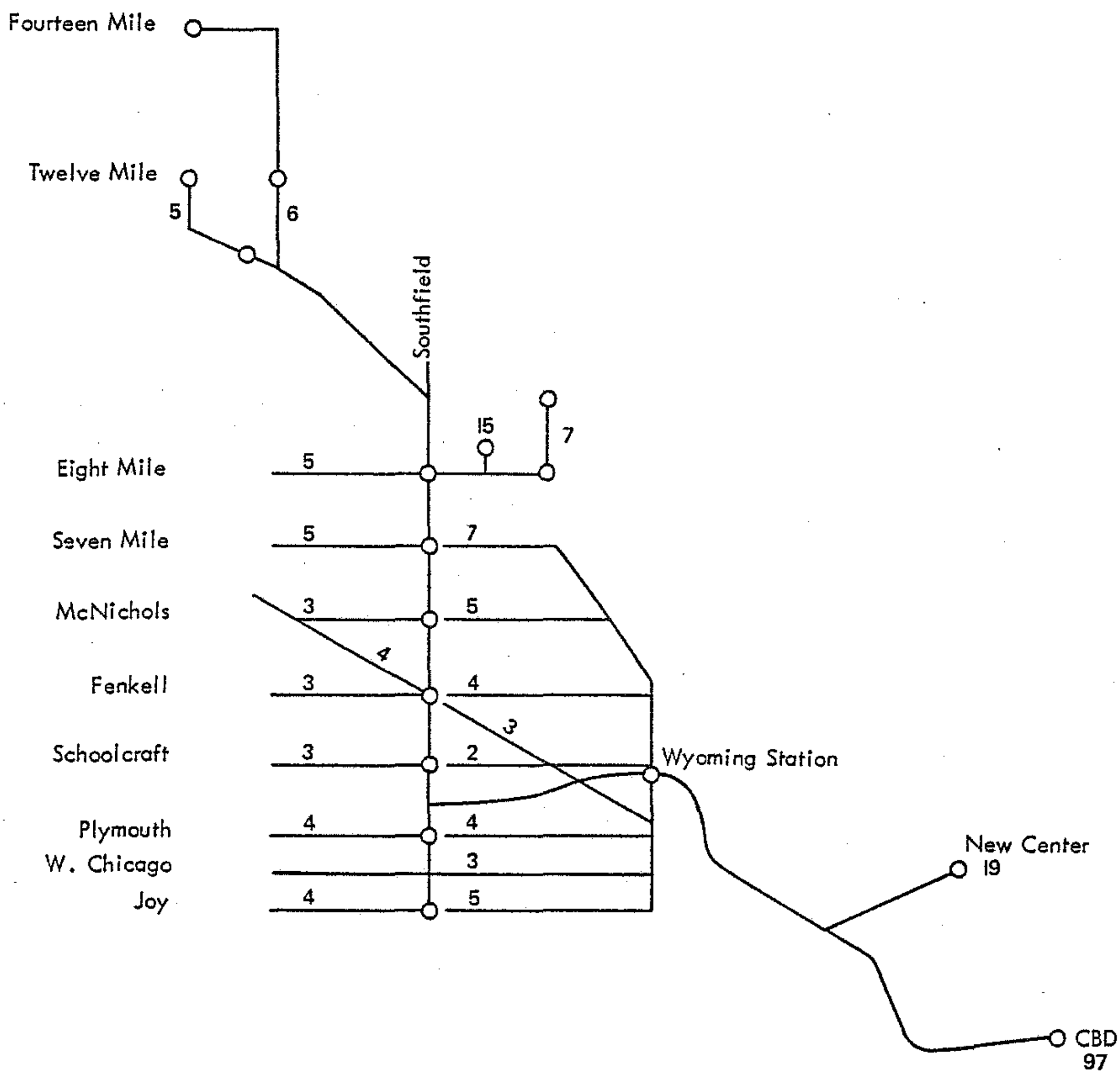


Figure 3-44 Number of BRT Peak-Hour Bus Trips by Route

Table 3-32 Proposed Number of BRT Bus Trips

ROUTE	PEAK PERIOD DEMAND	PEAK HOUR BUS TRIPS	PEAK PERIOD BUS TRIPS
Beth El	610	6	14
Tel-12	501	5	10
Americana	645	7	15
Northland	1488	15	30
8 Mile	452	5	10
7 Mile W	454	5	10
7 Mile E	753	7	15
6 Mile W	311	3	7
6 Mile E	581	5	10
5 Mile W	298	3	7
5 Mile E	477	4	9
Grand River W	339	4	8
Grand River E	373	3	7
Schoolcraft W	310	3	7
Schoolcraft E	255	2	6
Plymouth W	330	4	8
Plymouth E	437	4	9
West Chicago		3	3
Joy W	392	4	9
Joy E	578	5	10
TOTAL	9584	97	204

3.7 BRT System Sizing

The assumptions associated with determining the number of buses required for the BRT and Oakland County Feeders Systems are described in this section. A discussion of bus storage and maintenance facility requirements is also included.

3.7.1 BRT System Bus Requirements

The number of buses required to provide BRT service on each collection route during the morning peak period was determined, using a very simple bus scheduling process. Each BRT route is assumed to consist of four parts: a collection phase, a line-haul phase to the CBD using the Jeffries reserved bus lane for at least part of the route, a distribution phase in the Detroit CBD, and a non-stop deadhead phase back to the route starting point. The New Center Shuttle route includes line-haul, distribution, and deadhead. In the scheduling process, buses are assigned to particular routes and are not reassigned to other routes during the peak period. Although it is recognized that certain economies in the number of buses required for the system can probably be achieved by assigning buses to alternate routes for subsequent trips during the peak period, bus scheduling at this level of detail was not attempted in this study.

The time required to complete a round-trip on each BRT route was calculated. The average bus speeds on collection routes in Detroit were taken from published DDOT schedules, and they range from 14 mi/h to 18 mi/h for collection routes in the corridor. The average bus speed on park-and-ride collection routes in Oakland County is assumed to be 25 mi/h. The assumed average speeds for the line-haul portions of the routes are 37 mi/h for mixed traffic operation on the Southfield and Lodge Freeways, and 50 mi/h for exclusive-lane operation on the Jeffries Freeway. The CBD distribution loop is two miles in length. Assuming as average speed of eight mi/h, 15 minutes are required to complete the loop. The New Center loop is approximately 4.1 miles long. Assuming an average distribution speed of ten mi/h, 24.6 minutes are required to complete the loop. The deadhead portion of each route is assumed to make maximum use of freeway and other high-speed links. The round-trip time for each route also includes an additional ten minutes for layover and schedule adjustment.

The peak-period BRT demand for each collection route was used to determine the number of bus trips required to serve the demand, assuming the use of 53-passenger coaches. The peak-period demand estimates for the CBD and New Center by route are summarized in Figures 3-40 and 3-42, respectively. The distribution of this demand during the peak period was determined by analyzing the TALUS Survey data. The resulting time distribution, shown in Table 3-33, was used to more closely match the required number of bus trips to the BRT demand. The demand is assumed to be uniformly distributed during each time segment.

The total number of buses required to make the estimated number of trips on each route was determined by considering the round-trip time and the number of repeat trips possible on each route during the peak period. The total number of trips and buses required to

Table 3-33 Time Distribution of Demand in Peak-Period

PERIOD	TIME SEGMENT	PERCENT OF PEAK-PERIOD DEMAND
Pre-Peak	7:00 - 7:30	10
First Peak	7:30 - 8:30	50
Second Peak	8:30 - 9:30	30
Post-Peak	9:30 - 10:00	10

satisfy the estimated BRT demand is summarized in Table 3-34. Many of the buses required for providing BRT service in Detroit are already in service on express routes which will ultimately be integrated into the BRT system. In order to estimate the number of DDOT buses currently providing express bus service in the Southfield-Jeffries Corridor, the following assumptions, which are completely consistent with those used to estimate the required number of BRT vehicles, were made:

- Express routes start at the western boundary of the corridor.
- After completing an inbound trip, buses deadhead back to the start of the same route.
- Buses are not reassigned to other routes if another trip can be completed on the same route during the peak period.

Based on these assumptions, it is estimated that 65 buses are currently being used to provide express service on routes which will be integrated into the BRT system. As indicated in Table 3-34, the difference between the total number of buses required for the BRT system (151) and the number of buses currently in service (65) is the number of additional buses required to provide the proposed BRT service. The number in parentheses in the last column of the table is the total number of BRT vehicles required, including a 7 percent maintenance float to account for buses which may be out of service for one reason or another.

Table 3-35 presents the number of BRT vehicle operating hours and vehicle miles for the Southfield/Jeffries corridor. The figures were generated by considering each peak-period and off-peak route separately. Since driver scheduling was not attempted in this phase, the number of drivers required to provide BRT service in the corridor was not explicitly determined. The total number of vehicle operating hours is used in Section 3.8 to determine driver labor cost.

Table 3-34 Southfield/Jeffries Peak-Period BRT Bus Requirements

	BRT DEMAND	NO. OF BUS TRIPS	NO. OF BRT BUSES
BRT Collection	9584	204	132
New Center Shuttle	2088	41	19
Subtotal			151
Existing Express Service to be Integrated		85	65
Net Bus Requirement			86 (92)

3.7.2 Oakland County Feeder System Bus Requirements

As described in Section 3.4.3, the proposed Oakland County Feeder System is designed to feed the BRT system at Northland and to operate on a policy headway of approximately 20 minutes during the peak period. The total number of bus trips and buses required to provide this feeder service is summarized in Table 3-36. The estimated demand includes the number of passengers using the feeder system to access the Greenfield Intermediate line as well as the BRT system during the morning peak period. The buses are assumed to follow the same routes and to provide local service on both the inbound and outbound trips. No express deadheading is assumed. The number in parentheses in the last column is the total number of feeder buses required, including the assumed 7 percent maintenance float.

The number of vehicle operating hours and vehicle miles for the Oakland County Feeder System is presented in Table 3-37. As described in Section 3.4.3, the feeder system operates over the same routes during the off-peak period, but on 30 to 40 minute headways.

3.7.3 Vehicle Storage and Maintenance Facilities

DDOT's modern heavy maintenance facility, located at 1301 E. Warren, presently has the capacity for maintaining approximately 60 buses per day by operating one shift. The capacity of the facility can be significantly increased by working more shifts. Therefore, it is assumed that this facility can accommodate the increase in overall fleet size which the BRT system requires, and no additional heavy maintenance facilities are required. However, the operating cost associated with maintaining the additional buses will be considered in the next section.

In addition to the main terminal on Warren, DDOT currently operates three other terminals which are used for light maintenance and bus storage. These facilities, located at Shoemaker and St. Jean, Wabash and Stanley, and Schaefer and Schoolcraft, are all operating at about capacity. SEMTA will be moving in June 1976 from the Birmingham station to a terminal in Troy located on Barrett between Crooks and Livemois. Although

Table 3-35 BRT System Operating Characteristics

	NO. OF BUS TRIPS	VEHICLE HOURS PER DAY	VEHICLE HOURS PER YEAR	VEHICLE MILES PER DAY	VEHICLE MILES PER YEAR
Peak-Period CBD Service	408	496.7	126,659	12,205.7	3,112,454
Peak-Period New Center Shuttle	82	71.3	18,182	1,144.7	291,899
Total AM & PM Peak Period		568.0	144,841	13,350.4	3,404,353
Off-Peak CBD Service	18	32.0	8,160	657.0	167,535
Off-Peak New Center Shuttle	13	11.3	2,882	181.5	46,283
Total Off-Peak Period		43.3	11,042	838.5	213,818
Toral BRT		611.3	155,883	14,188.9	3,618,171

Table 3-36 Oakland County Feeder System--Peak-Period Bus Requirements

ROUTE	AM PEAK-PERIOD DEMAND	NUMBER OF BUS TRIPS	NUMBER OF BUSES
Fifteen Mile	233	9	4
Fourteen Mile	98	8	3
Thirteen Mile	216	9	3
Twelve Mile	263	9	3
Eleven Mile	71	8	2
Ten Mile	119	9	2
TOTAL	1000	52	17 (18)

Table 3-37 Oakland County Feeder System Operating Characteristics

	NO. OF BUS TRIPS - ALL ROUTES	VEHICLE HOURS PER DAY	VEHICLE HOURS PER YEAR	VEHICLE MILES PER DAY	VEHICLE MILES PER YEAR
AM and PM Peak Periods	104	98.7	25,168	1,584	403,920
Off-Peak Period	76	72.5	18,488	1,163	296,565
TOTAL	180	171.2	43,656	2,746	700,485

this facility has some excess capacity for maintenance, inside storage space for buses is limited. Therefore, since existing facilities for light maintenance (including fueling and cleaning) and storage are already operating near capacity, a new facility to accommodate the additional buses required by the BRT system is proposed. No attempt has been made in this study to design the required facility, but estimated costs (exclusive of land) will be included in Section 3.8. The cost estimate presented in the following section is based on previous analyses of the requirements of operating garages.

3.8 Cost Estimates

Capital and operating costs were estimated for both the BRT system and the Oakland County feeder system. Table 3-38 provides a summary of annual costs for the entire BRT system, including the Oakland County feeders. An 8 percent interest rate was assumed for the annualized capital cost calculations. Table 3-38 also lists the estimated number of one-way passenger trips per year on the BRT system and the Oakland County feeder system. Based on these demand and cost estimates, the total cost per trip is estimated to be $0.93 for the BRT system and $0.68 for the Oakland County feeder system.

The information required to form other cost/performance ratios which are typically used to evaluate public transit systems have been provided in this report. For example, Table 3-39 lists the values of other possible measures of BRT system cost and performance.

Table 3-39 BRT System Cost/Performance Measures

MEASURE		VALUE
Total Annualized Cost	(Table 3-38)	$4,753,000
Annual Operating Cost	(Table 3-38)	$3,261,000
Annual Person Trips	(Table 3-38)	5,109,690
Annual Vehicle Trips	(Table 3-35*)	132,855
Annual Vehicle Miles	(Table 3-35)	3,618,171
Vehicle Operating Hours	(Table 3-35)	155,883
Average Number of Passengers per Vehicle Trip		38.46
Average Number of Passengers per Vehicle Mile		1.41
Average Number of Passengers per Vehicle Hour		32.78
Total Annualized Cost per Vehicle Mile		$1.31
Total Annualized Cost per Vehicle Hour		$30.49
Total Annualized Cost per Seat Mile		$.025
Annual Operating Cost per Vehicle Mile		$.90
Annual Operating Cost per Vehicle Hour		$20.92
Annual Operating Cost per Seat Mile		$.017

* Assuming 255 operating days per year

3.8.1 Capital Costs

Tables 3-40 and 3-41 provide summaries of the capital costs of the BRT system and Oakland County feeder system, respectively. The annualized capital costs are included in these summaries.

Table 3-38 Summary of Annual Costs of BRT System

	SYSTEM COST ELEMENTS (THOUSANDS OF DOLLARS)				ANNUAL PERSON TRIPS	AVERAGE COST PER TRIP
	CAPITAL	ANNUALIZED CAPITAL	ANNUAL OPERATING	ANNUAL TOTAL		
BRT System Only	12,430	1,492	3,261	4,753	5,109,690*	$.93
Oakland County Feeder	1,698	230	819	1,050	1,532,805**	$.68
TOTAL	14,128	1,722	4,080	5,803		

* Includes assumed off-peak demand of 150 passengers per hour during mid-day period and 60 passengers per hour during the two-hour period following the evening peak period.

** Includes Greenfield Intermediate Service patrons who use the Oakland County Feeder System.

Table 3-40 Capital Cost - BRT System

ITEM	UNIT COST	QUANTITY	TOTAL COST	AMORT. PERIOD	ANNUAL COST
Highway Improvements					
Third Street Exit Ramp	350,000	1	350,000	30	31,091
Fisher Freeway Bus Lanes	1,505,000	1	1,505,000	30	133,689
Scotten Entrance/Exit Ramps	350,000	1	350,000	30	31,091
Wyoming Transfer Station	1,356,000	1	1,356,000	30	120,453
Southfield-Eight Mile Bus Ramp	300,000	1	300,000	30	26,649
Engineering & Contingency (15%)	580,000		580,000	30	51,521
Subtotal			4,441,000		394,494
BRT Signs					
Jeffries Exclusive Lane			162,000	15	18,922
Bus-Only	100	8	800	15	93
Bus Stop	100	55	5,500	15	642
Subtotal			168,300		19,657
Shelters	3,000	145	435,000	15	50,808
BRT Vehicles (Less Existing D-DOT Express Buses)	67,000	92	6,164,000	10	918,621
Vehicle Storage Facility	$25/sq ft	38,640 sq ft	966,000	30	85,810
Operating Garage	$2780/bus	92	255,800	30	22,723
TOTAL			12,430,100		1,492,113

Table 3-41 Capital Cost - Oakland County Feeder System

ITEM	UNIT COST	QUANTITY	TOTAL COST	AMORT. PERIOD	ANNUAL COST
Feeder Buses	67,000	18	1,206,000	10	179,730
Bus Stop Signs	100	130	13,000	15	1,518
Shelters	3,000	80	240,000	15	28,032
Vehicle Storage Facility*	$25/sq ft	7560	189,000	30	16,789
Operating Garage*	$2780/bus	18	50,040	30	4,445
TOTAL			1,698,040		230,514

* Incremental facility costs

Highway Improvements

Preliminary cost estimates for the highway improvements proposed for the BRT system were provided by the Michigan Department of State Highways and Transportation.

The ramp from the exclusive lane on the Fisher Freeway to the Third Street overpass is estimated to cost $350,000. The Fisher Freeway lane widening, with two bridge structures over existing roadways, is estimated to cost $1,505,000.

The exclusive BRT ramp from the Jeffries Freeway median to the Scotten overpass is estimated to cost $350,000.

The Wyoming transfer station, with two exclusive ramps from the Jeffries median and crossover bridges linking the station with both the eastbound and westbound service drive, is estimated to cost a total of $1,356,000.

The Southfield-Eight Mile Bus Ramp to Northland is estimated to cost $300,000.

The total cost of the above mentioned improvements is $3,861,000. An additional 15 percent, $580,000, was added to this total for engineering and contingency costs.

The assumed amortization period for highway improvements is 30 years.

Signs

A variety of signs are provided in the corridor to designate priority use of facilities by buses and to identify bus stop locations. Bus stop and bus priority signs are assumed to be standard 3- by 4-foot signs which cost $100 each, including installation. For the BRT system, eight bus priority signs and 55 bus stop signs are required. For the Oakland County feeder system, 130 bus stop signs are required.

The cost of the signs for the Jeffries exclusive lanes were extrapolated from the SEMTA cost estimate for lane delineation and signing. Raised, reflective lane markers were included in previous BRT cost estimates. These markers were mentioned in the SEMTA report and were for the purpose of delineating the exclusive lanes. These markers are no longer recommended, for two reasons. A search of the literature available on exclusive bus lanes indicated that pavement paint striping was sufficient for lane delineation, and snow removal equipment would dislodge the markers, making frequent replacement and repair necessary. The capital cost of signs is amortized over a period of 15 years.

Shelters

The estimated cost of bus shelters, $3,000 each, is based on typical shelter costs quoted by the Colombia Equipment Company plus assumed installation costs. The cost of shelters is amortized over a period of 15 years to obtain estimated annual system costs.

Bus shelters are to be located at high demand locations throughout the corridor. They will be located at bus stops along the distribution loops and feeder and collection routes and at each corridor access node. Additional shelters will be located at areas of concentrated demand such as park-and-ride lots. Based on this consideration, it is estimated that 145 shelters are required for the BRT system and 80 shelters are required for the Oakland County feeder system.

The amortization period for bus shelters is assumed to be 15 years.

Vehicles

Based on information received from GMC Truck & Coach Division, $67,000 is a typical price for a coach used in urban transit service. However, it should be noted that coaches with deluxe accommodations suitable for use on reserved bus lanes cost approximately $70,000 each.

The amortization period for vehicles is assumed to be 10 years.

Vehicle Storage Facility

It is estimated that 420 square feet are required to store a transit coach. Storage building costs are assumed to be $25 per square foot, excluding land costs. These capital costs are amortized over a period of 30 years.

Separate entries are provided for vehicle storage facilities for the BRT system vehicles and for the feeder system vehicles. It should be noted that only one structure would be constructed, and the feeder bus storage cost represents the incremental cost necessary to build a large storage facility.

Operating Garage

The operating garage, where buses are fueled, cleaned, and serviced, is estimated to cost $2,780 per bus. This is based upon previous analyses of the requirements and costs of operating garages. These capital costs are amortized over a period of 30 years.

Separate entries are provided for the operating garage costs for the BRT system and for the Oakland County feeder system.. Only one structure will be constructed. The entry provided for feeder system operating garage costs represents the incremental cost necessary to construct a larger facility.

3.8.2 Operating Costs

Tables 3-42 and 3-43 provide summaries of the operating costs of the BRT system and Oakland County feeder system, respectively.

Table 3-42 Annual Operating Cost - BRT System

ITEM	UNIT COST	QUANTITY	TOTAL COST
Facilities Maintenance			
Shelter Maintenance	300	145	43,500
Station Maintenance	3,000		3,000
Station Security	$20,000/m yr	2.5 man yr	50,000
Subtotal			96,500
Vehicle Expense			
Garage	$.1453/mi	3,618,171	525,700
Maintenance	$.1954/mi	3,618,171	707,000
Subtotal			1,232,700
Driver Expense	$12.35/v-hr	155,883	1,925,200
Pavement Markings			
Diamond Markings - Jeffries	$2.45 @	137	300
BRT Lane Striping	$.03/ft	206,000 ft	6,200
Subtotal			6,500
TOTAL			3,260,900

Table 3-43 Annual Operating Costs - Oakland County Feeder System

ITEM	UNIT COST	QUANTITY	TOTAL COST
Shelter Maintenance	300	80	24,000
Vehicle Expense			
Garage	$.1713/mi	700,485 mi	120,000
Maintenance	$.1941/mi	700,485 mi	136,000
Subtotal			256,000
Driver Expense	$12.35 v-hr	43,656 hr	539,150
TOTAL			819,150

The operating costs of the BRT system as well as the Oakland County feeder system include driver wages, garage expenses, vehicle maintenance expenses, and shelter maintenance costs. The BRT system costs also include facilities maintenance expenses and pavement restriping costs.

Driver costs are estimated to be $12.35 per vehicle operating hour. This is based on the expected driver costs per revenue hour for DDOT in July of 1975. The average base salary is $6.36 per hour. However, because the $12.35 is a cost per revenue hour, it includes non-production time such as sign-on time, travel time, deadhead, premium pay, waiting time, lost time, vacation and holiday pay, sick leave, and retirement benefit costs.

Vehicle garage expenses include fuel costs, lube costs, cleaning materials, and the labor required to clean and service the vehicles. DDOT garage expense from July 1974 to March 1975 was 17.13 cents per vehicle mile. DDOT buses average about 12 miles per hour. BRT buses will average 20 to 25 miles per hour and will, therefore, have greater fuel efficiency. It is expected that they will get 6 to 6.5 miles per gallon rather than the 4 miles per gallon average for DDOT buses. Therefore, BRT garage expenses are estimated to be 14.13 cents per mile (assuming fuel costs at 29.75 cents per gallon). The garage expenses associated with the Oakland County feeder buses are assumed to be 17.13 cents per mile because these buses are expected to operate at speeds similar to DDOT buses.

Vehicle-related maintenance expense is the cost of heavy maintenance. It includes labor, supervision, and material costs. Also included are the costs of maintaining the building and grounds. The DDOT cost of 19.54 cents per vehicle mile are used in the calculations.

Lane striping and diamong-shaped markings are used to delineate exclusive transit lanes on public streets. According to DDOT estimates, the cost of striping is 3 cents per linear foot. Two stripes are required for each exclusive bus lane of the Jeffries and Fisher Freeways. The combined length of these four stripes is 206,000 feet. Diamond-shaped pavement markings are also required to identify the exclusive BRT lanes. Each 12- by 2.5-foot diamond consists of 24.5 linear feet. An average 100-foot spacing is assumed. The cost of these pavement markings, assuming the DDOT estimate of 10 cents per linear foot for hand work, is $2.45 each. There are 137 diamond-shaped pavement markings required. Although public streets usually require restriping twice a year, these transit priority pavement markings are assumed to last a full year as a result of the lower vehicle volumes associated with a reserved bus lane.

The Wyoming station maintenance expense is assumed to be $3,000 per year and includes periodic cleaning and repair. In addition, one station security guard will be present during the hours of system operation. The cost of a guard is assumed to be $20,000 per man year. The station will be in operation approximately 14 hours a day. It is assumed that 2.5 man years of effort will be required to provide this manned patrol service.

The annual bus shelter maintenance expense is assumed to be $300 per shelter to cover periodic cleaning and repair.

3.9 Cost/Revenue Analysis

In this section, estimates of the revenues will be compared to BRT costs, variable and fixed. This is not a benefit/cost analysis since no social benefits are included; only fare box totals are considered. The objective is to compare revenues and costs at various fare structures to supply administrators with guidelines for selecting fare policies.

3.9.1 BRT Modal Split Fare Sensitivity

By employing the modal split model briefly discussed in Section 4.0, Stage I, patron sensitivity to fare for the Southfield/Jeffries corridor can be measured. Six different fares, ranging from $0.20 to $1.25 for a one-way trip, are used, while all other variables are held constant. It is assumed that all patrons pay the same fare, resulting in a flat fare structure.

One expects demand to decrease as fare increases; Figure 3-45 clearly supports this proposition for the destinations considered (CBD, New Center, and total). Plotting the percent change in fare versus the percentage change in the number of BRT trips, both determined from a nominal fare of $0.45, a sensitivity plot is attained (see Figure 3-46).

On the average, trips from the Southfield/Jeffries corridor to the New Center are shorter than trips to the CBD. Any increase in fare would cause a larger percent change in fare with respect to mileage for the New Center trips, one probable cause for the higher sensitivity to fare changes.

3.9.2 Revenues from Detroit Patrons

Two areas are used in the cost/revenue analysis--Detroit and Oakland County. Only one mode of BRT access is assumed for Detroit (collection bus), while two different modes are assumed for Oakland County (park-and-ride and feeder). Each of these modes needs to be treated separately, since various services and distances are involved.

A total of 6340 one-way peak-period trips originate in Detroit with destinations to the New Center or CBD. Of these trips, 5162 are destined for the CBD and 1178 trips are for the New Center. By multiplying demand by two-way fare, an estimate for daily revenue from peak-period patrons is determined. The explicit assumption is that everyone makes a round trip, a valid supposition about commuters.

As shown in the sensitivity analysis, demand decreases with an increase in fare. By employing Figure 3-46, adjustments in demands, and consequently revenues, are made. Revenue is calculated by:

$$R = 2FD_B (1 + \Delta D)$$

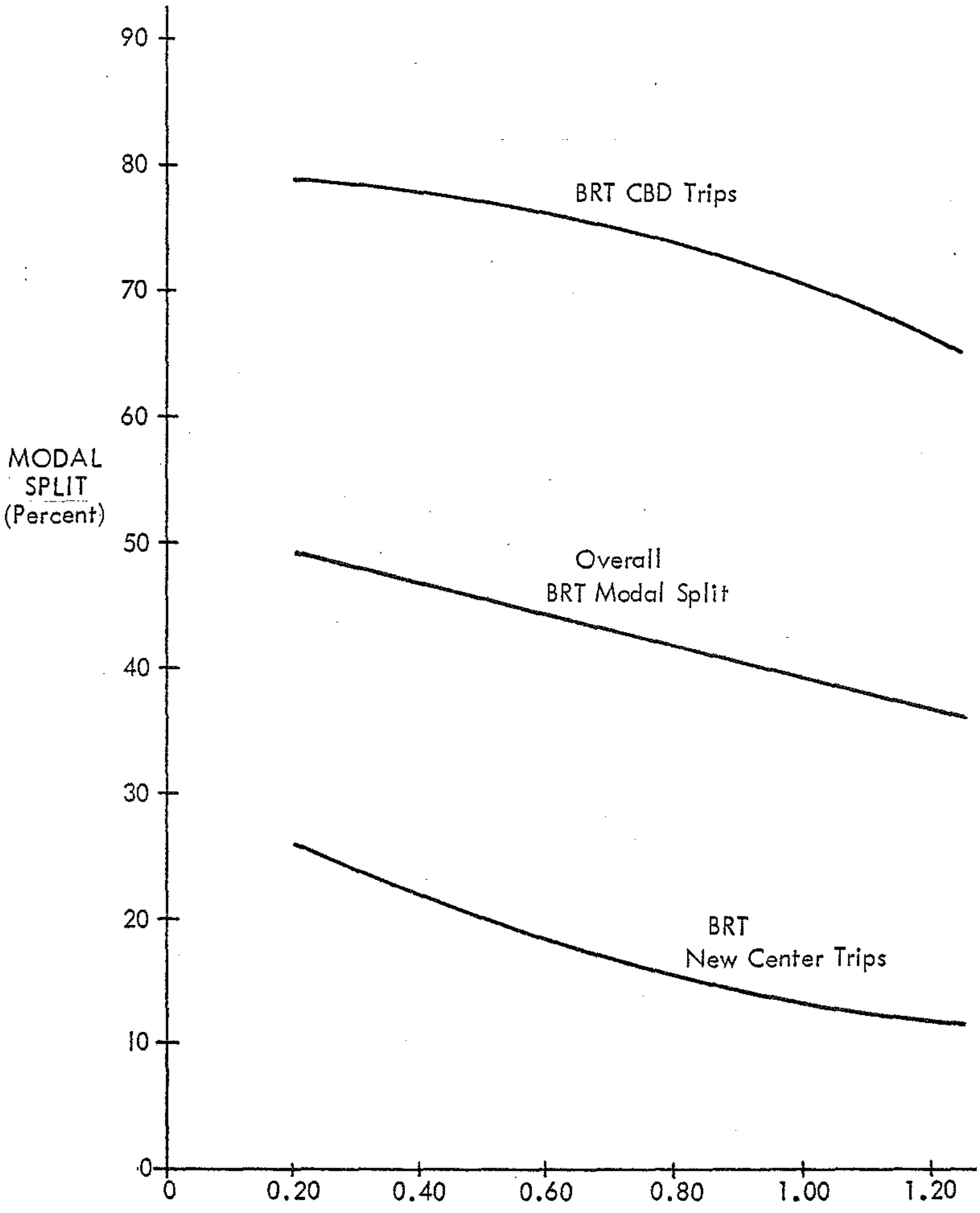


Figure 3-45 Modal Split Fare Sensitivity for Southfield/Jeffries Corridor (Flat Fare)

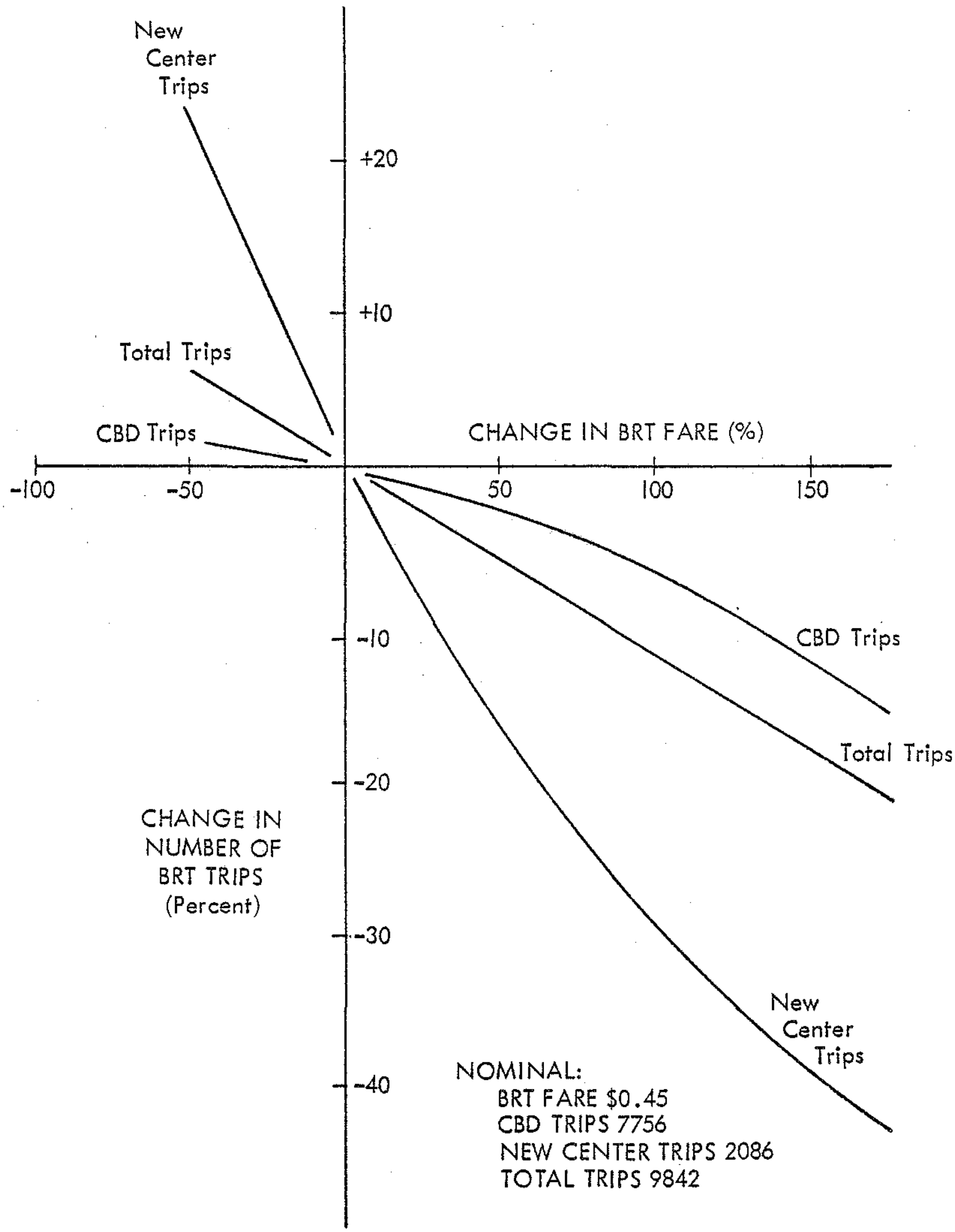


Figure 3-46 Modal Split Fare Sensitivity for Southfield/Jeffries Corridor by Percent Change (Flat Fare)

R = Daily revenue from both peak periods

F = One-way fare

D_B = Base demand

Δ_D = Change in demand, determined from Figure 3-46

The results of applying the sensitivity data are shown in Figure 3-47.

Since the length of travel and percent of mileage on the freeway varies among routes, a zonal fare structure is considered. As BRT mileage on the freeway increases with respect to distance on urban arterials, the level of service increases; and higher fares can be charged. The difference in zonal fares is dependent on level of service in each zone, but for simplicity, a 5- or 10-cent difference between zones is assumed.

All bus routes follow one of two basic patterns:

- Originate at the western boundary and travel east to Southfield, then an express run to the New Center or CBD with one stop at the Jeffries/Wyoming interchange
- Originate at Southfield and travel east to Wyoming, Wyoming to Jeffries, and then express to the New Center or CBD

Southfield is rarely crossed by bus routes, so it is used as a north-south zonal boundary. Figure 3-48 shows the fare zones finally selected for revenue analysis. Fare Zones 1 and 2 are separated since Zone 2 routes have a lower percent of expressway mileage than Zone 1. The fare structure is such that Zone 1 has the highest fare and Zone 3 the lowest, representative of the level of service and average distances.

The fare zone demands are shown in Table 3-44.

Table 3-44 Detroit Demands

FARE ZONE	CBD	NEW CENTER	TOTAL
1	1,332	374	1,706
2	985	123	1,108
3	2,845	690	3,535*
Total	5,162	1,178	6,340

* Excludes 221 person trips not well serviced and 226 person trips diverted to the Blue Express.

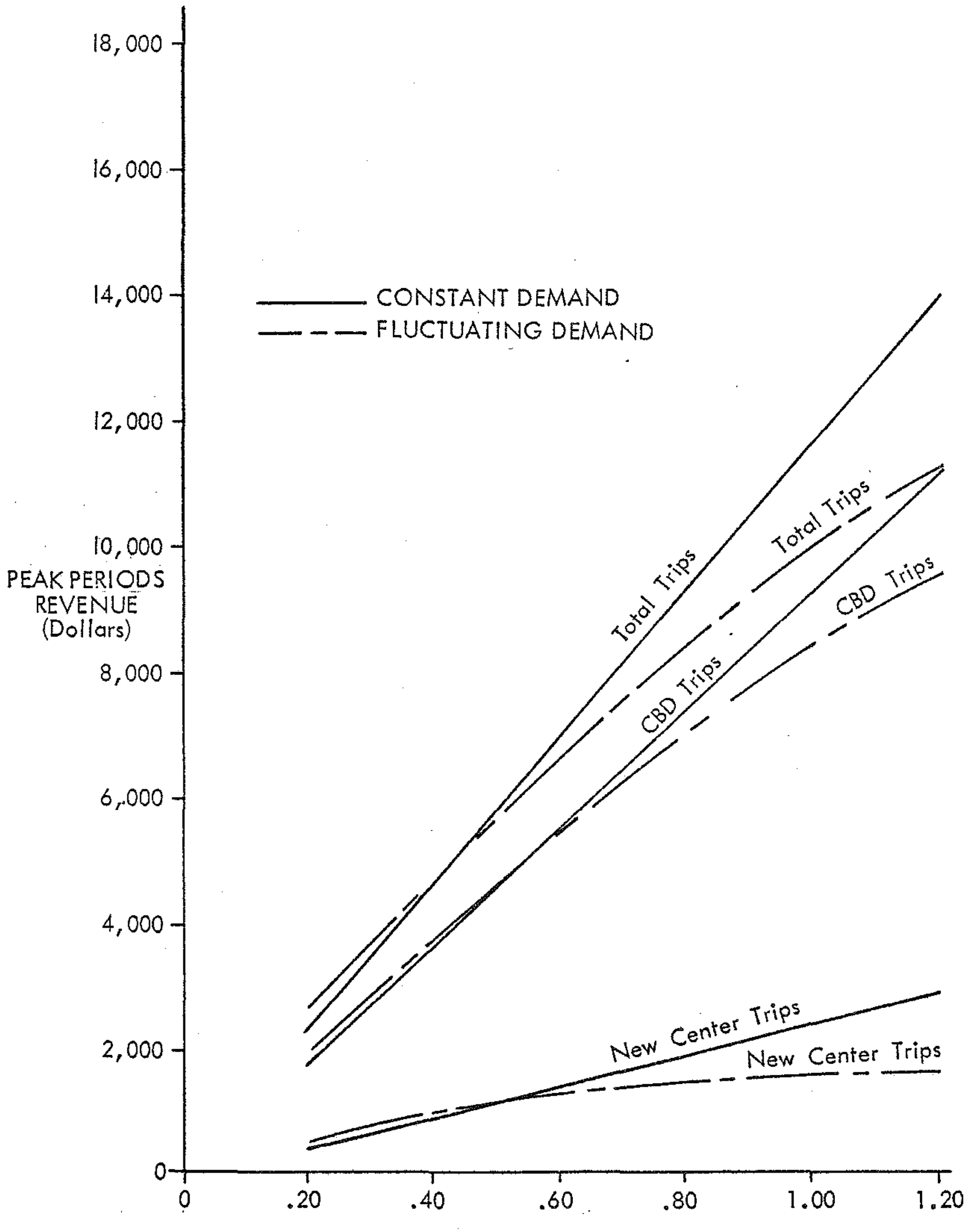


Figure 3-47 BRT Revenue from Detroit Patrons, Peak Periods, Flat Fare Structure Operation

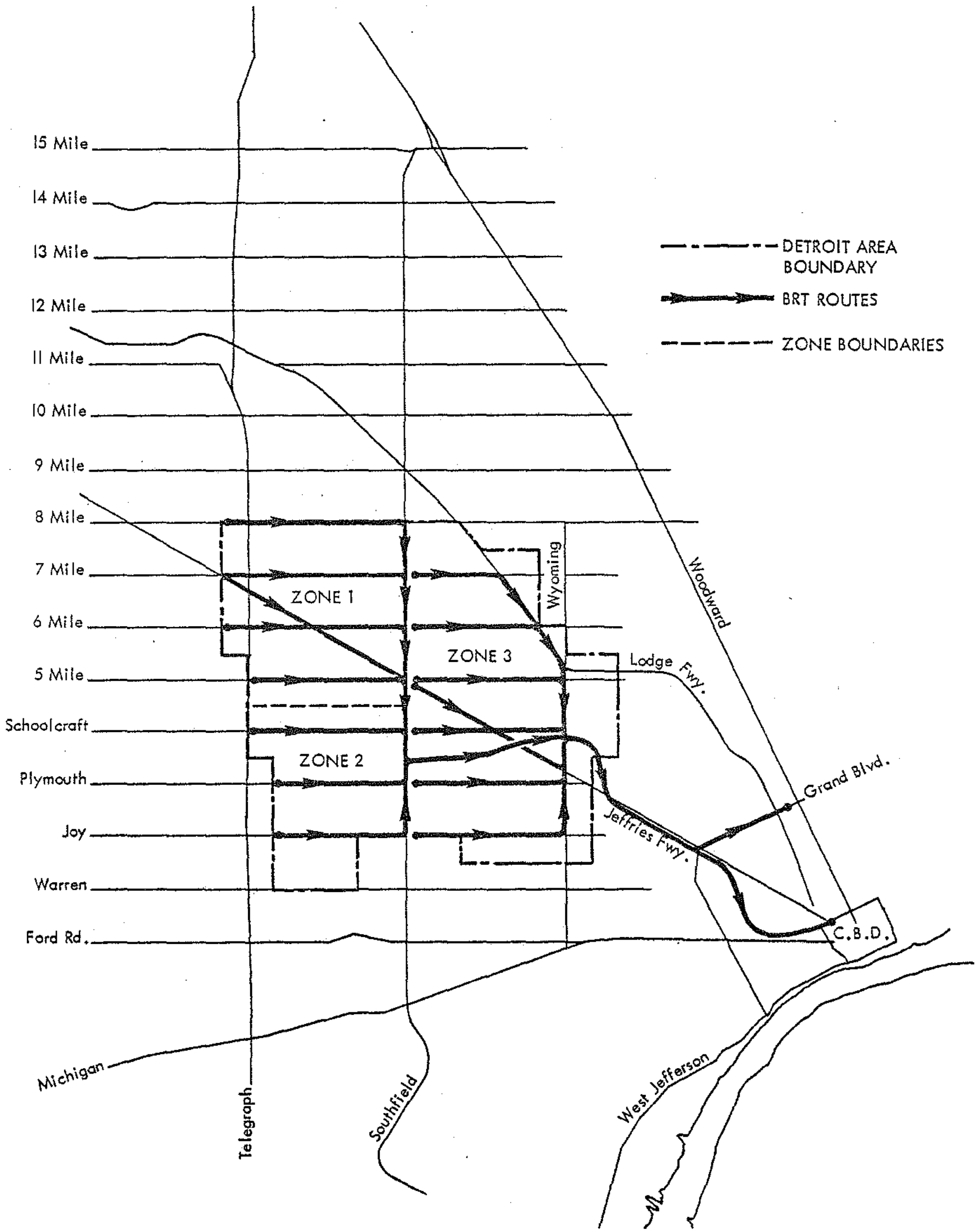


Figure 3-48 Assumed Fare Zones in Detroit

Using these demand figures, the daily revenue for various fare structures can be estimated. The equation for revenues when demand is fluctuated becomes:

$$R_z = 2\left[\sum_{i=1}^{n} F_i \; D_i \; (1 + \Delta D_i)\right]$$

R_z = Daily revenue from peak periods using zonal fares

F_i = One-way fare of Zone i, i = 1, 2, 3

D_i = Base demand for Zone i, i = 1, 2, 3

ΔD_i = Change in demand for Zone i, i = 1, 2, 3

n = Number of fare zones

The revenues resulting from two fare structures, 5- and 10-cent difference between zone fares, using both constant and fluctuating demand, are shown in Figure 3-49.

3.9.3 Oakland County Feeder System

Revenues from Oakland County feeder system are determined in a manner similar to that used in Section 3.9.2. Figure 3-50 graphically displays the results of a flat fare structure for various destinations. A zonal fare structure was then applied and revenues recalculated.

The three zones are (see Figure 3-51):

A - North of 13 Mile Road
B - North of 10 Mile Road to 13 Mile Road
C - North of 8 Mile Road to 10 Mile Road

The average distance from one zone to the next is one to one and a half miles. At a maximum, the difference in fares between two neighboring fare zones should be $0.10. Any difference greater than ten cents may result in a modal shift to park-and-ride since an out-of-pocket auto cost is taken as five cents per mile, and the distances are relatively short.

As in Section 3.9.2, a five or ten cents difference between fare zones is used to determine revenues. The results are shown in Figure 3-52.

The sensitivity and analysis results are used to determine fluctuating demand, but the analysis was made in Detroit which has a nominal fare of $0.45, while Oakland County's nominal fare is $1.00. By taking an average income group (income of $7,210+), an excess time ratio of 1.19-1.56 (Class 3), and a transit time ratio of 1 and 2, the diversion

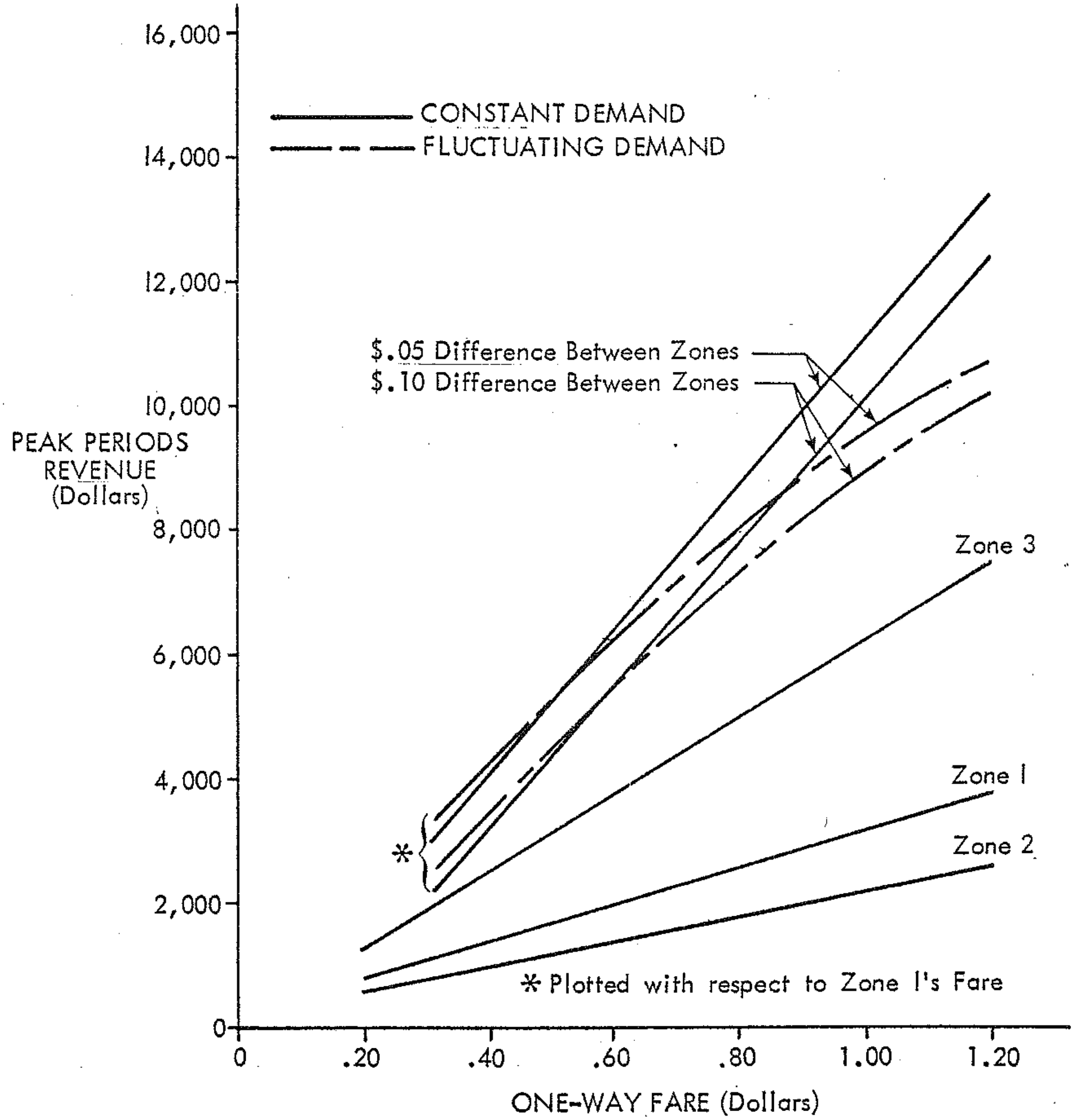


Figure 3-49 BRT Revenue from Detroit Operation during Peak Periods, Zone Fare Structure

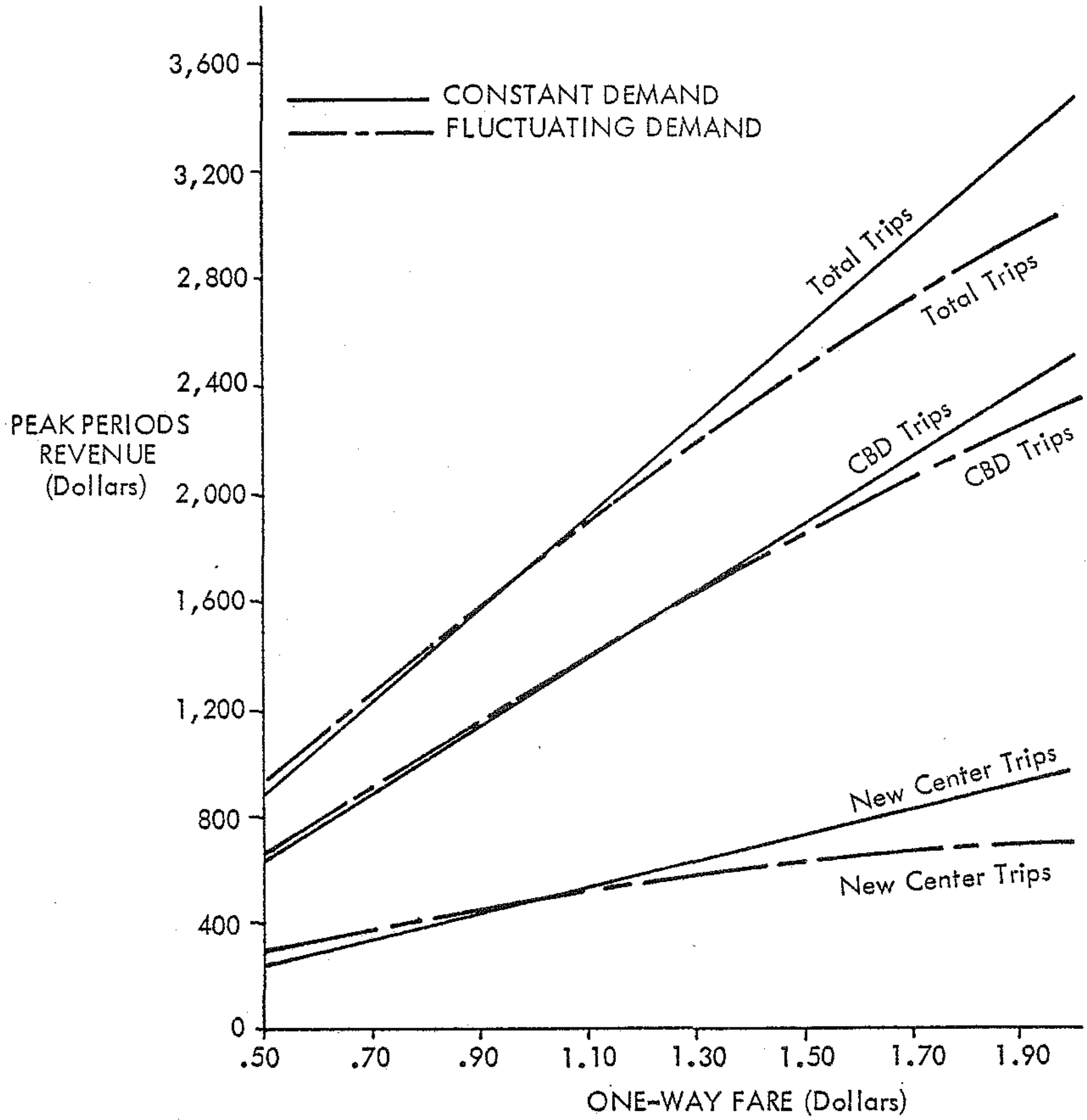


Figure 3-50 BRT Revenue from Oakland County Feeder Patrons, Peak Period Operation, Flat Fare Structure

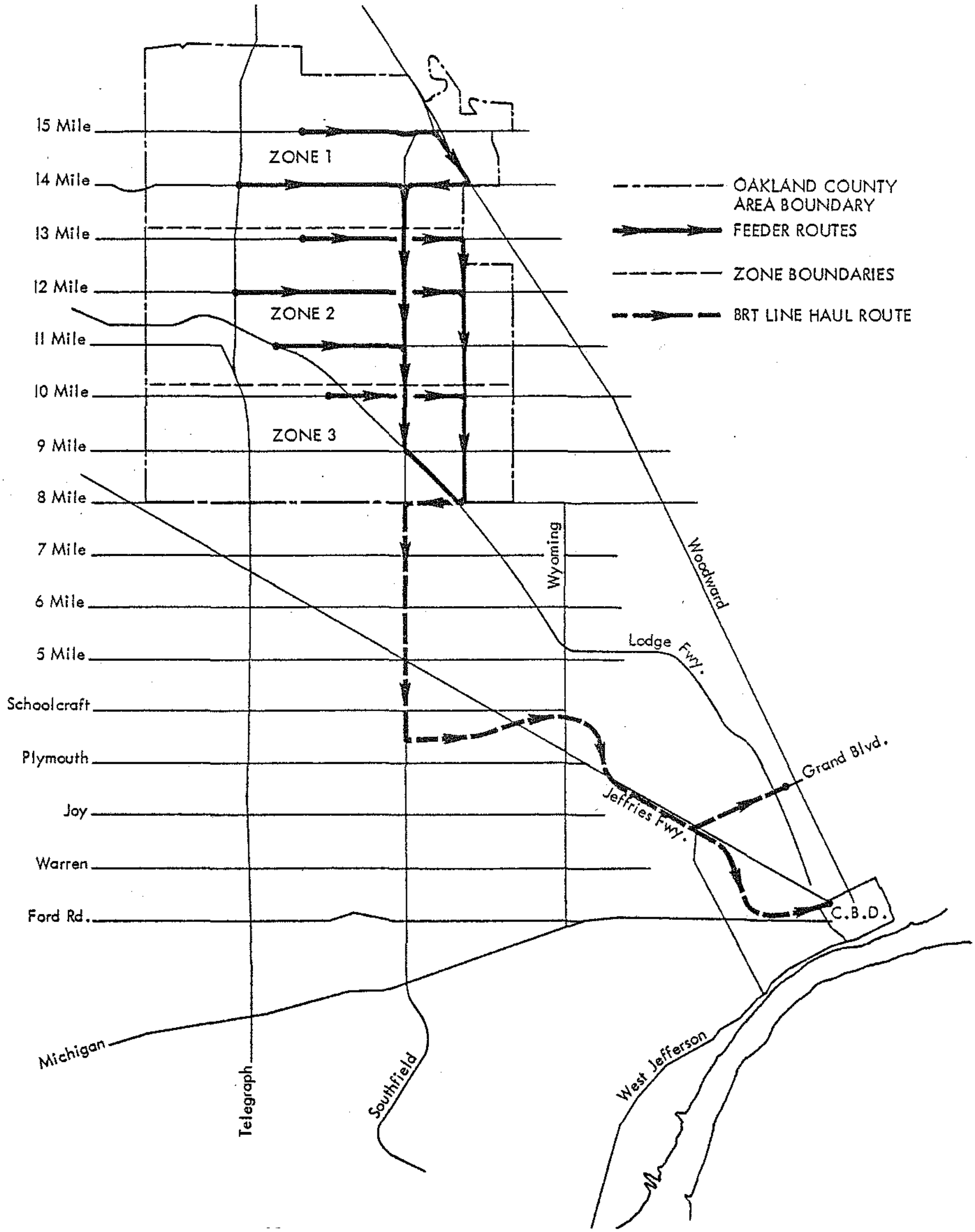


Figure 3-51 Assumed Fare Zones in Oakland County

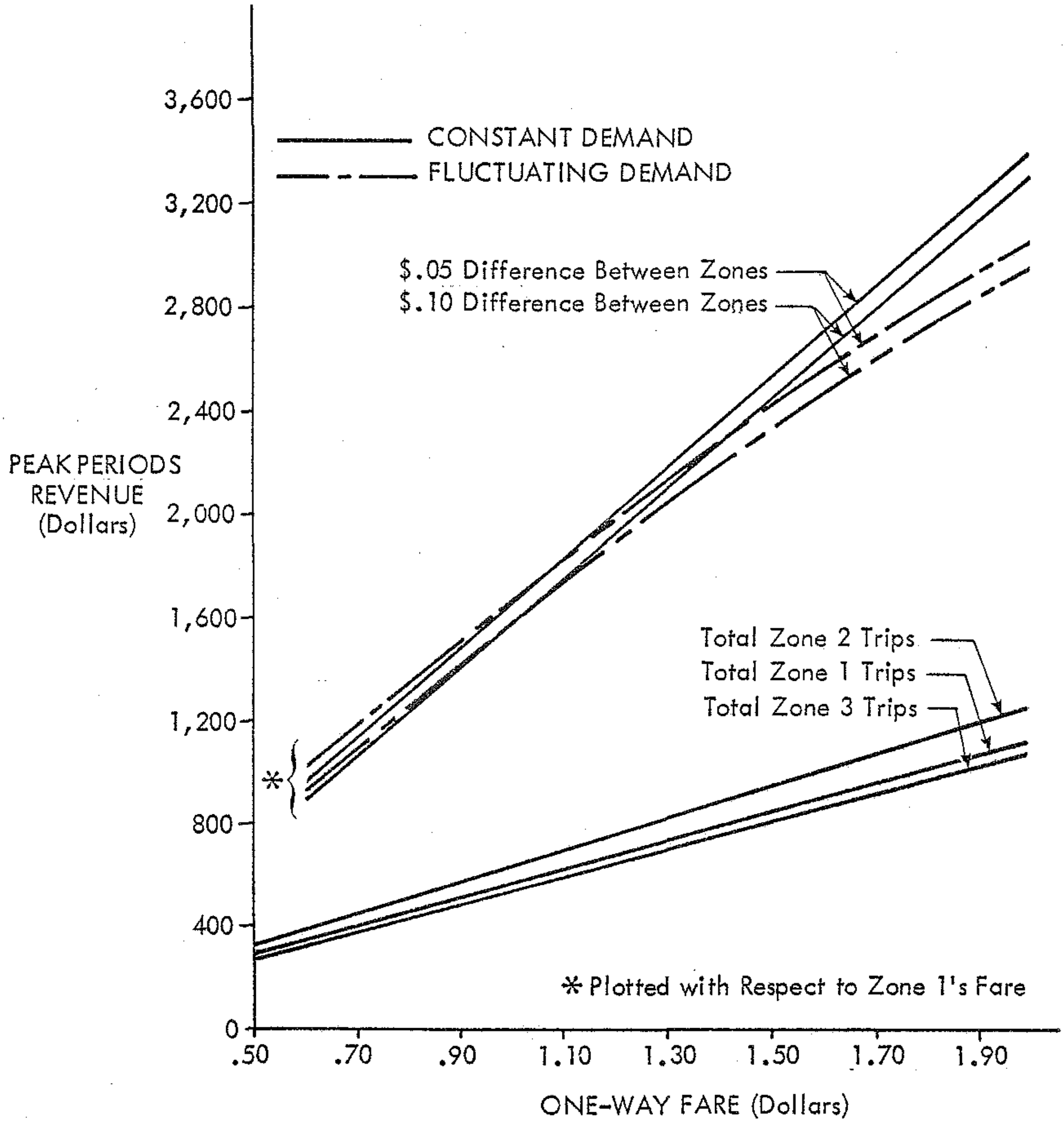


Figure 3-52 BRT Revenue from Oakland County Feeder Patrons, Peak Period Operations, Zone Fare Structure

curves were used to determine the effects of fare changes from a nominal $1.00. It was found that for any increase in fare above the base $1.00, the change in demand was very similar to the change using a base fare of $0.45. For decreases in fare, the $1.00 base fare sensitivities were lower. The sensitivities of the New Center and CBD were similar but not as close as total trips. The overall effect was that a 50 percent increase from $1.00 resulted in a smaller percent change in the number of BRT trips as a corresponding 50 percent increase from $0.45. The values from the $0.45 base fare study were used in determining Oakland County revenues. It is felt that the error is insignificant when compared to the total revenue, especially for total trips.

The demands for the feeder bus service are shown in Table 3-45.

Table 3-45 Oakland County Feeder Demands

FARE ZONE	CBD	NEW CENTER	TOTAL
A	201	79	280
B	242	73	315
C	186	90	276
Total	629	242	871

3.9.4 Oakland County Park-and-Ride System

As in the two previous sections, revenues are determined for total trips and two destinations, CBD and the New Center. Unlike the other sections, no zone fares will be implemented. As seen from Figure 3-53, access to the park-and-ride lots is very simple. To charge more at one lot may make it feasible for patrons to drive further to another lot. To prevent this migration toward lots with lower fares, a uniform fare at all lots is applied. This has the effect of making it beneficial and energy-efficient to drive to the nearest park-and-ride lot.

Another difference is in determining the change in demand due to a change in fare. In the modal split analysis, the out-of-pocket costs for a park-and-ride patron is the $1.00 base fare plus $0.05 per mile driven to the nearest lot. Patrons in Areas 1 and 2 of Figure 3-53 are served by the park-and-ride lots in those areas, and Area 3 lots serve the remaining patrons. By assuming an average distance of 1 mile to the lots of Areas 1 and 2, and 3 miles for Area 3, it is possible to determine the effects of fare changes. Instead of determining the change in fare from the basis of $1.00, it is now determined on the basis of $1.05 for Areas 1 and 2, and $1.15 for Area 3. The results are plotted in Figure 3-54, while the base demands used are shown in Table 3-46.

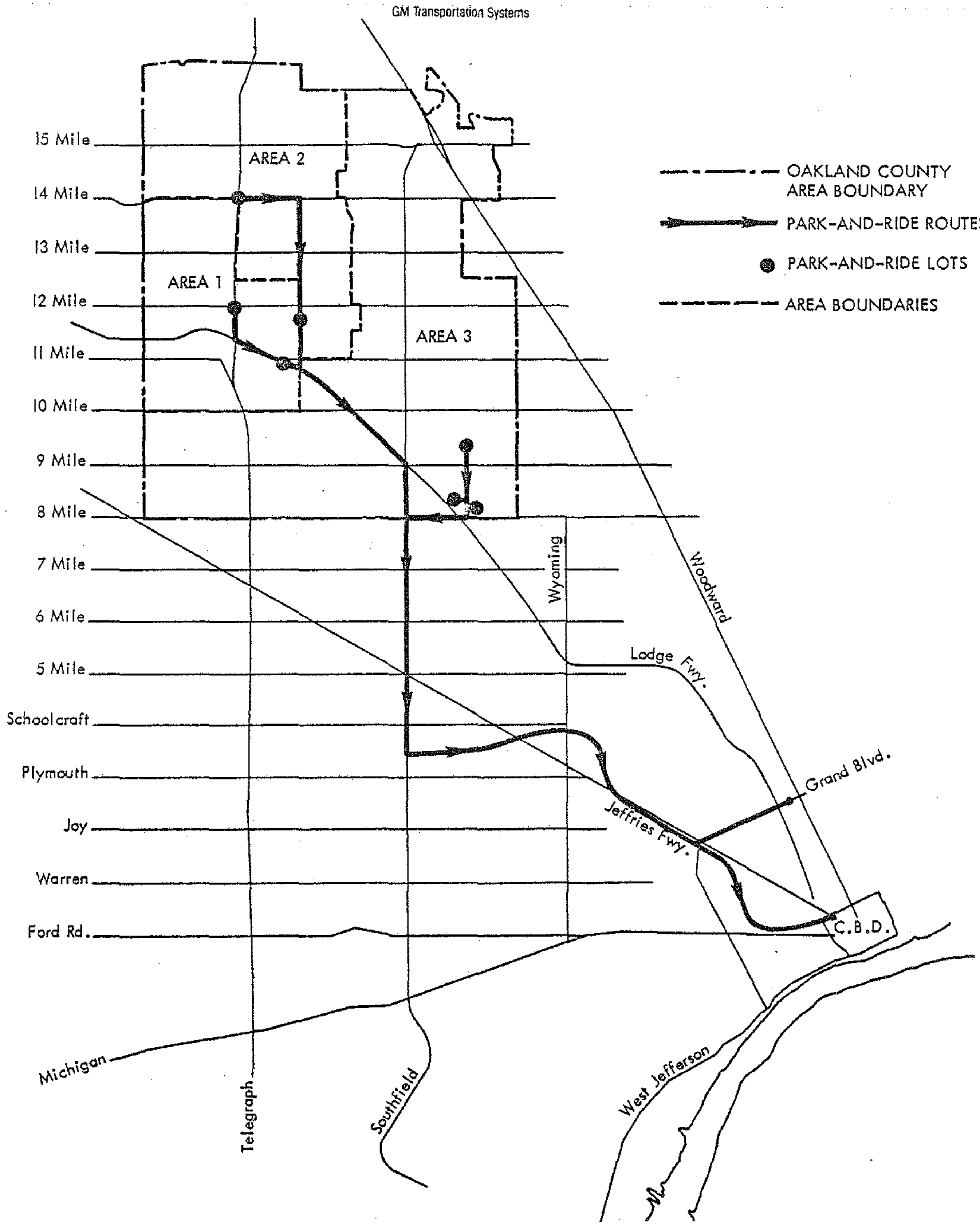


Figure 3-53 Proposed Oakland County Park-and-Ride Lots and BRT Collection Routes

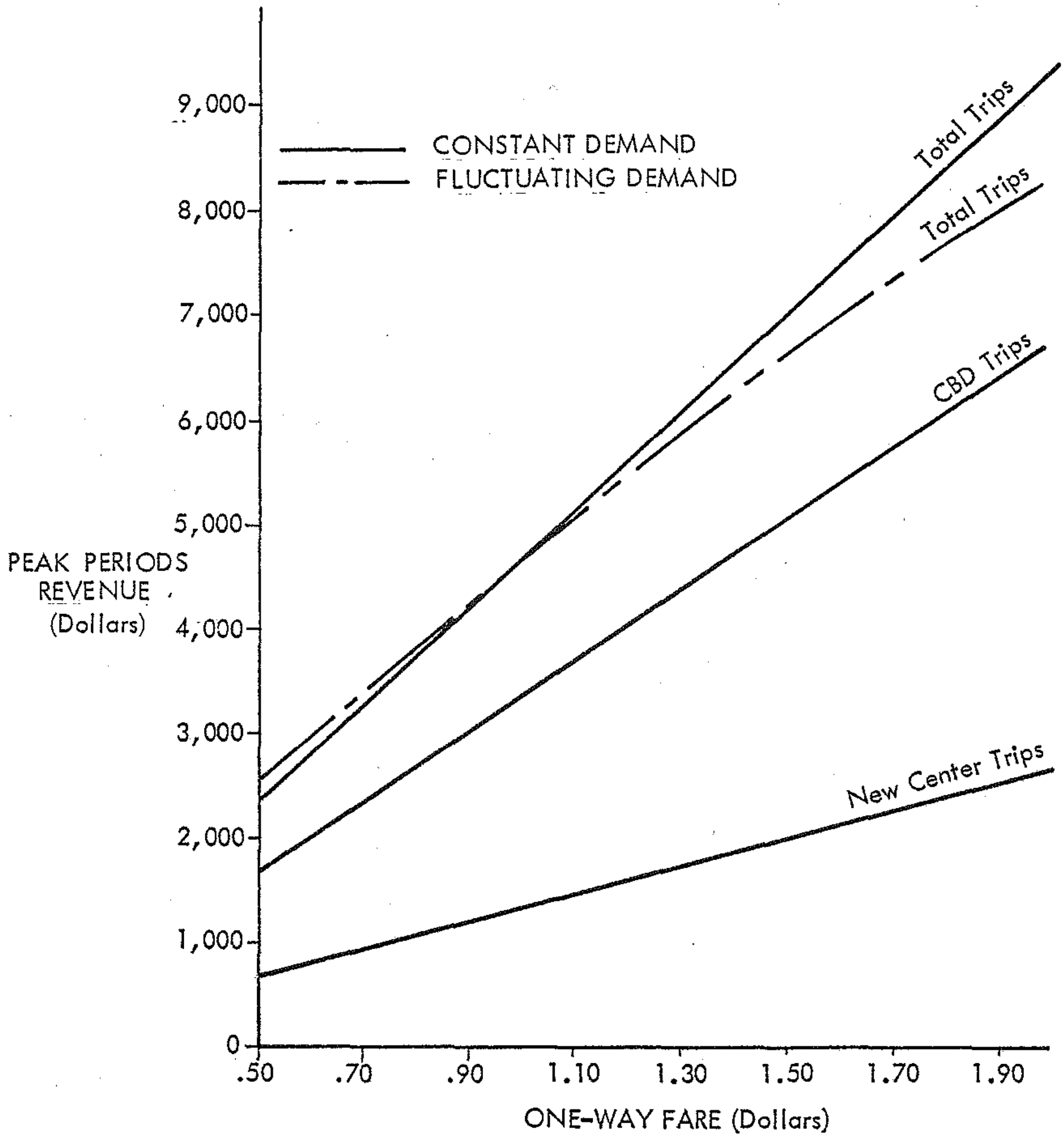


Figure 3-54 BRT Revenue from Oakland County Park-and-Ride Patrons, Peak-Period Operation, Flat Fare Structure

Table 3-46 Oakland County Park-and-Ride Demand

AREA	CBD	NEW CENTER	TOTAL
1 & 2	749	362	1,111
3	930	299	1,229
Total	1679	661	2,340

3.9.5 Comparison of Costs and Revenues

In Section 3.8, the annual costs of the BRT and Oakland County feeder system are determined. By employing these costs, it is possible to perform a cost/revenue analysis.

In Sections 3.9.2 through 3.9.4, revenues were determined using both constant and fluctuating demands. The effects of raising fares is to decrease demand, yet costs were determined assuming a constant demand. By maintaining the change in demand under 5 percent, the effect on system sizing, and consequently costs, is felt to be negligible. This assumption may not hold true at Northland, where the volume of passengers may be significantly large to be affected by a 5 percent change in demand. But overall, the total system costs would show little change. Fare changes only up to 50 percent are used, resulting in, at a maximum, a 5 percent change in demand (see Figure 3-46).

Three fare structures are used to estimate annual revenues for comparison with costs: flat fare, a 5-cent difference in zonal fares, and a 10-cent difference. The revenue versus fare graphs of Sections 3.9.2 through 3.9.4 are used to determine the revenues from Detroit and Oakland County feeder and park-and-ride systems. These figures give revenue in terms of daily peak period, while costs are estimated on an annual basis. The revenues are expanded to yearly sums so that comparisons can be made.

Table 3-47 shows the comparison of costs and revenues, using a flat fare structure. When compared to total annual costs, revenues are lower than costs. When compared to annual operating costs, revenues are larger when a 50 percent increase in fare is applied.

When a zone fare structure is assumed for Detroit and Oakland County feeder system, different revenues are obtained. The results of using a 5-cent difference in zone fares are shown in Table 3-48. Since there are three zones, one had to be chosen as a basis for determining the percent change from the base fare. In all cases, the zone with the lowest fare is used so that no zone would have a base fare lower than the existing base fare.

The effect of a 10-cent difference in zone fares are displayed in Table 3-49. Initiating a zonal fare system results in a decrease in revenues and an increase in required annual funding. Only at a 50 percent increase in fares are operating costs covered.

Table 3-47 Annual Revenues (in Thousands) Using Flat Fares and Fluctuating Demand

REVENUE	PERCENT CHANGE FROM BASE FARE				
	-50%	-25%	0%	+25%	+50%
Annual Revenue[a]	1,719	2,386	3,092	3,732	4,412
o Annual Revenue Less Total Annual Costs[b]	-4,081	-3,414	-2,708	-2,068	-1,388
o Annual Revenues Less Total Annual Operating Costs[c]	-2,358	-1,691	- 985	- 345	335

Table 3-48 Annual Revenues (in Thousands) Using Zone Fares ($0.05)

REVENUE	PERCENT CHANGE FROM BASE FARE[d]				
	-50%	-25%	0%	+25%	+50%
Annual Revenue[a]	1,799	2,546	3,239	3,959	4,532
o Annual Revenue Less Total Annual Costs[b]	-4,001	-3,254	-2,561	-1,841	-1,268
o Annual Revenue Less Total Annual Operating Costs[c]	-2,278	-1,531	- 838	- 118	455

Table 3-49 Annual Revenues (in Thousands) Using Zone Fares ($0.10)

REVENUE	PERCENT CHANGE FROM BASE FARE				
	-50%	-25%	0%	+25%	+50%
Annual Revenue[a]	1,959	2,626	3,319	3,972	4,585
o Annual Revenue Less Total Annual Costs[b]	-3,841	-3,174	-2,481	-1,828	-1,215
o Annual Revenue Less Total Annual Operating Costs[c]	-2,118	-1,451	- 758	- 105	508

(a) Using daily peak-hour demand x 1.045 x 255 days/yr; 1.045 increases demand to daily usage (peak and off-peak).
(b) Annualized capital plus operating, $5,800 thousand
(c) $4,077 thousand
(d) The percentage change in fare will be taken from the zone with the lowest fare; revenues from park-and-ride lots are not affected by zone fares.

4.0 INTERMEDIATE SERVICE IN THE SOUTHFIELD-GREENFIELD CORRIDOR

The potential transit demand in the Southfield-Greenfield corridor, as estimated in Stage I, is not sufficient to support the non-stop (or one-stop) BRT service envisioned for the Southfield-Jeffries corridor. An intermediate stopping service is therefore proposed to provide improved transit service in the corridor. This section of the final report presents the analyses which led to the design of the Intermediate Service. Following an overview of the system, the evaluation of alternative routes and implementations is described. Then a summary of the corridor demand analysis, including consideration of potential demand for Fairlane, is presented. Finally, system cost estimates are presented.

4.1 Overview of Greenfield Intermediate Service

The objective of the Intermediate Service is to provide a higher level of service in the Southfield-Greenfield corridor than is currently being provided by local buses with a system that can be deployed quickly and with low capital investment.

The system which is proposed to satisfy this objective is an intermediate level bus service operating on Greenfield Road between Southfield and Dearborn. The system is designed to provide improved travel time for relatively long transit trips (two miles or more) by stopping only at major cross-streets and by operating with traffic signal pre-emption. The proposed system operates at constant 12-minute headway throughout the day from 7:00 a.m. to 9:00 p.m. During periods of peak work trip demand (7:00 to 10:00 a.m. and 3:00 to 6:00 p.m.), the route is configured so that direct distribution service is provided to employment sites in Dearborn and in Southfield along Northwestern Highway. A schematic representation of this route, showing stop locations, is shown in Figure 4-1. In addition, a shuttle bus operating at 15- to 20-minute headways between Fairlane Town Center and the Ford Route Plant is proposed. During off-peak periods, Southfield and Dearborn Distribution Routes are eliminated, and the Intermediate Service operates between Northland and Fairlane. Access to the Northland terminal is provided by the Oakland County Feeder System described earlier in this report. The existing DDOT local bus system is assumed to provide feeder service to the line-haul portion of the Intermediate line. Off-peak access to the Fairlane terminal from Dearborn employment sites is provided by a proposed Dearborn Shuttle which operates on a headway of about 35 minutes.

4.2 System Synthesis

This section describes the evaluation of alternatives which led to the selection of Greenfield as the line-haul route for the Intermediate Service. The distribution routes proposed for Southfield and Dearborn are also described.

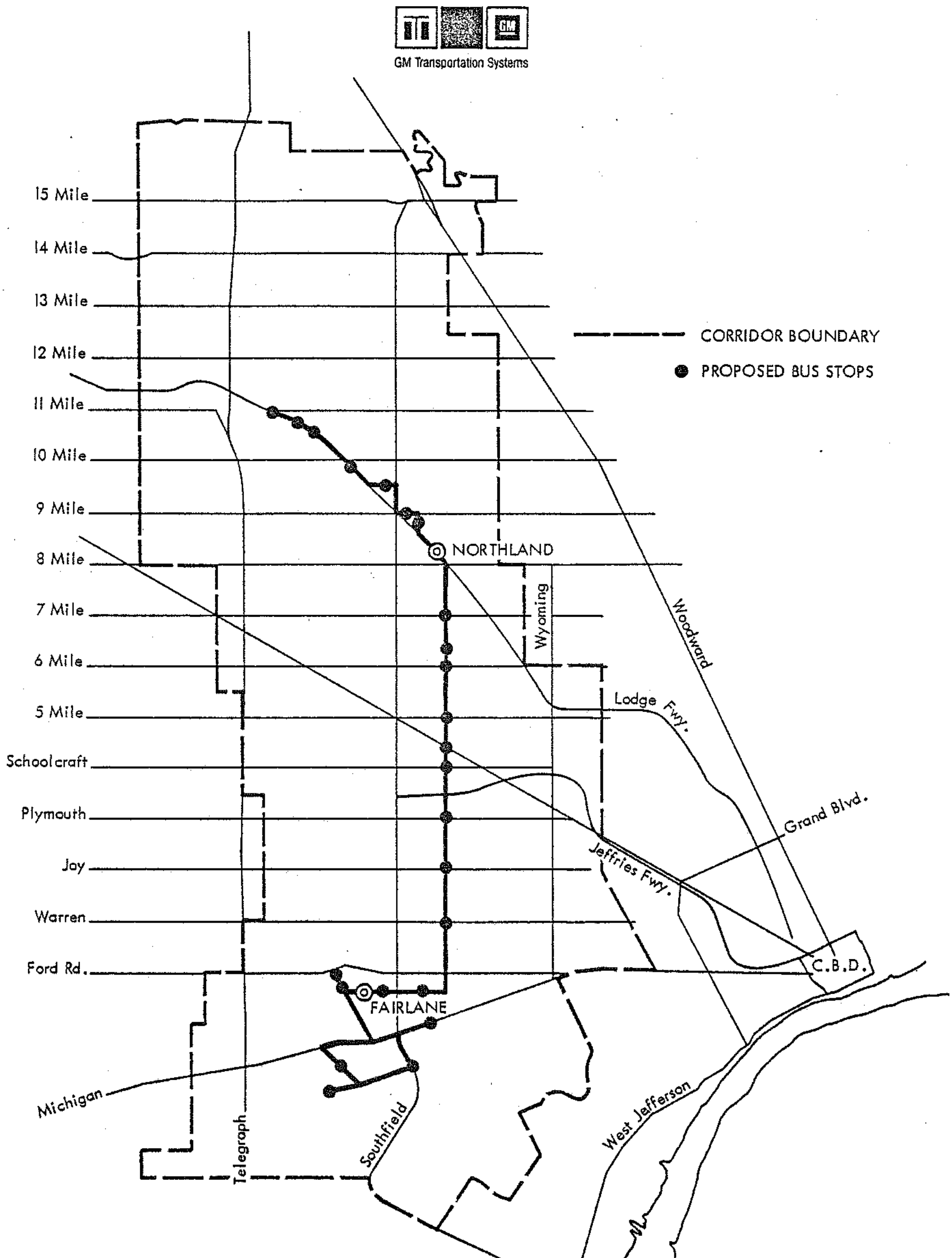


Figure 4-1 Schematic of Greenfield Intermediate Service Route

4.2.1 Alternative Bus Priority Treatments

Two alternative line-haul routes, one using Southfield and the other using Greenfield, were considered in the design of the Intermediate Service. Alternative bus priority treatments on these two routes were considered in detail in Stage I. The evaluation of alternatives in Stage I was concerned with selecting an essentially non-stop BRT route assuming that a relatively large number of buses would be in operation in the peak hour. Since the Intermediate Service involves a fewer number of buses operating throughout the day and stopping at approximately one-mile intervals, the alternative priority treatments for each route were re-evaluated. It was concluded that the best Intermediate Service implementation alternative for Southfield is, essentially, the one that was recommended in Stage I. The alternative involves mixed-traffic operation with the existing signal progression system in Oakland County and mixed-traffic operation without special priority on the freeway. It is not recommended that Southfield Road be widened north of Lincoln as proposed in Stage I because the volume of buses operating on the Intermediate Service route (5 per hour as indicated in Section 4.3 of this report) is not sufficient to justify the construction cost.

The best alternative implementation for the Greenfield route is also similar to the one recommended in Stage I. The route is the same as the Southfield alternative north of Eight Mile Road but follows Greenfield instead of Southfield Freeway in Detroit. The implementation alternative recommended for the Greenfield portion of the route is mixed-traffic operation with traffic signal pre-emption. Pre-emption was not recommended in Stage I because the volume of BRT buses operating on the route would totally disrupt cross-street progression. This is not considered to be a serious disadvantage with the Intermediate Service implementation because the average interval between buses (6 minutes - 5 buses per hour in each direction) is equal to several cycle times of the signal.

Less than 25 percent of the cycles will be pre-empted thus retaining the benefits of progression for most of the traffic. Signals at all intersections need not be equiped with pre-emption equipment to realize a significant increase in bus speeds. Signals at streets with particularly high traffic flows (e.g., Grand River) may be exempt from pre-emption.

4.2.2 Route Selection

Concurrent with the re-evaluation of implementation alternatives, the design of the proposed Oakland County Feeder System was being completed. As indicated in Section 3.4, the proposed feeder system is focused on Northland, and the routes use both Southfield and Greenfield to access Northland Center.

The proposed headway on each route is about 20 minutes in the peak period and ranges from 30 to 40 minutes during off-peak periods. The combined headway on Southfield Road between Northland and Fourteen Mile is less than 20 minutes even during base periods. It was determined that this new service is sufficient to service the portion of the corridor north of Northland. Therefore, the alternative routes were evaluated on the basis of providing line-haul service between Northland and Fairlane Center in Dearborn.

The alternative route using Southfield runs southeast on the Lodge Service Drive from Northland to Eight Mile, west on Eight Mile to Southfield, south on Southfield Freeway to Ford Road, south on Southfield Service Drive to Hubbard Drive, and then west on Hubbard to Fairlane Center. Buses operating on this route would exit the freeway at each mile road to make intermediate stops on the Service Drive. They would operate on the Service Drive between Seven Mile and McNichols to serve Mercy College. The alternative route using Greenfield runs southeast on the Lodge Service Drive from Northland to Greenfield, south on Greenfield to Hubbard Drive, and then west on Hubbard to Fairlane Center. Buses operating on this route would make intermediate stops at the mile roads plus Outer Drive and Grand River.

The two routes were evaluated on the basis of the six factors listed in Table 4-1. The first factor, estimated demand potential, is a measure of the total number of trips in the corridor to destinations potentially served by each route. TALUS zones located adjacent to each route were identified as destinations. Other zones located in Southfield and Dearborn which were assumed to be served by Intermediate Service distribution routes, were also identified as potential destinations. Table 4-2 lists the destinations which were assumed for each route. The number of trips attracted to these destinations by all modes during the morning peak period was determined from the TALUS Survey data. The modal split program developed in Stage I was used to estimate the number of Intermediate Service riders assuming each route. The resulting transit trips were screened to eliminate trips of less than two miles. It is assumed that these short trips are served by local buses rather than by the intermediate stopping service. As Table 4-1 indicates, slightly larger number of trips (both total trips and screened transit trips) are attracted to destinations adjacent to the Southfield route in the morning peak period.

The second evaluation factor that was considered is the estimated average bus speed on each route. Average bus speeds for the off-peak period were calculated based on a number of assumptions. These assumptions are summarized in Table 4-3. As indicated in the evaluation matrix (Table 4-1), the Southfield route results in a very slight overall speed advantage even though the potential maximum speed on the freeway is much greater than that on Greenfield. The low acceleration capability of a transit coach nearly eliminates the advantage of using a high speed link when operating between closely spaced stops.

The estimated cost of making the physical changes necessary to implement the Intermediate Service on each route was considered. Initially, no modifications to existing facilities are required for the Southfield Route. However, if the proposed ramp metering system, SCANDI, is implemented on the Southfield Freeway, exclusive bus access ramps will be required to allow buses to bypass the auto queue at the ramp meters. Based on conceptual ramp designs and cost estimates generated during Phase I of the Michigan Bus Rapid Transit Demonstration Program, the estimated cost of queue by-pass ramps for the Southfield Freeway is \$35,000 each. Since approximately 15 ramps would be required, the total estimated cost is \$525,000. The cost of the signal pre-emption system proposed

Table 4-1 Route Evaluation Matrix - Intermediate Service

EVALUATION FACTOR	ALTERNATIVE ROUTE	
	SOUTHFIELD	GREENFIELD
Estimated Demand Potential	58,000 (total) 2,301 (transit)	52,000 (total) 1,946 (transit)
Estimated Bus Speed	21 mi/h	19 mi/h
Implementation Cost	None, initially $525,000 when SCANDI is implemented	$43,600 for signal pre-emption
Existing Local Service	15-30 min headway in peak period	10-15 min headway in peak period
Effect on Other Traffic	Bus accel/decel may slow freeway traffic; freeway & S.D. already over capacity	Temporary disruption of cross-street progression by bus signal pre-emption; street currently under capacity
Safety	Bus accel/decel on the freeway may be a safety hazard.	

Table 4-2 Destination Zones for Demand Potential Evaluation

SOUTHFIELD ROUTE			GREENFIELD ROUTE		
900	960	2101	712	932	2100
901	961	2102	713	960	2101
902	962	2103	722	963	2102
903	963	2104	723	970	2103
920	970	2110	724	971	2104
921	971	2111	740	972	2110
922	972	2112	741	1203	2111
923	973	2120	744	1204	2112
924	1212	2130	900	1222	2130
930	1222	2133	902	1223	2133
931	1223	2134	920	1212	2134
932	1260	2135	922	1260	2135
933	2100	2136	930	2032	2136

Table 4-3 Assumptions for Off-Peak Speed Comparison

	SOUTHFIELD	GREENFIELD
Average speed in vicinity of Northland & Fairlane Terminals (mi/h)	10	10
Maximum cruise speed on Eight Mile Road (mi/h)	38	--
Maximum cruise speed between bus stops (mi/h)	50 fwy 28 S.D.	33
Average acceleration (gravitational units)	.05 fwy .08 S.D.	.08
Average deceleration (gravitational units)	.15	.15
Ave. dwell time for passenger boarding/deboarding (s)	20	20
Average traffic signal delay (s)	20	0

for the Greenfield route is estimated in Section 4.4 to be $43,600. Therefore, assuming SCANDI is to be implemented on Southfield, implementation of the Intermediate Service on Greenfield is by far the less expensive alternative.

Since the Intermediate Service will stop only at approximately one-mile intervals, many patrons will depend on the parallel local service to access the intermediate stops or to reach their final destination along the route. Therefore, the availability of adequate local service was considered an important route evaluation factor. As indicated in Table 4-1, more frequent local service is currently provided on Greenfield than on Southfield. Both routes are served by buses running on east-west routes.

The final evaluation factors considered in the route evaluation process are the effect of the Intermediate Service on other traffic on the route and safety considerations. Since the volume of buses involved is small compared to the volume of other traffic, these factors were not particularly significant. Southfield Freeway and the Service Drives currently operate above capacity. Bus acceleration and deceleration on the freeway will reduce capacity somewhat and may represent a safety hazard to other traffic. On the other hand, Greenfield is currently operating below capacity. The proposed signal pre-emption system will result in intermittant disruption of cross-street progression. The overall effect of this interruption is expected to be minimal as discussed in the previous section.

Consideration of these evaluation factors does not result in the identification of a clearly superior alternative. However, primarily because the Southfield alternative does not offer a significant speed advantage and more frequent transit service is currently provided on Greenfield, the Greenfield alternative was selected for further design of the Intermediate Service.

4.2.3 Distribution Concept

The Greenfield Intermediate line is primarily designed to provide service between Northland and Fairlane. However, during the morning and eveing peak periods, the route is extended to serve employment sites in Southfield along Northwestern Highway and in Dearborn. During the midday period the Oakland County Feeder system links Southfield employment sites to Northland. A midday shuttle is proposed to link Dearborn employment sites to Fairlane. The remainder of this section presents a description of these distribution and shuttle routes.

Northland/Southfield Distribution Concept

The Southfield distribution route, depicted in Figure 4-2 originates at the Northland bus station. After the Northland stop, the buses proceed along the service drive to J. L. Hudson Drive, northeast on J. L. Hudson to Providence Drive, then north on Providence to Providence Hospital. After the hospital stop, the buses turn west onto Nine Mile Road and stop at the Honeywell Office Building. The buses then proceed north on Southfield Road. From Southfield Road, the buses turn into the Bell Telephone facility south of Mt. Vernon. From Bell, the buses return to the service drive of Northwestern Highway and proceed to the Prudential Towers. From the Towers the buses turn west on Civic Center Drive, stop at Bendix, turn north on Central Park Boulevard, stop at the Traveler's Building, return south on Central Park, and return to the service drive via Civic Center Drive. At Lahser the buses cross over the highway and stop at Federal Mogul. From there the buses proceed southeast on the service drive and stop at IBM west of Evergreen, completing the route. The route is approximately eight miles long and takes roughly 35 minutes to complete.

Dearborn/Ford Distribution Routes

During the peak periods, the intermediate buses from the Greenfield line will provide distribution service in the Dearborn area. In addition a shuttle bus will be provided to serve the Ford Rouge Plant. The Dearborn distribution loop followed during the peak periods shown in Figure 4-3. The intermediate buses turn west from Greenfield onto Hubbard, stopping at the Parklane Towers and the AAA Building. These two stops are considered to be part of the line haul portion of the Intermediate Service. The distribution route begins at the Fairlane Center where the first stop is made. From the Fairlane Center the buses proceed via Evergreen to a stop at the Henry Ford Community College. The buses then go south on Evergreen, stop at the Dearborn Center of the

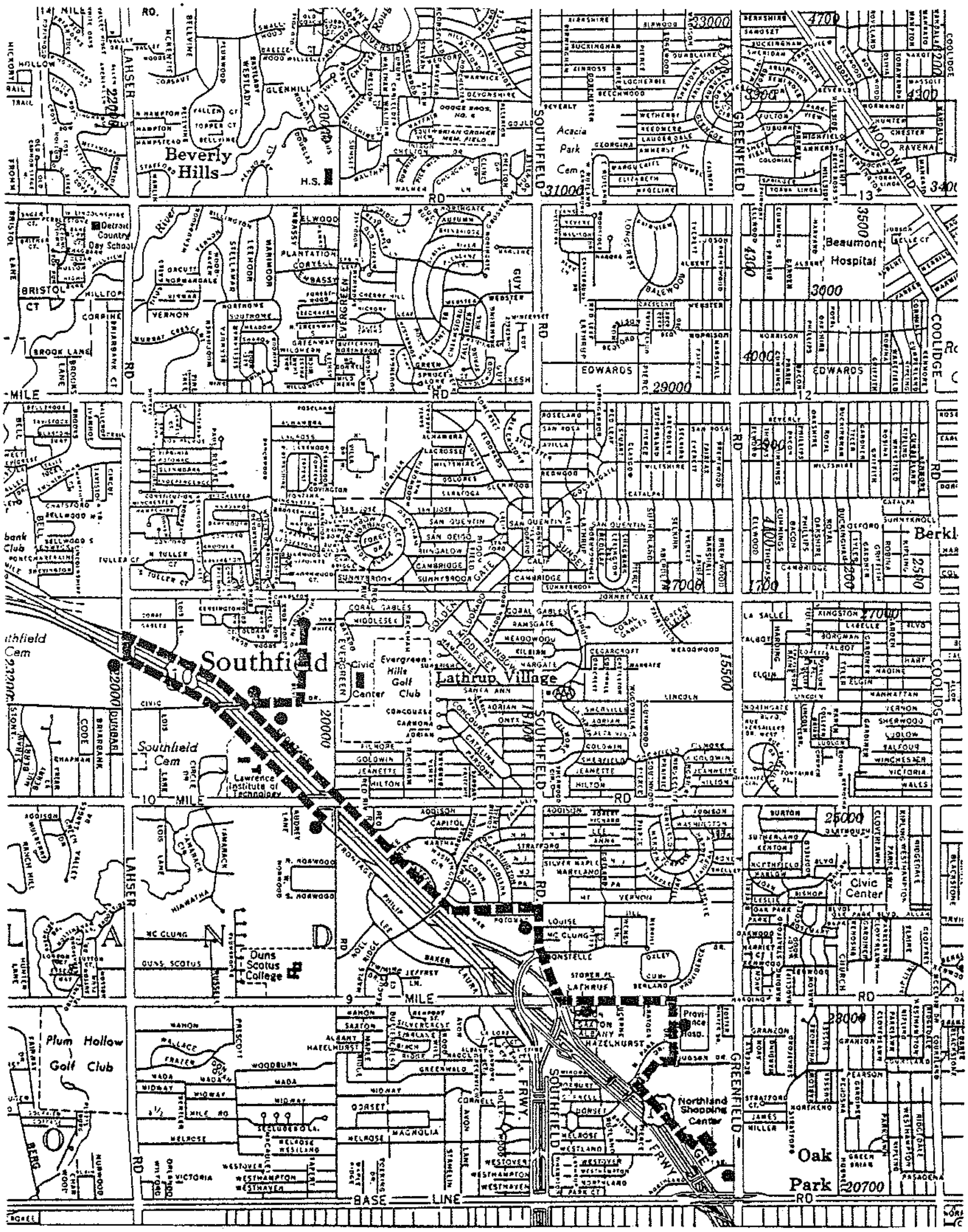


Figure 4-2 Southfield Distribution

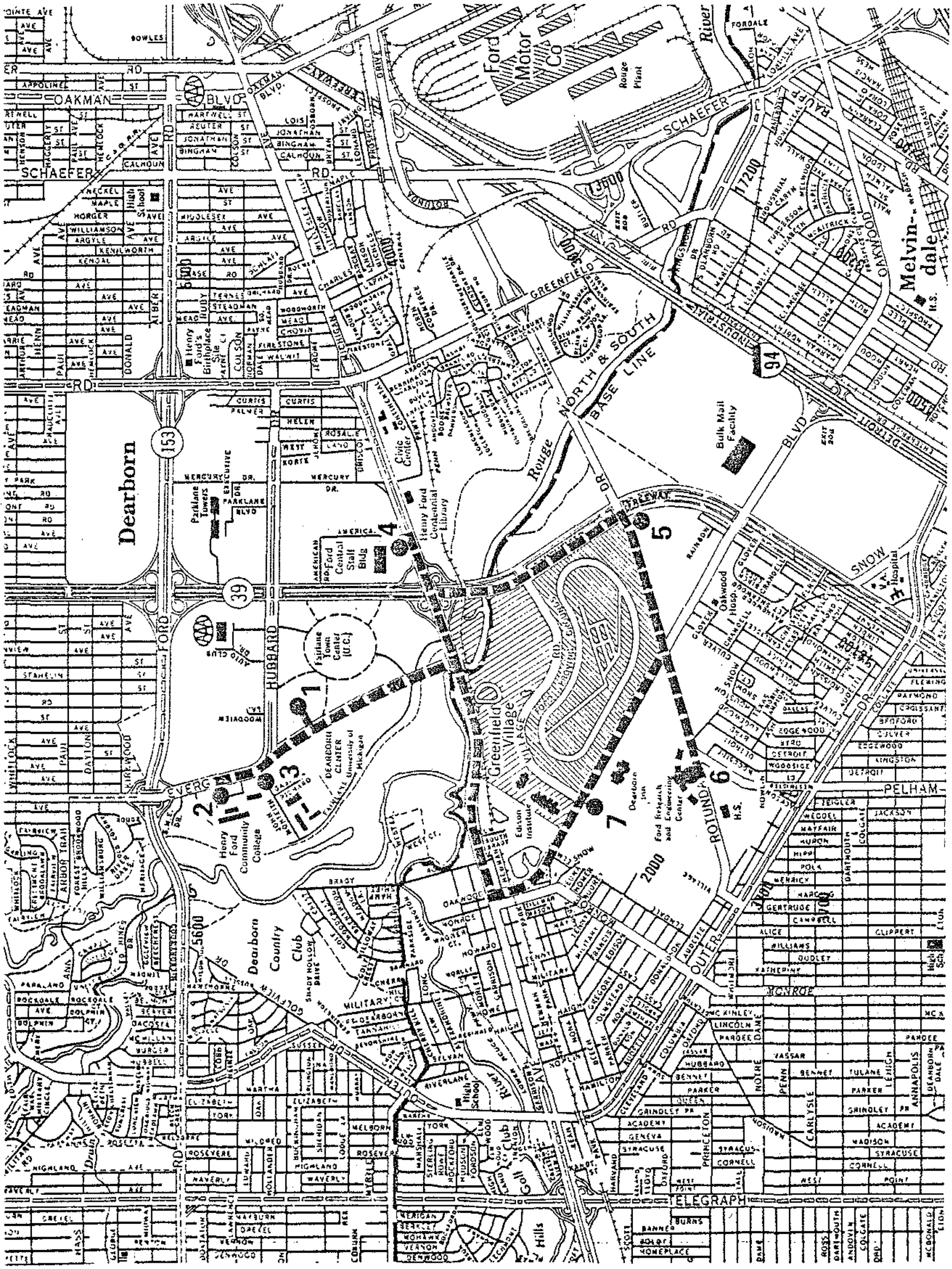


Figure 4-3 Dearborn/Ford Distribution Route

University of Michigan, continue south on Evergreen to Michigan Avenue, and east on Michigan to the Ford Central Staff Building. From the Central Staff Building, the route proceeds west on Michigan to Southfield, south on the Southfield service drive to the Ford Division Building at Rotunda. From the Ford Division Building, the buses proceed west on Rotunda to the Ford Research and Engineering Center. From there, the buses go to the Ford Engineering buildings on Oakwood Boulevard. There are two alternative routes between the Ford Engineering buildings. For one, the buses would go east on Rotunda and then turn west on Oakwood to the Engineering Buildings. The other route would use private roads internal to the Ford Complex. The internal route is the more desireable, but would require approval for use. From the second Engineering building stop the buses return to the Fairlane Center via Oakwood, Michigan, and Evergreen. The Fairlane Center is a potential park-and-ride lot location and, therefore, the Greenfield buses return there before starting the northbound trip. From the Fairlane Center the buses return to Greenfield via Hubbard. This route is approximately 11.3 miles. Assuming a 20 mile per hour distribution speed, the total time required to complete one trip around the loop, from the Fairlane Center, is approximately 34 minutes.

Shuttle service from the Fairlane Center to the Ford Rouge Plant is also provided during the peak periods. Figure 4-4 shows the route the shuttle buses follow. From the Fairlane Center, the buses proceed west on Hubbard to Greenfield, down Greenfield to Rotunda, east on Rotunda to Miller and along Miller to the Rouge Plant. The round trip takes about 42 minutes.

Off-peak the entire Ford Complex is served by a shuttle. The route is shown in Figure 4-5. The shuttle bus starts at the Fairlane Center, proceeds via Evergreen to Henry Ford Community College and the Dearborn Center of the University of Michigan, then east on Hubbard stopping at the AAA Building and the Ford Central Staff Building, and next turns south on Mercury Drive. From Mercury Drive the route is west on Michigan to the Ford Central Staff Building; the route proceeds west on Michigan to Southfield, south on the Southfield service drive to the Ford Division Building at Rotunda. From the Ford Division Building, the buses travel west on Rotunda to the Ford Research and Engineering Center. From there, the buses would go to the Ford Engineering buildings on Oakwood Boulevard, either via private roads internal to the Ford Complex or via Rotunda to Oakwood. From the Oakwood Ford Engineering buildings the buses go to the Rouge Plant via Oakwood, Rotunda, and Miller. From the Route Plant on Miller the buses return to the Fairlane Center on Miller to Rotunda, to Greenfield, and on Hubbard. The round trip distance for this off-peak shuttle route is approximately 19.6 miles. One circuit of the route requires roughly 60 minutes assuming a 20 mile per hour distribution speed.

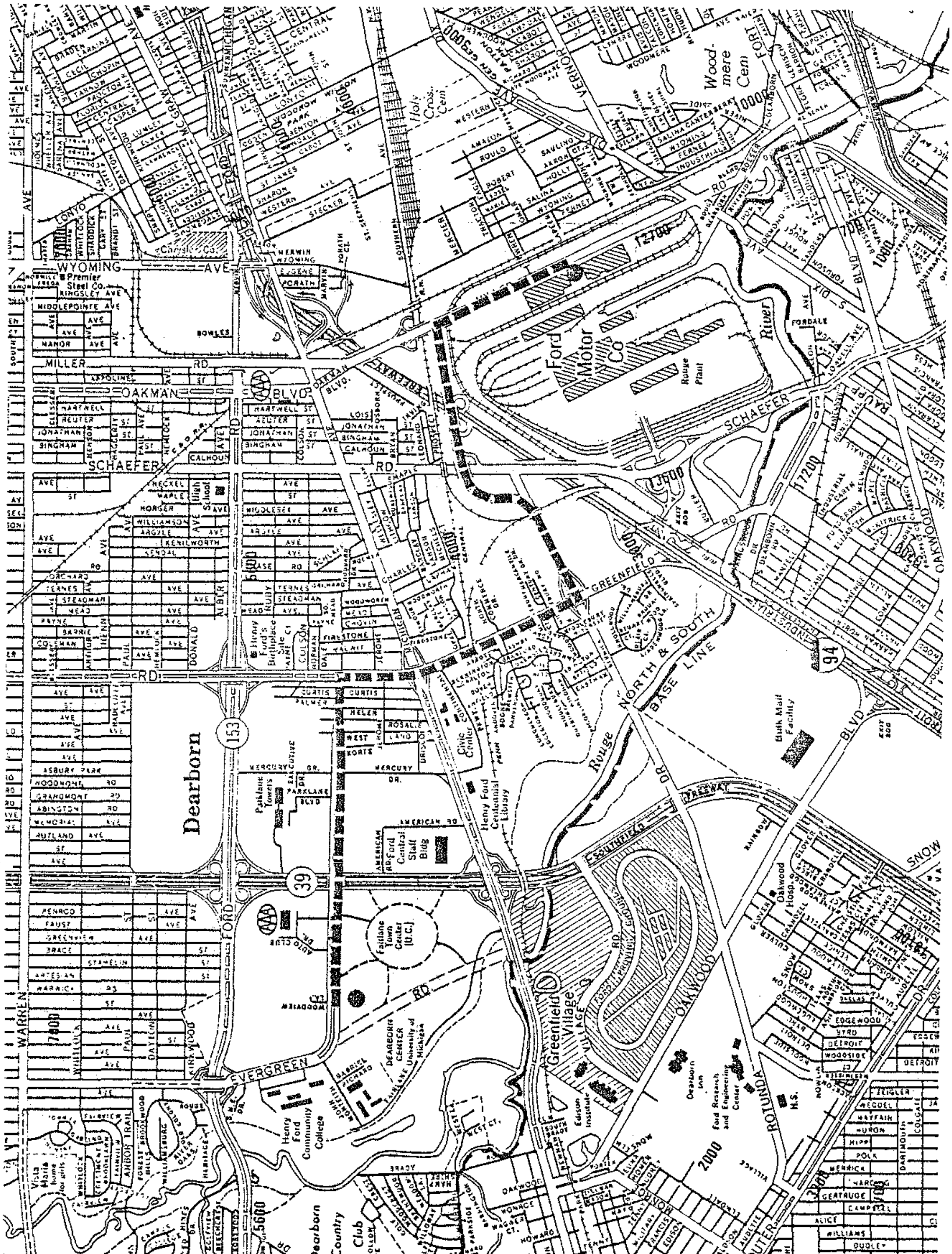


Figure 4-4 Rouge Plant Shuttle

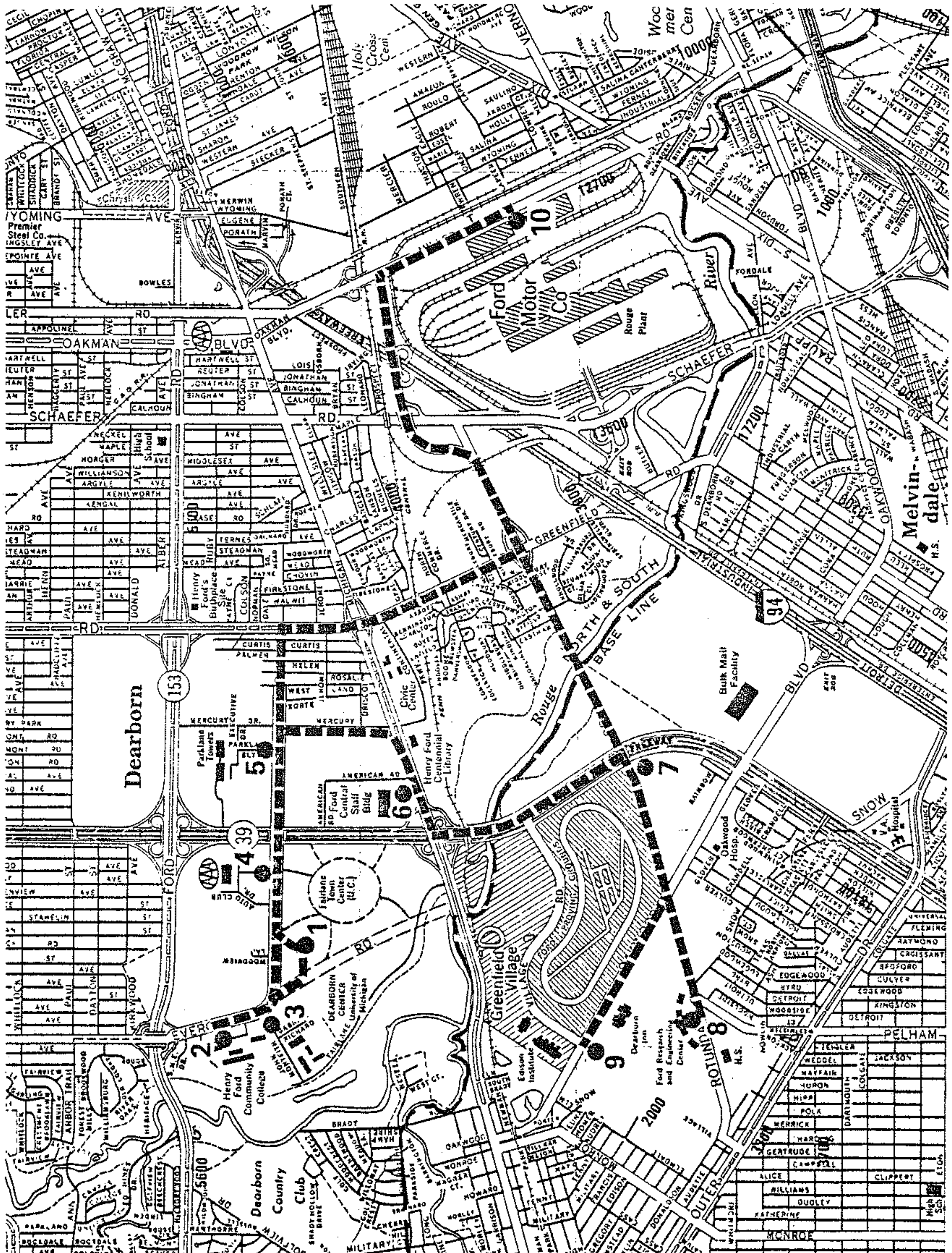


Figure 4-5 Midday Dearborn Shuttle

4.3 Greenfield Intermediate Service Demand Estimates

4.3.1 Demand and Modal Split Estimates

The demand estimation process for the proposed intermediate-level service in the Greenfield corridor was quite similar to the BRT demand estimation effort described above. Therefore, only specific results and substantial differences in input data and methodology are presented in this section.

The Greenfield corridor definition is very different from that of the Southfield/Jeffries corridor, as indicated by the zone list in Table 4-4. Destinations in this corridor are less concentrated, and two-way travel along the length of the corridor is more feasible.

The temporal peaking of trip volumes is less pronounced in the Greenfield corridor then in corridors which are CBD-oriented. In addition to a morning peak-period trip matrix, then, a midday trip matrix for the three-hour period from noon to 3:00 p.m. was compiled, and the modal split program was run separately with each matrix. The analysis of midday demand utilized diversion curves intended for the estimation of 24-hour transit modal split, since it was judged that those curves would be more applicable than would peak-period curves. (Both sets of diversion curves were developed for SEMCOG by Peat, Marwick, Mitchell and Company.)

Submodal weighting factors (described in Section 2.4) were used in the Greenfield corridor analyses to simply designate which of two sets of feeder service parameters were to be applied in the evaluation of each origin zone's trips. For Oakland County origins, a unity weighting factor was specified for the Oakland County feeder mode; zero weighting factors applied to other modes. For other origins, a different feeder mode was "enabled" with unity weighting factors, while other modes were "disabled" with zero weighting factors. The modal split parameters employed in the Greenfield corridor analyses are listed in Table 4-5.

Greenfield corridor modal split analysis results are graphically presented in Figures 4-6 through 4-11. The transit trip quantities shown in those figures and discussed below have been "screened" to eliminate any transit trips having less than two miles of travel on line-haul network links; it is assumed that such trips are taken by local bus which is better suited to accommodate short trips.

Morning peak-period trips by all modes totaled 50,374; of these, 1,193 (or 2.4 percent) were assigned to intermediate-level transit service. Oakland County was the origin of 281 transit trips, while 912 originated elsewhere in the Greenfield corridor. Figure 4-6 indicates the morning peak-period trip attraction of various zones in the corridor. Figures 4-7 and 4-8 illustrate the transit route trip loadings northbound and southbound, respectively.

A large number of intermediate-level transit trips was predicted for the midday period (noon to 3:00 p.m.): 1,343. This represents only 1.9 percent of the corridor's total trips, however. The short-trip screening process, in this case, eliminated 2,589 trips which would have otherwise been assigned to intermediate-level transit. The midday transit trip attraction of each zone is shown in Figure 4-9, while Figure 4-10 and 4-11 indicate trip loadings northbound and southbound, respectively.

Table 4-4 Greenfield Corridor Zone List

TALUS ORIGIN ZONES					TALUS DESTINATION ZONES
0353	0900	0955	1254	2122	0712
0354	0901	0960	1255	2130	0713
0355	0902	0961	1256	2131	0723
0356	0903	0962	1257	2132	0724
0700	0910	0963	1260	2133	0740
0701	0911	0970	1261	2134	0741
0702	0912	0971	1262	2135	0744
0703	0913	0972	1263	2136	0900
0704	0914	0973	1264	2137	0902
0710	0920	1200	1265	2140	0920
0711	0921	1201	1266	2141	0922
0712	0922	1202	1330	2143	0930
0713	0923	1203	1331	2143	0932
0720	0924	1204	1332	2144	0960
0721	0930	1210	1333	2145	0963
0722	0931	1211	1334	2146	0970
0723	0932	1212	2032	2147	0971
0724	0933	1220	2034	2400	0972
0725	0940	1221	2040	2401	1204
0730	0941	1222	2041	2402	1212
0731	0942	1223	2043	2403	1222
0732	0943	1230	2100	2404	1223
0733	0944	1231	2101	2405	1260
0734	0945	1232	2102	2420	2032
0735	0946	1233	2103	2421	2100
0736	0947	1234	2104	2422	2101
0740	0950	1235	2110	2423	2104
0741	0951	1250	2111	2424	2110
0742	0952	1251	2112	2425	2111
0743	0953	1252	2120	2526	2112
0744	0954	1253	2121		

Table 4-5 Greenfield Intermediate Service Modal Split Parameters

	AUTOMOBILE	OAKLAND COUNTY INTERMEDIATE SERVICE	DETROIT INTERMEDIATE SERVICE
Access			
Out-of-vehicle time	1.0 min	15.0	15.0 min
Cost policy	Graduated	Flat	Flat
Cost rate	$0.05/mi	$0.45	$0.45
Additional cost	$0.00	$0.00	$0.00
Travel speed	30.0 mi/h	20.0 mi/h	16.0 mi/h
Collection			
Cost policy	Graduated	Flat	Flat
Cost rate	$0.05/mi	$0.00	$0.00
Line-haul			
Cost policy	Graduated	Flat	Flat
Cost rate	$0.05/mi	$0.00	$0.00
Distribution			
Cost policy	Graduated	Flat	Flat
Cost rate	$0.05/mi	$0.00	$0.00
Local Egress			
Out-of-vehicle time	2.0 min	5.0 min	5.0 min
Cost policy	Graduated	Flat	Flat
Cost rate	$0.05/mi	$0.00	$0.00
Additional cost	$0.00	$0.00	$0.00
Travel speed	25.0 mi/h	-	-
Activity Center Egress*			
Out-of-vehicle time	3.0 min	5.0 min	5.0 min
Cost policy	Graduated	Flat	Flat
Cost rate	$0.05/mi	$0.00	$0.00
Additional cost	$0.50 park	$0.00	$0.00
Travel speed	15.0 mi/h	-	-
CBD Egress*			
Out-of-vehicle time	7.0 min	3.0 min	3.0 min
Cost policy	Graduated	Flat	Flat
Cost rate	$0.05/mi	$0.00	$0.00
Additional cost	$1.00 park	$0.00	$0.00
Travel speed	15.0 mi/h	-	-

*Parameters not applicable to Greenfield Intermediate Service

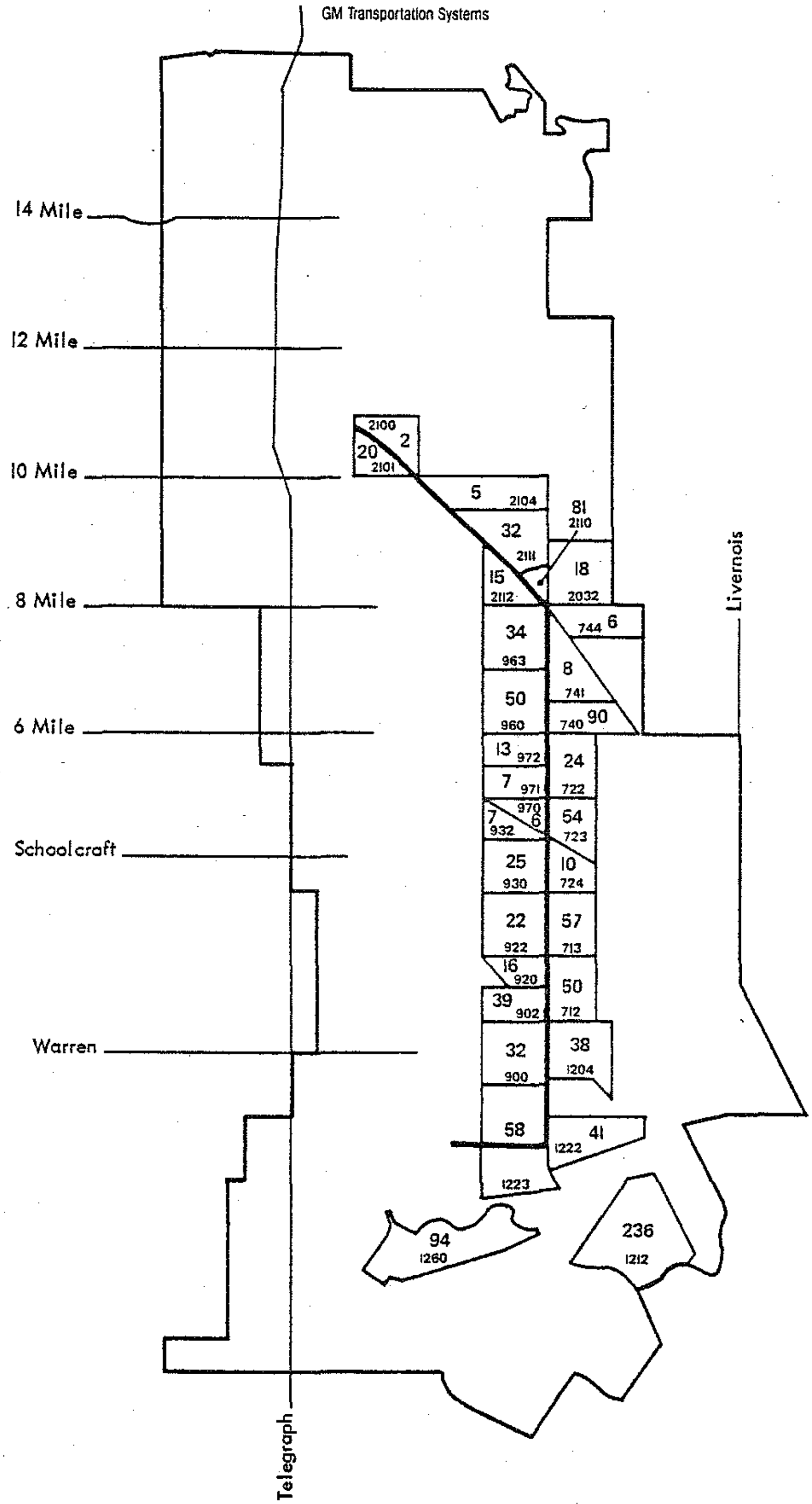


Figure 4-6 Morning Peak-Period Attraction by Zone - Greenfield Intermediate Service

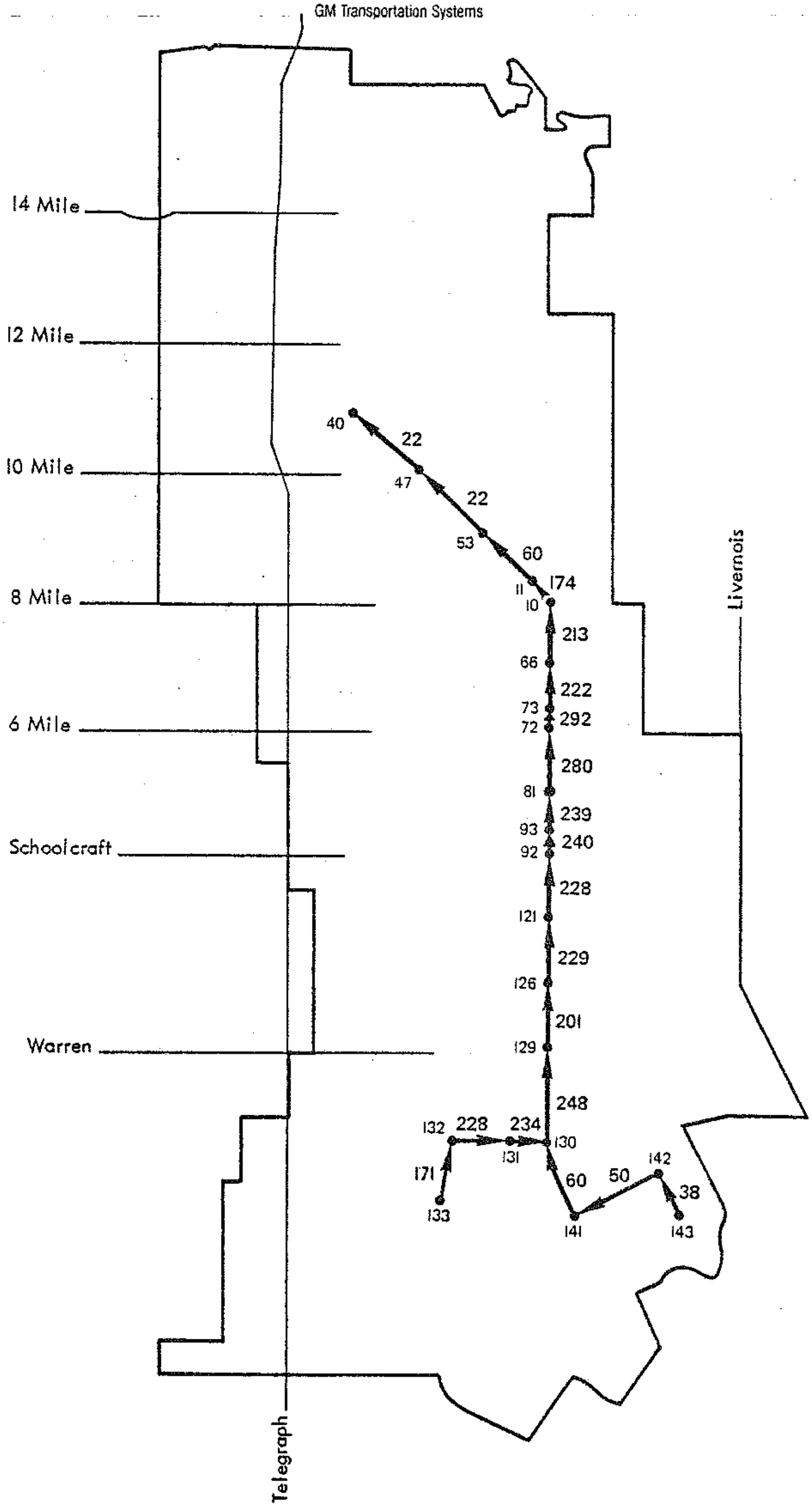


Figure 4-7 Morning Peak-Period Link Loads - Northbound - Greenfield Intermediate Service

GM Transportation Systems

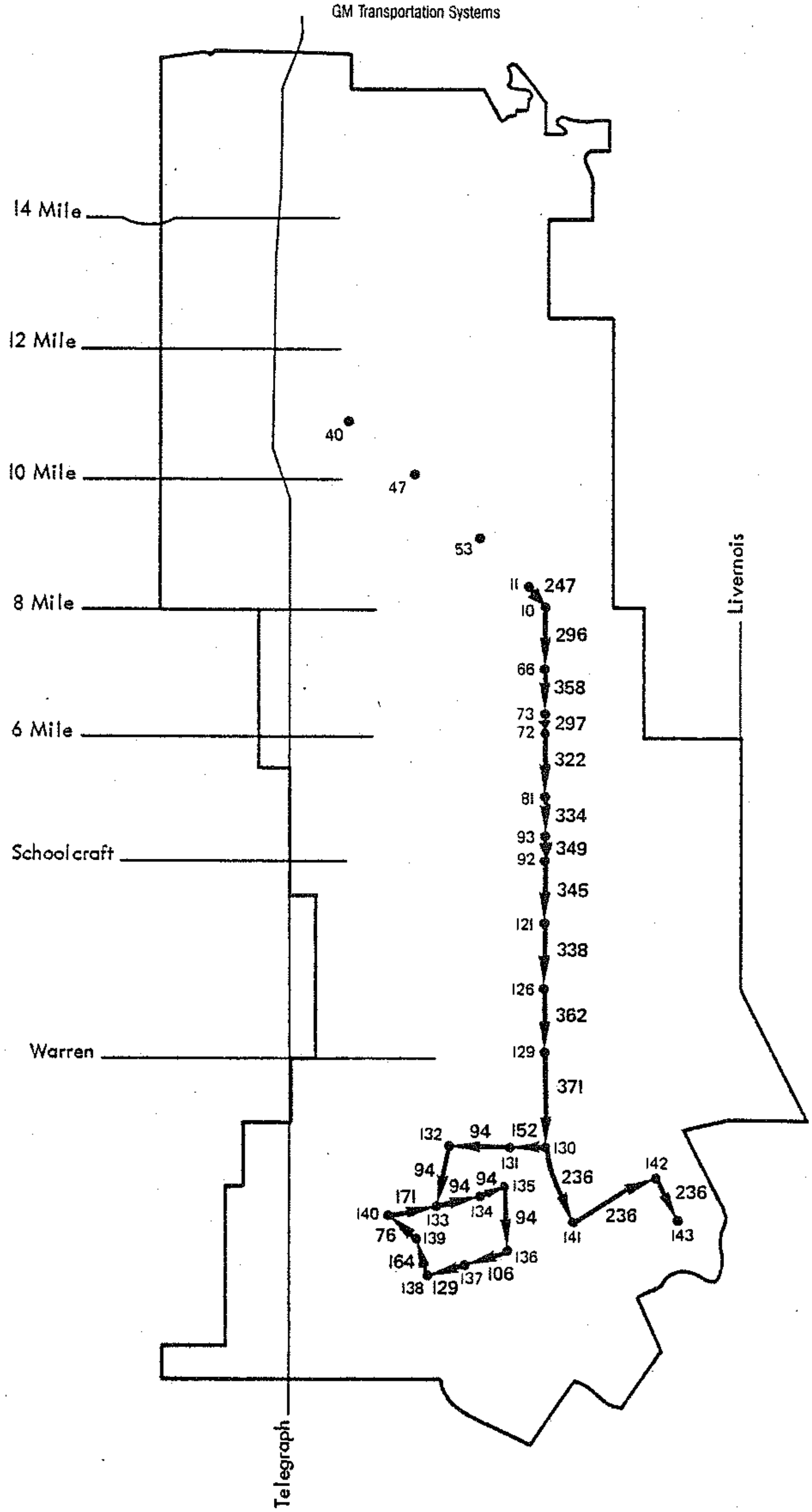


Figure 4-8 Morning Peak-Period Link Loads - Southbound - Greenfield Intermediate Service

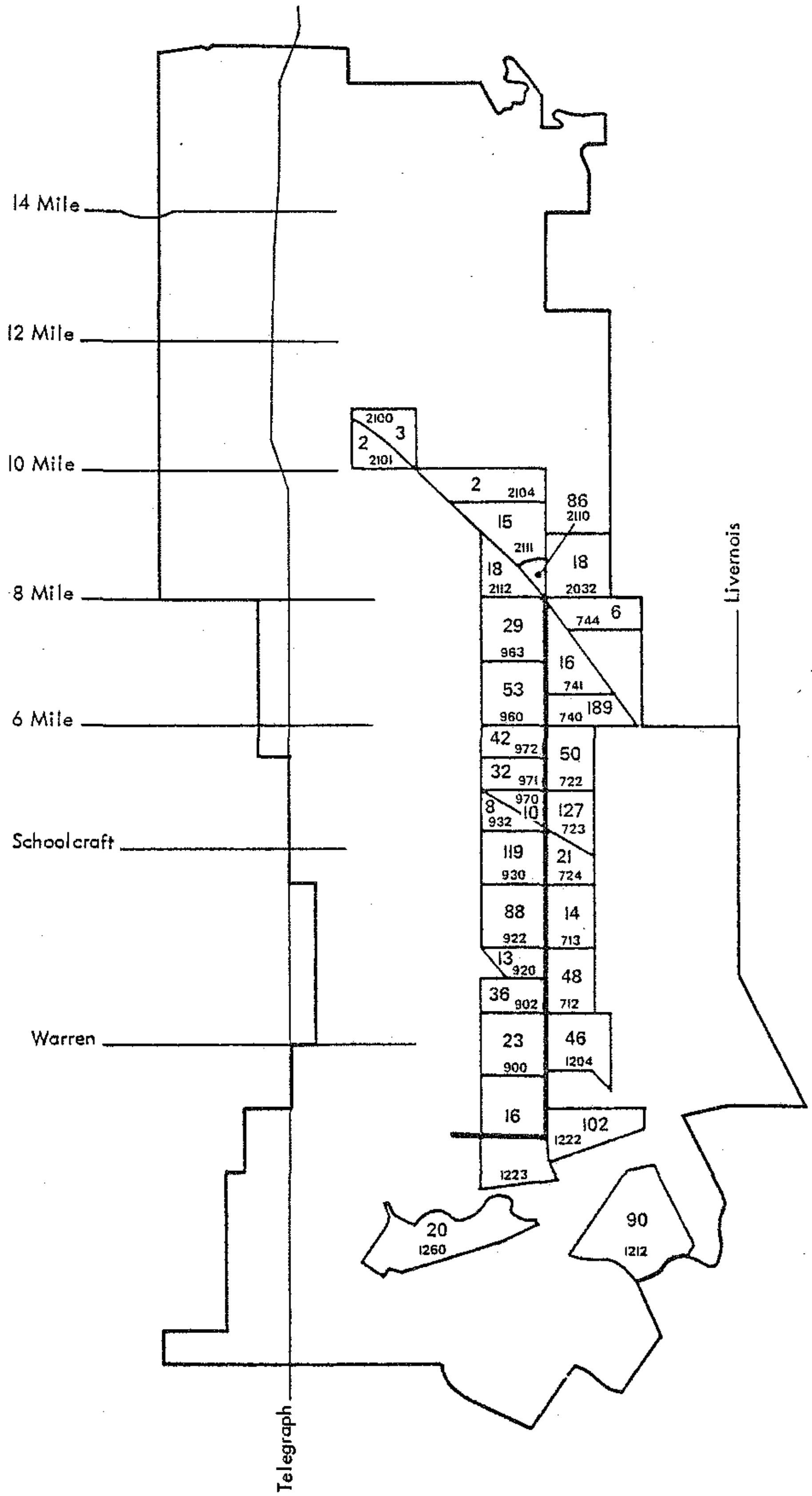


Figure 4-9 Midday Period Attraction by Zone - Greenfield Intermediate Service

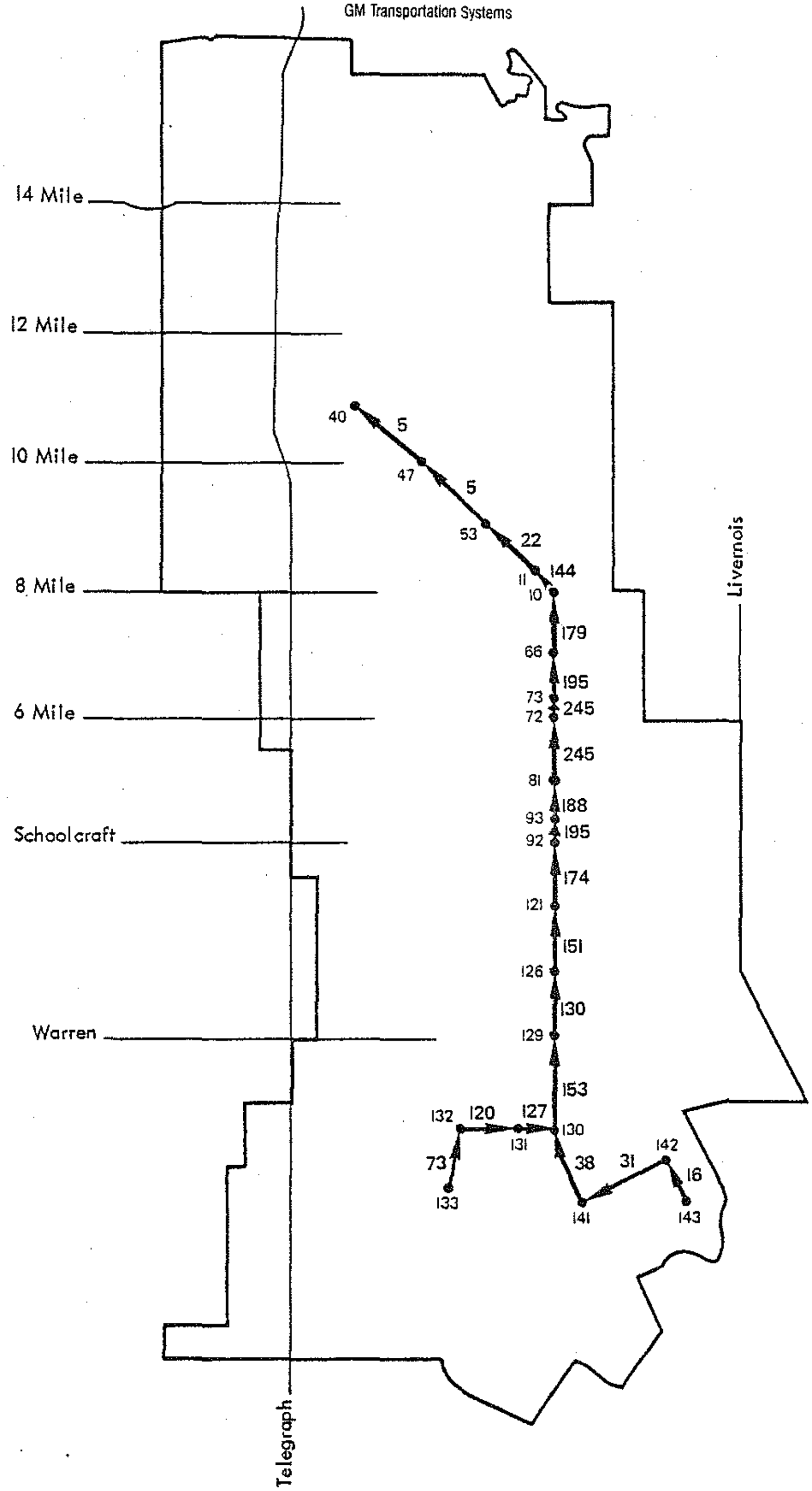


Figure 4-10 Midday Period Link Loads - Northbound - Greenfield Intermediate Service

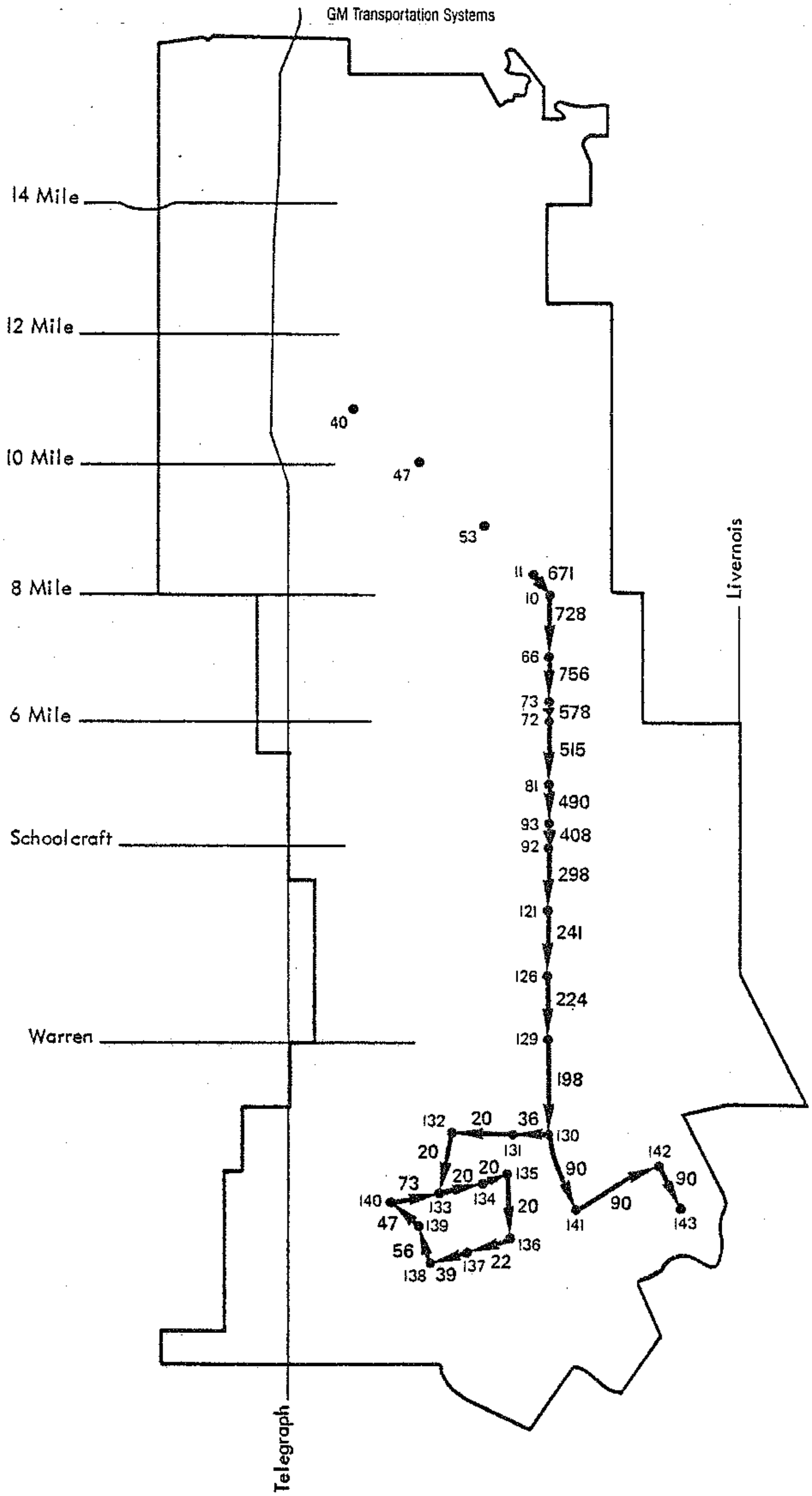


Figure 4-11 Midday Period Link Loads - Southbound - Greenfield Intermediate Service

4.3.2 Projected Demand Characteristics for Fairlane

The demand estimates presented in the foregoing section are based on 1965 TALUS Survey data projected to 1975 on the basis of population changes only. They do not include the effects of new trip attractors such as the Fairlane complex. Therefore, an attempt was made to determine the demand characteristics from the Southfield-Greenfield corridor to Fairlane including shopping as well as work trips.

Peak Period

The morning peak-period interval for work trips to the Fairlane complex is assumed to be the same as that being used for trips to other destinations in the corridor--7:00 to 10:00 a.m. The shopping center is expected to employ about 5,000 persons.[1] In addition to these, the following number of employees are expected to work in the remainder of the Fairlane complex:[2]

• Henry Ford Hospital	270
• Hyatt Regency Hotel	1000
• Office Town Center	300
	1570

The total estimated employment in Fairlane, then, is 6,570.

The origins of current work trips to the Dearborn area are distributed as follows:[2]

- 19 percent from the South
- 36 percent from the North/Northwest
- 29 percent from the West
- 16 percent from the East/Southeast

If the new work trips to Fairlane are assumed to be distributed similarly, about 35 percent, or 2,300 trips, originate in the general area served by the Greenfield Intermediate Line. If it is further assumed that the modal split for these trips is 3.4 percent, as predicted for other destinations in the Dearborn area, then a total of 78 peak-period trips can be added to the Intermediate Service demand reported in Section 4.3.1.

Midday Period

Fairlane Shopping Center is expected to generate 50,000 to 80,000 shopping trips per day.[2] The peak period interval for shopping trips is 5:30 to 7:30 p.m. and 8:30 to 9:30 p.m.[1] It is expected that 70 percent of the shopping trip demand will come from

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[1] Mr. Robert Schout, Vice President, Director of Market Research, The Taubman Co.
[2] Mr. Dom, President, Ford Land Development Corporation

the area west of the shopping center, 10 to 15 percent from the Farmington area, and 10 to 15 percent from the area south of the shopping center.[1] It appears that most of the shopping demand is outside the service area of the Greenfield Intermediate Line. Consequently, it is expected that the number of shopping trips accessing the center by the Intermediate Service is negligible, and the midday demand estimates reported in Section 4.3.1 were not increased. In spite of the doubtful demand, it is still recommended that the shopping center be served by transit. First, it is a natural terminal for the route; and second, if bus service is provided to people in the corridor, even though they may be out of the market area, they may be induced to use the Intermediate Service to access the shopping center.

4.3.3 Headway Requirements

The headway of the Greenfield Intermediate Service was selected on the basis of the number of bus trips per hour required to serve the heaviest-loaded link. As indicated in Figures 4-7 and 4-8, the most heavily loaded link during the morning peak period is one approaching Dearborn (Link 129-130, Warren to Hubbard), where the southbound link load is 371. If the estimated peak period Fairlane demand (78) is added to this load, the total link load is 449. The time distribution of trips for this corridor is assumed to be the same distribution assumed for the Southfield-Jeffries Corridor and presented in Table 3-33. According to that distribution, 50 percent of the peak period trips terminate in the peak hour. Based on the peak-hour link load (224), five buses per hour are required.

The peak-period demand for the Rouge Plant shuttle, as illustrated in Figure 4-8, is 236 trips. According to the assumed time distribution of demand, this represents demands of 118 trips in the peak hour, 72 trips in the second peak hour, and 23 trips in the pre-peak and post-peak half hours. Policy headways of 15 minutes in the peak hour and 20 minutes in the second peak hour, were selected to serve this demand. In addition, one bus trip is assumed in both the pre-peak and the post-peak half hours.

The number of line-haul bus trips per hour required during the midday period was determined similarly. As indicated in Figures 4-10 and 4-11, the most heavily loaded link during the midday period is one just south of Northland (link 66-73, Seven Mile to Outer Drive), and the link load is 756. Based on an analysis of TALUS data for trips in the Southfield-Greenfield corridor, it was determined that trips are approximately evenly distributed in time over the midday period. Therefore, the average hourly demand for this link is 252 trips, and five bus trips are required. This is the same number of bus trips that was determined for the peak hour. Therefore, a constant average headway of 12 minutes (five buses per hour over each link) is proposed for the Greenfield Intermediate Service during all hours of operation throughout the day.

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[1] Mr. Robert Schout, Vice President, Director of Market Research, The Taubman Co.

Based on midday attraction to distribution zones in Dearborn, as indicated in Figure 4-9, the demand for the Dearbom shuttle, which operates only during off-peak periods, is 228 trips in the midday period or 76 trips per hour. Approximately two bus trips per hour are proposed to serve this demand.

4.4 System Sizing and Cost Estimates

Capital and operating costs were estimated for the Greenfield Intermediate Service using the same unit costs as reported in Section 3.8 where applicable. Table 4-6 is a summary of estimated capital and operating costs. The table also shows the estimated number of annual person trips on the system. This number includes the morning and evening peak-period demand and the off-peak demand assuming the average hourly midday demand is sustained during the periods from 10:00 a.m. to 3:00 p.m. and from 6:00 p.m. to 9:00 p.m. Weedkay operation (255 days per year) is assumed for both operating cost and annual demand calculations. The total system cost and demand estimates result in an estimated average cost per line-haul trip of $0.58.

4.4.1 Capital Costs

The estimated capital cost of the Greenfield Intermediate Service is summarized in Table 4-7. An eight percent interest rate was assumed for the calculation of annualized capital cost.

Bus Requirements

The number of buses required to provide the intermediate-level service on Greenfield was determined for the peak period considering the time required to complete a round trip. The peak-period route includes distribution in Southfield and Dearborn and requires 2.3 hours to complete one round trip. Considering a three-hour peak period, 12 buses are required to provide the 15 bus trips in the peak period. In addition, three buses are required to provide the nine Rouge Plant Shuttle trips in the peak period. The time required for the shuttle to complete a round trip is 0.7 hour. A total of 16 buses are required for the Greenfield Intermediate Service including a 7 percent maintenance float as described in Section 3.7.1. The number of vehicle operating hours and vehicle miles associated with the Intermediate Service is summarized in Table 4-8. The figures are based on six hours of peak-period operation and eight hours of off-peak operation per day. Weekday service only is assumed (255 days per year). The unit vehicle cost is assumed to be $67,000 as indicated in Section 3.8.1.

Signal Pre-Emption

The cost of traffic signal pre-emption equipment is based on costs reported late in 1975 by 3M Company on their equipment called Opticon. The Opticon equipment consists

Table 4-6 Summary of Annual Costs - Greenfield Intermediate Service

SYSTEM COST ELEMENTS (THOUSANDS OF DOLLARS)				ANNUAL PERSON TRIPS	AVERAGE COST PER TRIP
CAPITAL	ANNUALIZED CAPITAL	ANNUAL OPERATING	ANNUAL TOTAL		
1,440	197	711	908	1,562,130	.58

Table 4-7 Capital Cost - Greenfield Intermediate Service

ITEM	UNIT COST	QUANTITY	TOTAL COST	AMORT. PERIOD	ANNUAL COST
Signal Pre-Emption Equipment					
Vehicle On-Board Equipment	850	16	13,600	10	2,026
Signal Controller Equipment	1,500	20	30,000	15	3,504
Subtotal			43,600		5,530
Bus Stop Signs	100	41	4,100	15	479
Shelters	3,000	36	108,000	15	12,614
Vehicles	67,000	16	1,072,000	10	159,771
Vehicle Storage Facility	25/sq ft	6720 sq ft	168,000	30	14,923
Operating Garage	2780/bus	16	44,480	30	3,951
TOTAL			1,440,180		197,268

Table 4-8 Bus Operating Characteristics - Greenfield Intermediate Service

	NO. OF BUS TRIPS	NO. VEHICLE HOURS/DAY	NO. VEHICLE HOURS/YEAR	NO. VEHICLE MILES/DAY	NO. VEHICLE MILES/YEAR
A.M. & P.M. Peak Period					
Line Haul & Distribution	30	69.9	17,824	1178.4	300,492
Rouge Shuttle	18	12.4	3,162	185.7	47,404
Subtotal		82.3	20,986	1364.3	347,896
Off-Peak Period					
Line Haul	40	47.2	12,036	816.8	208,284
Dearborn Shuttle	16	18.4	4,692	313.6	79,968
Subtotal		65.6	16,728	1130.4	288,252
TOTAL		147.9	37,714	2494.7	636,148

of a light source and switch box which is mounted on each bus and a light receiver and control equipment which is mounted at each intersection to be controlled. The cost of the on-board equipment totals $850 per vehicle--$750 for the light source and $100 for the switch box and cabling. The intersection-mounted equipment ranges in cost from $1,300 to $1,500 for most controllers to $2,500 for exotic eight-phase controllers. An average cost of $1,500 per intersection was assumed for the system cost estimate.

Signs

Bus stop signs are provided at each stop location on the line-haul route and on each of the two distribution routes. A total of 41 signs costing $100 each is assumed.

Shelters

A shelter is assumed to be provided at each stop location in the Intermediate Service system. Some shelters have already been installed along Greenfield so a total of 36 new shelters are required. As in the BRT system costing, the average cost of each shelter is assumed to be $3,000.

Operating Garage and Vehicle Storage

It is estimated that 420 square feet are required to store a transit coach and that storage facility costs are $25 per square foot exclusive of land. Operating garage facilities, where vehicles are fueled, cleaned, and serviced, are estimated to cost $2,780 per vehicle.

4.4.2 Operating Costs

The operating cost estimates for the Greenfield Intermediate Service are summarized in Table 4-9. The operating costs include driver wages, garage expenses, vehicle maintenance expense, and shelter maintenance costs. The unit costs are the same as were assumed for the BRT system cost estimate as reported in Section 3.8.2. The vehicle operating characteristics used in the cost estimates are summarized in Table 4-8.

Table 4-9 Annual Operating Cost - Greenfield Intermediate Service

ITEM	UNIT COST	QUANTITY	TOTAL COST
Shelter Maintenance	300	41	12,300
Vehicle Expense			
Garage	.1713/mi	636,148	108,972
Maintenance	.1954/mi	636,148	124,303
Subtotal			233,275
Driver Expense	$12.35/v-hr	37,714	465,768
TOTAL			711,343

5.0 STAGED IMPLEMENTATION

The final configuration of the Bus Rapid Transit System has been described in detail in Section 3.0 of this report. The stages of implementation leading to this final system, the time constraints under which this staged implementation is planned, and the implementation goals are discussed in this section of the report. The preliminary staged implementation plan described in this section is based on the assumption that preliminary engineering and detailed operational planning have been completed. Two alternative routings for BRT vehicles from Oakland County to the Jeffries Freeway are proposed. Alternative I routes BRT vehicles from Oakland County down the Southfield Freeway to the Jeffries exclusive lanes. Alternative II routes the Oakland County BRT traffic down the Lodge Freeway to Wyoming Avenue, then down Wyoming to the Jeffries.

5.1 Time Factors

Several time factors predicate a staged rather than a one-step implementation of the BRT system. However, implementing the system in stages is not a negative factor. Staging the implementation allows the system to gradually build ridership by providing increasingly better transit service.

One time factor or constraint is the area of negotiations. For example, the use of the proposed park-and-ride lots in Oakland County must be preceeded by securing a section of those lots to provide space for BRT patrons to park their automobiles. The number of spaces; the location of the spaces; the rental cost, if any; snow removal; and signing and pavement marking are factors which will have to be negotiated.

Material delivery delays will also necessitate a staged implementation scheme. There will be delays associated with the delivery of buses, bus shelters, light pre-emption equipment, and the informational and regulatory signs necessary to the BRT system. The longest lead time item would be the transit coaches. Delivery schedules for coaches are dependent upon the size of the order; i.e., delay is a function of the number of coaches ordered. The minimum wait for coach delivery is approximately 180 days, with the average time being 200 to 240 days. It is not extraordinary to expect a 270-day lead time on coach delivery. The BRT staged implementation plan will be structured as a function of expected coach delivery dates.

The three major construction projects associated with the BRT system will be pivotal factors controlling the implementation of the envisioned final system. These three projects are: the Wyoming transfer station, the new exclusive BRT facility at the southeast terminus of the Jeffries Freeway, and the Scotten entry/exit ramp serving the New Center. Portions of the BRT system can be implemented before the construction is completed. However, there will be entry/exit delays at Wyoming, Grand Boulevard (Scotten), and the Jeffries southeast terminus. BRT buses will have to enter/exit the Jeffries free-flow with mixed traffic at existing ramps and weave across traffic to access the exclusive lane. The proposed final BRT system, the system with the shortest headways and highest level of service, requires that the transfer station at Wyoming be operational. Therefore, it is the completion date of the Wyoming station that indicates the final stage of system implementation. The construction lead times are actually the sum of two separate times. Once the contract is let, structural steel must be ordered and delivered before the actual construction begins. Presently, there is up to a one-year delay on the delivery of structural steel. In addition to the time spent waiting for steel, the actual construction time must be considered. For scheduling purposes, approximately one and one-half years is the estimated time necessary to complete the construction projects necessary to the BRT system.

For Alternative I, with buses routed down the Southfield Freeway from Oakland County, one further construction project is planned. There would be an exclusive BRT-only exit ramp from the northbound Southfield Freeway north of Eight Mile Road at Winora. This ramp would provide rapid BRT access to the Northland bus station. Structural steel would not be required to construct this ramp. Therefore, the one-year delay for steel delivery is not a factor at this location.

Another factor impacting system implementation is the requirement that agency approvals be obtained before major steps are undertaken. Agencies which need to coordinate this program include the Michigan Department of State Highways and Transportation, the Southeastern Michigan Transportation Authority, and the Detroit Department of Transportation.

5.2 Goals of the Staged Implementation Plan

The staged implementation plan is devised with specific goals in mind. These goals were formulated to help provide a logical, successful progression of stages leading to a final, integrated BRT system. The goals are presented below.

An important consideration of the first stage of implementation is that there should be a high probability of initial success. That is, the first line implemented should be the line with the highest probability of success. Public acceptance of the BRT system will be strongly influenced by initial impressions of the BRT concept demonstrated during the first stage of implementation. Every effort should be made to assure that the public, potential patrons, builds up enthusiasm for the BRT service concept as incremental stages are implemented.

It also may be beneficial to provide early implementation of service to presently transit-starved areas. Providing service to areas where mass transit is not presently available should aid initial acceptance of the BRT concept and system, because an immediate benefit is perceived by patrons of the system. In the corridor being studied, Oakland County is presently without adequate transit service. An additional benefit of providing BRT service from Oakland County is that the entire length of the Jeffries exclusive lanes is more fully utilized, thereby establishing the transit identity of the exclusive lanes while providing a relatively fast line-haul trip for BRT patrons.

The transit identity of the BRT system should be established early and enhanced as the system expands. This strong public image should portray the BRT system as a benefit to the entire community, providing very good transit service to the Southfield/Jeffries corridor. A positive transit identity will help promote ridership, and it should aid in policing the exclusive BRT lanes on the Jeffries Freeway. The Wyoming transfer station will provide a center of focus for the BRT system and will, to a large extent, help provide the strong transit identity desired.

A requirement of the staged implementation of the BRT system is that there should be a time savings for BRT service relative to existing transit service. That is, a trip on the BRT system should take less time than a similar trip on existing transit. At no time should a trip take longer via BRT.

5.3 Stages of Implementation

Table 5-1 outlines the three stages of implementation.

Stage I

The first stage of implementation includes those steps necessary to initiate BRT service. The expected duration of this stage is 3 to 6 months. The following steps are proposed:

- Order buses.
- Let the contracts for the three major construction projects: the Wyoming transfer station, the southeast terminus of the Jeffries Freeway, and the Scotten ramp, with construction to begin as soon as possible.
- Implement the marketing and public information plan.
- Place the necessary signs and paint the pavement markings to delineate the exclusive lanes on the Jeffries Freeway. (These identification devices should contribute to the special public identity of BRT, in addition to providing traffic control.)
- Negotiate for the park-and-ride lots in Oakland County. Once spaces are secured for use by BRT patrons, perform the necessary striping and signing.
- Begin BRT service from the SEMTA park-and-ride lot at Lahser and Northwestern Highway. Non-stop CBD buses will go from the park-and-ride lot down Northwestern Highway to the Southfield Freeway, down the Southfield Freeway to the Jeffries Freeway. The bus will then use the exclusive BRT lane on the Jeffries, exit at the Myrtle off-ramp to Michigan Avenue, and then go down Myrtle to the CBD distribution loop. The trip outbound will follow the same route, with one minor exception. To enter the Jeffries from

Table 5-1 Preliminary Staged Implementation Plan

STAGE I (3 - 6 Months)	STAGE II (Approx. 1 Year)	STAGE III

• Bus Procurement
 	
• Begin major construction
  - Wyoming transfer station
  - Jeffries SE terminus
  - Scotten ramp
 	
• ROW modifications - Jeffries
  - Signing
  - Pavement markings
 	
• Negotiate for P&R lots
  - Stripe & sign when available
 	
• Begin BRT service from P&R lot at Lahser & Northwestern Highway
  - CBD only
 	
• Divert Imperial Express buses originating west of Southfield to BRT facility
 	
• Greenfield Line
  - Begin service Northland to Dearborn
  - Distribution routes during peak periods - Shuttles off-peak
	• Decide between route Alternative I (Southfield) and Alternative II (Lodge)
	  - If Alternative I is chosen, construct Northland exit ramp
	
	• Implement service from all Oakland County P&R lots
	
	• One P&R lot to provide both CBD & NC service
	
	• Implement Oakland County feeder service
	
	• Express buses on existing routes west of Southfield Freeway diverted to BRT facilities
	  - CBD only buses exit at Myrtle
	  - New Center transfer service buses exit at Grand Blvd. then proceed to CBD via Grand River
	  - New express, as needed, started on existing routes at Southfield
	  - East of Southfield buses follow existing routes
		• Wyoming transfer station completed & phased into operation
		
		• Scotten ramp & SE terminus ramp completed & phased into operation (these ramps phased in when complete--can be Stage II)
		
		• New Center shuttle buses from Wyoming station begin operation
		
		• New Center distribution loop implemented
		  - Kirby made one-way
		
		• Express service started on Eight Mile Road
		
		• Express buses, east of the Southfield Freeway, enter BRT system via Wyoming
		  - All BRT buses go to CBD
		  - New Center access via shuttle from Wyoming station
		  - All BRT buses stop at Wyoming station

Michigan Avenue, the bus will take Michigan to 12th Street, turn north on 12th Street to the Jeffries service drive, and turn onto the service drive entering the freeway at Myrtle. The BRT vehicles will enter and exit the exclusive lanes by weaving across the outer freeway lanes, as necessary.

- Divert Imperial Express buses originating west of the Southfield Freeway onto the Southfield Freeway at the Seven Mile and Southfield intersection. Once on the Freeway, these buses will follow the route to the CBD outlined above. Additional Imperial Express buses will originate at Southfield and Seven Mile, and proceed east on Seven Mile following the normal route to the CBD.

- Initiate the Greenfield Intermediate Line. Begin service between Northland and Dearborn. Distribution routes will be operated in Southfield and Dearborn during the peak periods. Off peak, shuttle buses will provide the distribution/collection functions, as required.

Stage II

The second stage of implementation provides the bridge between the limited introductory service of Stage I and the final BRT system. During Stage II, there is both an expansion of service and an improvement in the level of service to accommodate the anticipated increasing ridership of the BRT system. The duration of this phase is approximately 1 year. The following steps comprise Stage II:

- The decision between the alternatives of the Southfield route and the Lodge route is made in this stage. The decision depends, in part, upon the negotiations for a park-and-ride lot at Northland during Stage I. In addition, a travel time comparison will be made between the two proposed routes. If the Northland park-and-ride lot is available, and if the Lodge route is quicker, the decision will be made to use the Lodge. If the Lodge route is chosen, no new construction will be initiated in this stage. However, if the Southfield route is chosen, the Southfield Freeway to the Northland exit ramp will be constructed during this stage.

- Service will be implemented from the remaining park-and-ride lots in Oakland County. These buses will be non-stop to the CBD via the Southfield route at this time. If the decision to use the Lodge is made during this stage, these buses will use the Lodge route.

- One park-and-ride lot in Oakland County is designated to provide non-stop service to the New Center, in addition to the CBD service. If Northland is available, the Northland lot will be used for this service; otherwise the SEMTA lot on Northwestern Highway and Lahser will be designated for New Center patron use.

- Oakland County feeder bus service will begin in this stage. The park-and-ride lot providing both CBD and New Center service will be the focus of the feeder service.

- BRT collection buses on Grand River and the Mile Roads - Seven Mile, Six Mile, Fenkell, Schoolcraft, Plymouth, and Joy - will enter at the Southfield Freeway and then proceed onto the exclusive Jeffries BRT lanes. Those buses destined non-stop for the CBD will exit at the Myrtle Avenue exit and proceed to the CBD via Michigan Avenue. CBD-bound buses which provide transfer service to the New Center will exit the Jeffries at Grand Boulevard, and, after deboarding the New Center passengers, will proceed to the CBD via Grand River. Additional express buses, as needed, will begin at the mile road intersections with the Southfield Freeway and follow existing routes to the east and south.

- Service will be improved on the Greenfield Intermediate Line. Bus shelters will be added along the route. Light pre-emption equipment will be installed at selected intersections for BRT intermediate level service buses operating on Greenfield.

Stage III

During Stage III, the final BRT system, as conceived, is implemented. This stage will be implemented as soon as the Wyoming transfer station is completed. The following steps apply to Stage III:

- The Wyoming transfer station will be completed and phased into operation.

- The Scotten ramp and the Jeffries southeast terminus exit ramp at Third Street will be completed and phased into the system. Should either or both of these construction projects be completed during Stage II, they will be phased into the system at that time.

- New Center shuttle buses will begin operating from the Wyoming transfer station. The New Center distribution loop will begin operation. Kirby between Cass and Woodward will be made one way eastbound to accommodate BRT buses on the distribution route.

- BRT collection bus service will begin on Eight Mile Road. The route to the CBD will be via the Lodge and Wyoming.

- BRT collection buses operating on Grand River and the Mile Roads - Seven Mile, Six Mile, Fenkell, Schoolcraft, Plymouth and Joy Roads - east of the Southfield Freeway will enter the BRT system via Wyoming. All BRT buses will go to the CBD. New Center patrons will board the New Center shuttle buses at the Wyoming transfer station.

- All BRT buses, regardless of the origin will stop at the Wyoming transfer station.

5.4 Growth Steps

As the public accepts the final BRT system and ridership builds, it can logically be assumed that the system will meet this increasing ridership through growth in several areas.

One logical growth step would be to expand the service area of the BRT system. The system could be expanded to the west in Wayne County and possibly further into Oakland County.

System performance will be evaluated during all stages of implementation of the BRT system. After the entire BRT system is in operation, during Stage III, this performance evaluation will indicate areas of potential growth, and the system will be reconfigured and/or expanded to provide service to these growth areas, as warranted. As indicated in Section 3.5, the Wyoming station is sized to accommodate an increase in transit volume.

APPENDIX

FREEWAY BUS PRIORITY TREATMENTS

The following planning guideline factors are significant in achieving efficient use of urban freeways by buses:

1. The identification of major overload points on freeways provides an important guide as to where special bus priority facilities should be built.
2. It is not generally feasible to remove existing freeway lanes from auto use in the heavy direction and give these lanes to buses.
3. Right-hand freeway lanes are not usually desirable for exclusive bus use because of weaving conflicts with entering and exiting traffic.
4. Standardization of freeway entry and exit ramps to the right of the through traffic lanes will permit the use of median lanes by buses either in normal or contra-flows.
5. Metering of freeway ramps with bus bypass lanes should be introduced where the techniques will improve mainline through-flow and reduce bus congestion.
6. Street level bus stops, where buses leave the freeway for passenger pickup and delivery, are generally preferable to turnouts from freeway lanes.
7. Effective downtown passenger distribution facilities are essential complements to regional bus rapid transit services.
8. Busways should cost less than rail transit lines.
9. Busways should be designed to allow for possible future conversion to rail or other fixed guideway transit.
10. Busways should extend beyond the normal queuing distances from freeway convergence points and park-and-ride facilities should be provided.
11. There may be merit in redirecting busway emphasis to developing facilities within the CBD, and on the close-in miles of radial corridors adjacent to it.
12. Radial freeways in urban areas which exceed 1,000,000 should provide for future express transit either within the median or alongside the facility.

BUSWAYS

Busways are special roadways designed for exclusive or predominant use by buses. They are presently in operation in metropolitan Washington, D.C. and Los Angeles, and Runcorn, England. They are planned or proposed for several other cities.

To consider implementation of line-haul busways, the following basic conditions should be met:

1. The urban population should exceed 750,000 with CBD employment of 50,000 or more and with peak-hour cordon volumes of 35,000.
2. There should be a potential of at least 40 buses and 1600 passengers in the peak hour using the busway.
3. Buses should save at least 5 minutes on the busway over alternate bus routings.
4. Current highway demands in the corridor exceed capacity and additional road capacity cannot be provided.

Busways should also be considered when one or more of the following conditions are met:

1. Freeways cannot be returned to service level "D" with mixed traffic by ramp metering or ramp closures.
2. Contra-flow lanes are not feasible.
3. Short bypass lanes around congestion points are not feasible or enforcible.
4. Rapid rail will be warranted along the corridor within 20 years.
5. The travel time benefits to bus passengers exceed the annualized busway purchase and development costs.

Busway configuration criteria include the following:

1. Radial character - busways should radiate outward from the CBD. Cross-town should be developed only when warranted by land-use and travel densities.
2. Market penetration - the busway should penetrate high density residential areas and provide convenient CBD distribution.
3. Through service - through routing patterns are preferable except perhaps on long suburban routes.
4. Simplified route structure - minimize the number of branches and avoid complex routing patterns.
5. High operating speeds - portal-to-portal speeds between outlying areas and the CBD for buses should be comparable to auto speeds.
6. Station spacing - station spacing should vary inversely with population density. The need for stations is diminished by the ability of buses to leave the busway for collection.
7. Park-and-ride desirable in outlying areas.

DOWNTOWN DISTRIBUTION

> "The separation of buses from other traffic is more significant on the approaches to and (where conditions permit) within downtown, than it is in outlying areas. Moreover, commitment to capital costs for busways in radial corridors calls for parallel commitments to downtown distribution--either in special off-street facilities, or through the allocation of special streets or lanes to buses."*

Downtown distribution can be provided by bus streets and bus lanes which connect to busways, with traffic signal priorities for buses at key locations.

RESERVED FREEWAY LANES

Reserved bus lanes should be provided only where the total number of bus passengers in the heavy direction of flow is equal to or greater than the 'typical' lane carrying capacity of automobile passengers.

Preference should be given to use of median lanes by buses because these lanes are usually removed from ramp conflicts and weaving traffic. Conditions will generally favor contra-flow lanes. Normal-flow lane experience is limited because of bus weaving problems and because bus flows have never equalled the capacity of a freeway lane. Normal-flow lanes are also difficult to enforce.

NORMAL FLOW LANES

Normal flow bus lanes should be provided only where ample reserve capacity exists or where the lanes represent an addition to the total road capacity in the flow direction, such as is achieved through widening or unbalanced operations.

Enforcement of the bus lane may be difficult unless a physical barrier is present and lanes are relatively long.

For a normal-flow lane, the following criteria should be met:

1. The number of person-minutes saved by bus riders at least equals the number of person-minutes lost by general traffic. This criteria can be relaxed where community policy explicitly desires to reduce auto travel.
2. A normal-flow lane should have 60 to 90 buses in the peak hour when it involves adding a lane, and 300 or more buses in the peak hour where an existing freeway lane operating at peak capacity is pre-empted.

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* Levinson, H.S., Adams, C.L., and Hoey, W.F., Planning and Design Guidelines for Efficient Bus Utilization of Highway Facilities, p. 6-15.

CONTRA-FLOW LANES

Buses only should use contra-flow lanes for the following reasons:

1. The bus lane traffic stream is homogeneous, variation in vehicle performance is minimal, and there is no need to overtake slower vehicles.
2. Buses are highly visible to on-coming traffic. Use of headlights and flashers is recommended.
3. Bus drivers are professionals.
4. Bus lane volumes are relatively low making the risk of collision no greater than an undivided urban arterial.

Factors to be considered in design and planning include:

1. The need to remove median barriers at crossovers or transition points
2. Blocking of the exclusive lane by accidents or stalled buses
3. Safety
4. Possible congestion in the remaining off-peak directions
5. The general difficulty of providing stations and interim access for buses.

Contra-flow lanes should be used only on freeways with more than four lanes where the peak-hour traffic is highly imbalanced. The following conditions should prevail:

1. The freeway is at least six lanes wide.
2. All freeway entrances and exits are to the right of the through lanes.
3. The freeway is illuminated during night operations.
4. Freeway travel in the off-peak direction can be accommodated in the remaining lanes at level of service "D" or better.
5. There is a minimum of 40 to 60 buses in the peak hour and each bus saves two or three minutes.
6. Contra-flow bus lane passengers save more time than is lost by traffic in the opposite direction.

Design and operating features include:

1. Contra-flow bus lane should be provided adjacent to the median.
2. Lanes should be in operation a minimum of two hours.
3. Intermediate access can be provided via special bus ramps in wide freeway medians.

4. Removable, flexible traffic posts should separate the bus lane from opposing traffic flows. Buffer lanes may separate opposing bus and car traffic on eight-lane freeways where volume conditions permit and high operating speeds are desired.
5. Bus operating speeds should be 35 to 50 mph.
6. Contra-flow lane widths should increase in relation to operating speed; from at least 11 ft at 35 mph to 12-13 ft at 50 mph and 17 ft at 70 mph.

Maintenance and enforcement costs are approximately $80,000 to $100,000/mile/year/lane. Tow trucks are necessary to remove disabled vehicles.

BUSES IN MIXED FREEWAY FLOW

Where freeways operate above level of service "D", mixed traffic operations are more efficient than providing exclusive lanes or roads for buses.

To expedite bus flow at minimum costs with minimum delay to other users, the following treatments can be implemented, either singly or in combination:

- Ramp metering can keep main freeway lanes operating at reasonable speeds, reduce travel distances, and promote continuity in a system of bus priority treatments.
- Bus ramps can bypass queues, reduce travel distances, and promote continuity in a system of bus priority treatments.
- Bus stops are essential to provide access to tributary areas, as well as allow transfer to car or bus.

BUS STOPS ON FREEWAYS

Where buses use urban freeways, bus stops generally should be provided at street level for the following reasons:

- Often freeways are not located in major areas of existing or potential bus patronage.
- Freeway stops require construction which may not be cost effective.
- Freeway-level stops require local bus transfers on, under, or above crossing streets.

- Street level stops with priority treatments at metered on-ramps provide safer and more convenient pedestrian access. They eliminate the need for:
    1. Acceleration and deceleration lanes for buses
    2. Special pedestrian fences
    3. Stairs and escalators
    4. Additional bridge widths to accommodate bus stops at freeway level

FREEWAY LEVEL STOPS

The following are guidelines for freeway bus stops both at and between interchanges:

- The stops should be located on separate roadways at least 20 feet wide to permit standing or stalled buses to be passed and to physically preclude pedestrians from the main freeway lanes. Where positive pedestrian separation is not essential, the bus lane can be reduced to 12 feet. However, overtaking capabilities are always necessary to allow schedule adjustments and passing stalled vehicles.
- Platforms should be a minimum of 80 feet in length to allow two buses to load and unload simultaneously. Pedestrian islands should be 5 to 6 feet wide.
- Acceleration and deceleration lanes should be a minimum of 100 feet long.
- Pedestrians must be kept off freeways.
- Bus shelters, with benches, should be provided. The shelters should be visible from the roadway. Consideration should be given to install telephones and the shelter could be heated.
- Advance signing of bus stops should be provided.

ARTERIAL RELATED BUS PRIORITY TREATMENTS

The following are general planning guidelines for arterial bus priority treatments:

1. General traffic improvements and road construction should be coordinated with bus service to improve the overall efficiency of street use.
2. The prohibition of curb parking, at least during the peak hours, should be prerequisite to establishing bus lanes.
3. Bus routes should be restructured as necessary to make full use of priority lanes and streets. Sixty to 90 buses per hour are desirable to help "enforce" bus lanes.

4. Bus priority treatments should reduce both the mean and variance of average journey times.
5. A wide application of bus lanes is necessary before schedule speeds can increase sufficiently to produce significant operating economies and/or encourage additional riding.
6. Bus lane and bus street installations should recognize the service needs of adjacent land uses which often result from long established development patterns.
7. Design of the bus lane should reflect available street widths and prevailing operating practices. Lanes should be at least 10 feet wide, with appropriate signs and pavement markings. If necessary, right turns by non-bus traffic may be allowed.
8. Bus lanes should be provided wherever possible without reducing the lanes available to through traffic in the prevailing direction of flow.
9. Effective enforcement is essential.
10. Emergency vehicles should be allowed to use the exclusive lane. Taxis should be allowed in the lane when fewer than 60 buses per hour use the lane. There should be at least one bus per block to aid enforcement.

CURB BUS LANES - NORMAL FLOW

Curb bus lanes can be installed whenever the following general conditions apply:

1. There is no parking or standing along the curbs during the hours that the bus lane is in effect.
2. The bus lane does not reduce peak-hour, peak-direction traffic capacity, except where such reductions are part of regional transportation policy objectives.
3. There are at least two other moving lanes for general traffic in the same direction. This criteria could be relaxed on two-way, four-lane streets, where left turns are prohibited during peak hours.
4. Curb access of service and vehicles to abutting property can be reasonably prohibited during the periods of bus lane operation.

5. The number of existing and potential peak-hour bus passengers equals the average number of passengers carried by car in the adjacent lanes.
6. There are at least 30 to 40 buses and 1200 to 1600 people one way in the peak hour. Where lanes are in operation all day, there should be at least 300 buses. Bus flow rates should approach 60 buses per hour during the busiest 60-minute period.
7. When lanes traverse the principal shopping street, there should be at least 20 to 30 buses in the peak hour. Where lanes are in effect all day, there should be at least 200 buses.

MEDIAN BUS LANES

Median bus lanes are well suited for express bus service along wide multi-lane arterials; local bus service could remain in curb lanes. Buses in the median--operating non-stop or limited stop--could exceed peak-hour auto speeds.

Median lanes can be implemented whenever the following general conditions apply:

1. The bus lanes replace street railway operation in the center of the street, and the precedent for center-of-street loading is established.
2. Curb access requirement or enforcement factors preclude exclusive bus use of curb lanes.
3. A wide median exists and, if necessary, can be paved for buses without eliminating trees or otherwise impacting the environment.
4. The street is wide enough to allow at least two general purpose traffic lanes, or one traffic and one parking lane, on either side of the median.
5. The street is wide enough for passenger loading platforms. Minimum street widths range from 50 feet for a single median lane on a one-way street to 65 feet for double median lanes on a two-way street.
6. Conflicting left turns are prohibited or channeled into lanes outside the median.
7. The number of existing and potential bus passengers at least equals the average number of passengers carried by car in the adjacent lanes during the period of exclusive lane operation. Where peak-hour median lanes are provided, buses should carry 1.25 times the number of passengers.

8. A minimum of 60 to 90 buses serving 2400 to 3600 people use the median lane. Where lanes operate throughout the day, a minimum of 600 buses per day should be carried.

Generally, median buses should be in effect throughout the day. However, part-time operation is feasible.

Bus lanes should be at least 10 feet wide for one-way operation and 20-22 feet wide for two-way operations. Nine feet wide lanes may be utilized in unusually restrictive conditions.

CONTRA-FLOW BUS LANES

Contra-flow bus lanes enable buses to operate opposite to the normal traffic flow on one-way streets.

Buses using contra-flow lanes are separated from other traffic flows, removed from conflicts with other vehicles, and are unaffected by peak-hour congestion (or backups) at signalized intersections. The lanes are relatively self-enforcing, and they have high visibility.

Contra-flow lanes can: 1) retain existing bus routes when new one-way street patterns are instituted, 2) provide new service on existing one-way streets, 3) utilize available street capacity in the off-peak direction of flow, and 4) permit curb space on both sides of one-way streets to be used for passenger loading:

Contra-flow lanes perform the following basic functions:

- Provide radial bus service along pairs of one-way streets leading to the CBD.
- Provide downtown distribution for express bus routes.
- They allow two-way bus service on one-way downtown and radial streets.
- They provide short-circuit bus movements on one-way street grids, thereby reducing bus mileage.

Contra-flow bus lanes can be installed wherever the following general conditions apply:

1. Curb parking and standing are prohibited during the hours that the bus lanes are operating.
2. The bus lane does not reduce peak-hour, peak-direction traffic capacity, except where such reductions are an integral part of regional transportation policy objectives.

- Where a bus lane pre-empts a lane used by automobiles, sufficient capacity should be provided in remaining lanes or parallel streets to accommodate the displaced traffic.

3. Two or three lanes remain for traffic in the opposite direction. An exception may be made for short segments of contra-flow lanes of less than two or three blocks.
4. Traffic signals are spaced at greater than 500-foot intervals along the arterial streets affected.
5. There are at least 40 to 60 buses carrying 1600 to 2400 people one way in the peak hour. Where lanes are in effect all day, at least 400 buses should utilize the lanes.
6. Access to abutting properties must be worked out before lane implementation.
7. Peak period congestion exists in the corridor to be served by contra-flow lanes.

DESIGN AND OPERATING FEATURES

1. Contra-flow lanes should operate throughout the day.
2. Lanes should be 10 to 12 feet wide on streets 30 feet or wider (40 feet is a desirable minimum street width).
3. Contra-flow bus lanes may be separated from the normal direction of travel by paint or by physical barriers. Physical islands may pose maintenance problems where extensive snow removal is anticipated.
4. Lanes should be used by buses and emergency vehicles. Taxis may be permitted in the lanes where peak bus volumes are under 60 buses per hour.
5. Left turns by general traffic may be permitted where left-turn storage lanes may be incorporated in the roadway.
6. Loading may be permitted during off-peak hours from bus lanes, where bus lanes can be widened to permit mid-block passing of stopped vehicles. Loading should be done in the same direction as the bus lanes.
7. Access into driveways and parking facilities may be permitted across the bus lane.
8. Buses should not leave the lane except to pass a stalled vehicle.

9. Selective signal pre-emption may be employed where only limited delay accrues to traffic in the opposite direction.

BUSES IN MIXED TRAFFIC FLOW

Bus priority treatments in mixed traffic flow include:

1. Restricting entry from side streets
2. Prohibiting curb parking or vehicle loading
3. Special turn provisions for buses
4. Bus actuation or pre-emption of traffic signals
5. Improved bus stops and turnouts (near, far, or mid-block)
6. Bus shelter installations

These preferential measures can be used in combination with bus lanes, busways, and bus streets.

Mixed-traffic priority treatments are desirable where one or more of the following conditions apply:

1. Corridor capacity is extremely limited by topography or other barriers.
2. Only one or two continuous streets exist in a corridor.
3. There are less than 20 buses in the peak hour in the peak direction.
4. Allocating an exclusive lane for bus use would unduly reduce total corridor capacity for auto travel and induce forced flow conditions.
5. Roadway widening is not feasible.

TRAFFIC SIGNAL PRIORITIES

> "Adjustments of traffic signal timing at intersections to facilitate bus flow can substantially reduce average bus waiting times and can improve operating economy; bus delays at traffic signals usually represent 10 to 20 percent of overall bus trip times and nearly half of all delays."*

A short reserved bus lane upstream from a traffic signal, in conjunction with bus priorities through a signal enables buses to bypass queues, move freely up to the intersection, and then promptly through the signal either on the normal green or on a specially pre-empted phase.

Bus signal adjustments include passive and active systems.

1. Passive systems have no special bus detection, they involve:
   - Retiming of signals
   - Reordering of phases (progression)
2. Active systems depend upon special bus detection, they involve:
   - Provision of a special bus phase
   - Extension or recall of a normal phase

Special bus signal phases, actuated or fixed time, provide periods during which buses can cross conflicting traffic streams.

Bus pre-emption of signals may extend the artery green time when buses enter or approach an intersection to minimize person delay.

APPLICABILITY

1. Special Bus Phases - Special bus phases should be provided wherever bus routes conflict with heavy traffic streams, and it is logical from a safety standpoint to separate these conflicts. Signalization of bus left or right turns across through traffic should be considered wherever buses are required to cross more than two traffic lanes with each lane carrying 500 or more vehicles in the peak hour.

2. Bus Extension of Artery Green - Bus extension or recall of a normal signal phase should be considered when the following conditions apply:

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* See Henry R. Evans and Gerald W. Skiles, "Improving Public Transit Through Bus Pre-Emption of Traffic Signals," Traffic Quarterly, October 1970, p. 30.

- Bus pre-emption reduces total person delay. The person-minutes saved by bus passengers exceeds the person-minutes lost by side street (auto) passengers. The objective is to reduce person delay without adversely affecting signal network coordination.
- There are at least 10 to 15 buses carrying 400 to 600 people in the peak hour and a daily volume of at least 100 buses.
- The side-street green phase can be reduced and still provide adequate pedestrian clearance time.

The extension of artery green time by bus pre-emption will be constrained by signal network coordination requirements because pre-emption must take into account the effort on the entire signal network. Heavy pedestrian volumes, major intersecting bus volumes, and frequent intersection blockages will limit the nature and extent of signal timing modifications.

The greatest potentials for bus pre-emption exist along arterial streets at locations where side street progression is not a significant factor.

DESIGN AND OPERATING FEATURES

Bus detection of signals should take place before buses reach the stop line. If detection occurs during the green time of the artery phase, an extension of the green phase should provide sufficient time to allow buses to clear the signal. If detection occurs during the yellow or red period for the artery, the artery green can be recalled in advance of its normal time. These changes would decrease bus delay assuming there are no obstructions to the bus between the detection point and stop line.

- A minimum side street green is required in each cycle. It should provide adequate time for pedestrians to clear the artery.
- The artery green may be advanced up to a specified period before it normally takes place or extended up to the same period after it normally takes place.
- The artery green should not be extended and advanced in the same period.

The extent that artery green time can be increased by pre-emption will depend upon:

- Side-street volumes and coordination requirements
- Prevailing cycle length
- Artery roadway width

Typical extension times vary with conditions as follows:

1. Optimum Conditions - At isolated intersections, bus pre-emption could extend artery green time up to 10 seconds in a 60-second cycle and 18 seconds for an 80-second cycle.
2. Constrained Conditions - At intersections where coordination is provided on both streets, bus pre-emption could extend artery green time about six seconds.
3. Variable Conditions - At intersections where buses may pre-empt signals on either street, both artery and cross street green time may be increased or decreased about six seconds.

GENERAL TYPES OF TREATMENT

• Median Strip - Exclusive busways may be located in the median strips of existing freeways. This concept could have relatively low implementation costs and minimum community disruption. The type of median implementation is dependent upon the width of the median available. Sketches have been provided for five implementation schemes using median widths from one to five lanes.

The one-lane median busway implementation is the simplest and most limited of the five schemes (see Figure 1). All stations must be off-line, that is, outside of the freeway traffic lanes. Therefore, buses must leave the busway at each station and return. Two exiting schemes are possible: elevated bus ramps over the freeway lanes or crossing the freeway lanes on-grade with the buses. The latter results in serious bus weaving across the freeway lanes, a condition which is both unsafe and conducive to freeway congestion. The direction of flow on the busway is reversible and is dependent upon demand. For example, the busway would carry traffic toward the CBD during the morning rush and away from the CBD in the evening. Station access for this implementation is limited because the station is accessible from only one side of the freeway.

The two-lane median provides several advantages over the one-lane case (see Figure 2). The primary benefit is that stations can be constructed over the median with the passenger loading platform at grade level. Two lanes provide space for a bypass lane at stations, allowing buses to stop without blocking busway through traffic. Two lanes are required only at stations. One lane is sufficient for the remainder of the busway. Providing stations in the median eliminates the need to remove buses from the busway, thereby eliminating the need to construct costly bus ramps at each station. Relatively few access ramps are required. This implementation scheme allows busway travel in only one direction, the direction being determined by traffic demand. An alternate scheme, feasible where two lanes are available in the median for the entire busway length, would allow travel in both directions with on-line stops. Some problems would arise from buses queuing behind stopped vehicles at stations. For either two-lane scheme, access could be provided to the elevated station from either side of the freeway using walkways or moving sidewalks.

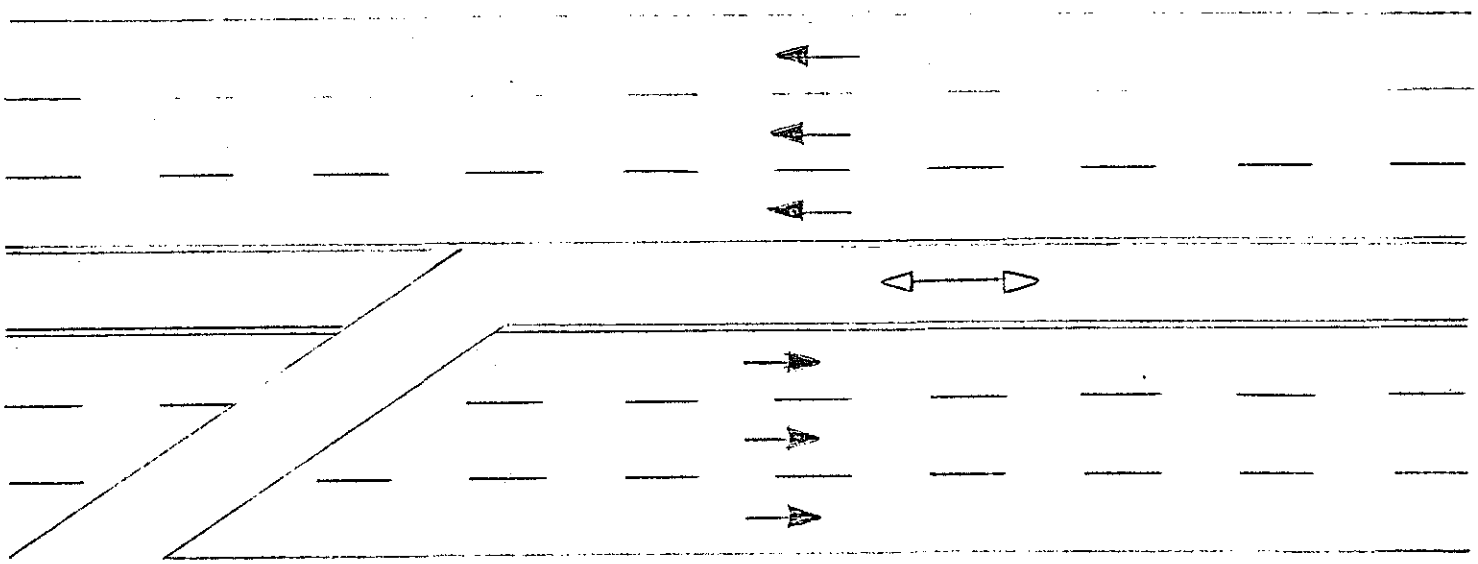

FIGURE 1 ONE-LANE MEDIAN

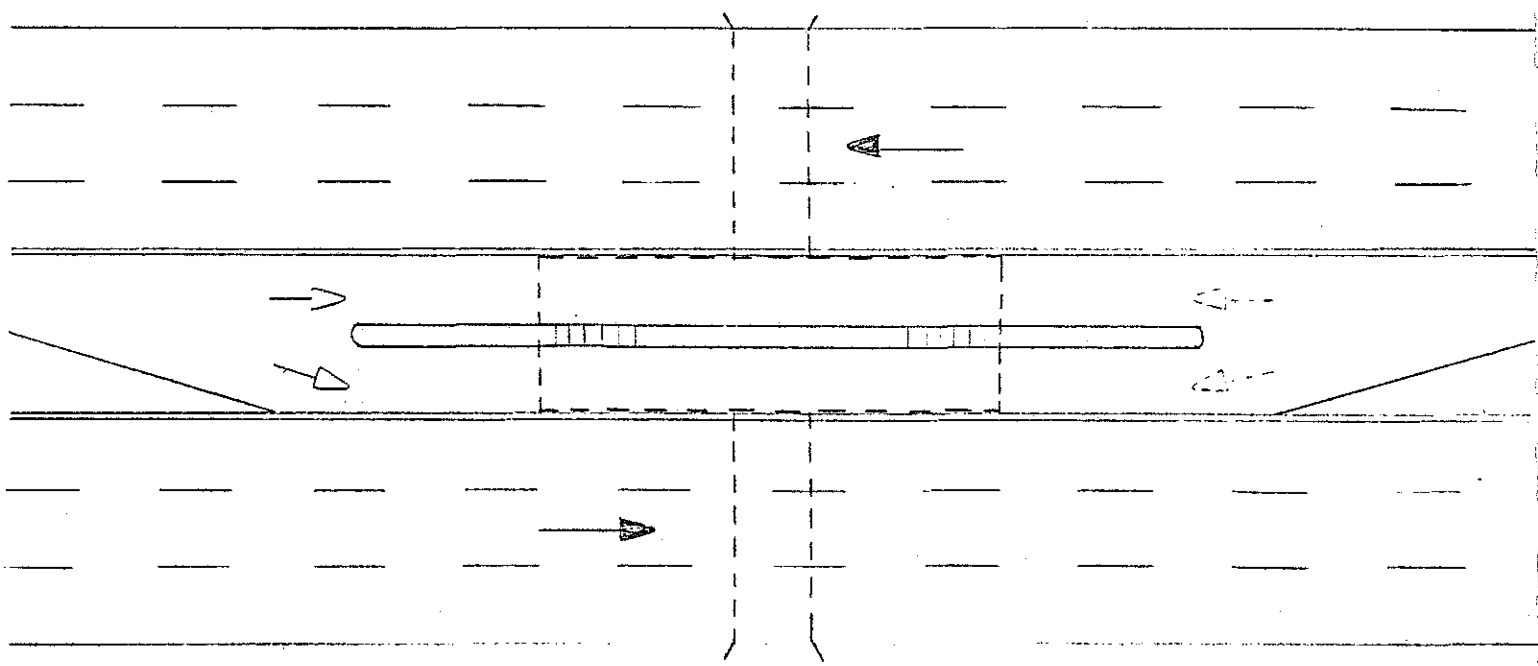

FIGURE 2 TWO-LANE MEDIAN

The three-lane median can be implemented to provide travel in both direction with areas for off-line stops at stations (see Figure 3). Three lanes are required for station areas where two lanes are necessary elsewhere. The two arms of the station platform are connected to a common center section containing escalators to the station above. Two lanes are required in non-station areas. If bus travel is required in one direction only or if only one lane is available in some areas of the median, the three-lane median station can be implemented with a wide passenger loading platform and an off-line station stop lane (see Figure 4). This implementation would provide a reversible busway with the direction of travel dependent upon demand. The overhead station would be linked to the Dial-A-Bus and parking facilities outside the freeway traffic lanes on either side by overhead walkways or moving sidewalks.

The four- and five-lane median implementations are similar (see Figures 5 and 6). Both need very wide medians at the stations, two lanes elsewhere. The four-lane implementation has two wide loading platforms linked to a common overhead station. The five-lane scheme requires only one platform to serve both directions, again linked to an overhead station. Busways will serve both directions and the station will connect to both sides of the freeway as discussed previously.

Median busway schemes provide several common advantages and disadvantages regardless of median width. They all use existing right-of-way for the busways without affecting normal freeway traffic flow. Use of existing freeways is also a limiting factor however, because quite often freeways do not provide access to the centers of population, and industry, as do major arterial streets. Freeway stations present some access problems to the stations themselves. Stations should link to both sides of the freeway with parking and other peripheral facilities; however, station access may be limited to one side of the freeway if access space is at a premium. The implementation of busways in median strips is also limited by overpass or bridge abutments located within the median, thereby restricting the space available for busway lanes.

Overhead stations in the freeway median provide efficient space utilization along with several related benefits. One station can serve both directions with a comfortable, safe waiting area for passengers. Passenger access to platforms could be allowed only as buses arrive, thereby limiting the time of exposure to the elements.

Most freeway median installations would also be readily convertible to automated dual mode use.

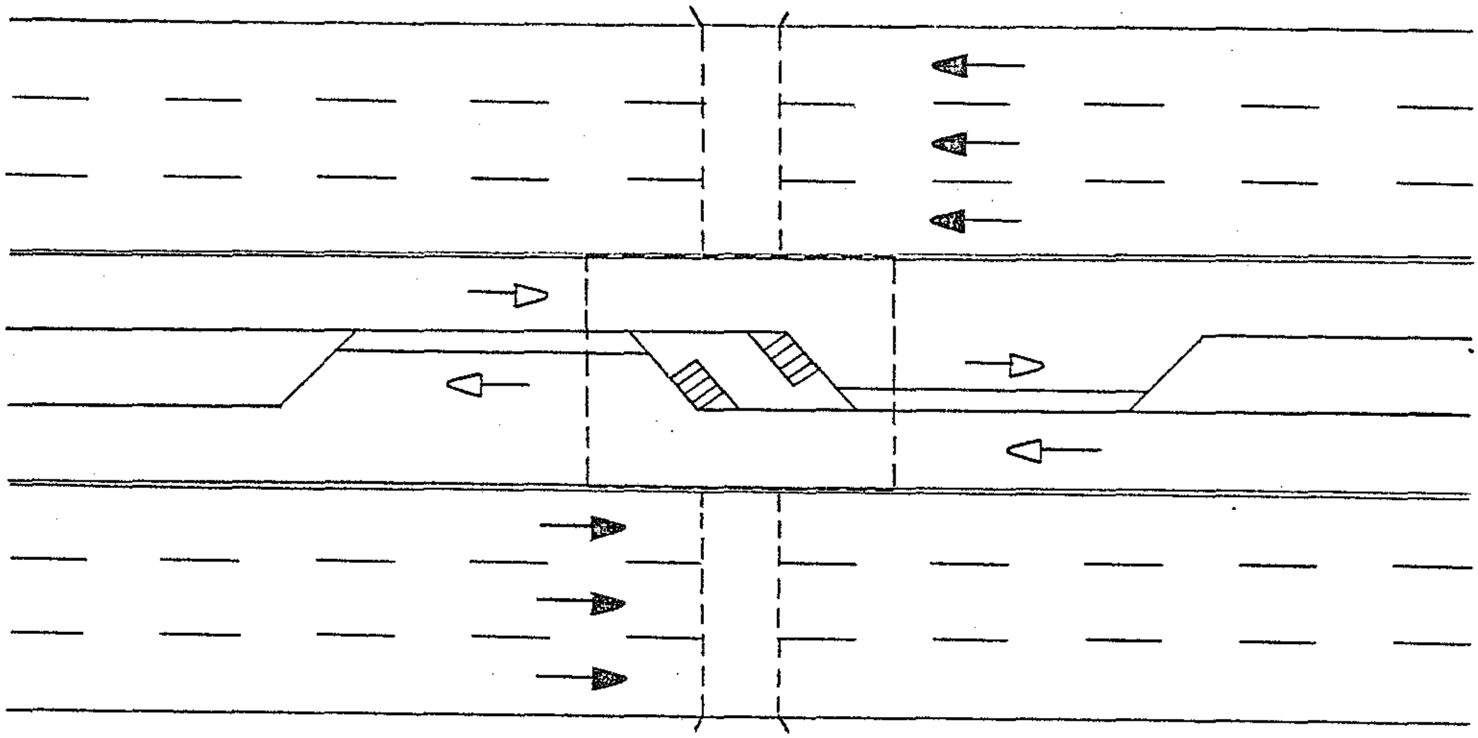

FIGURE 3 THREE-LANE MEDIAN

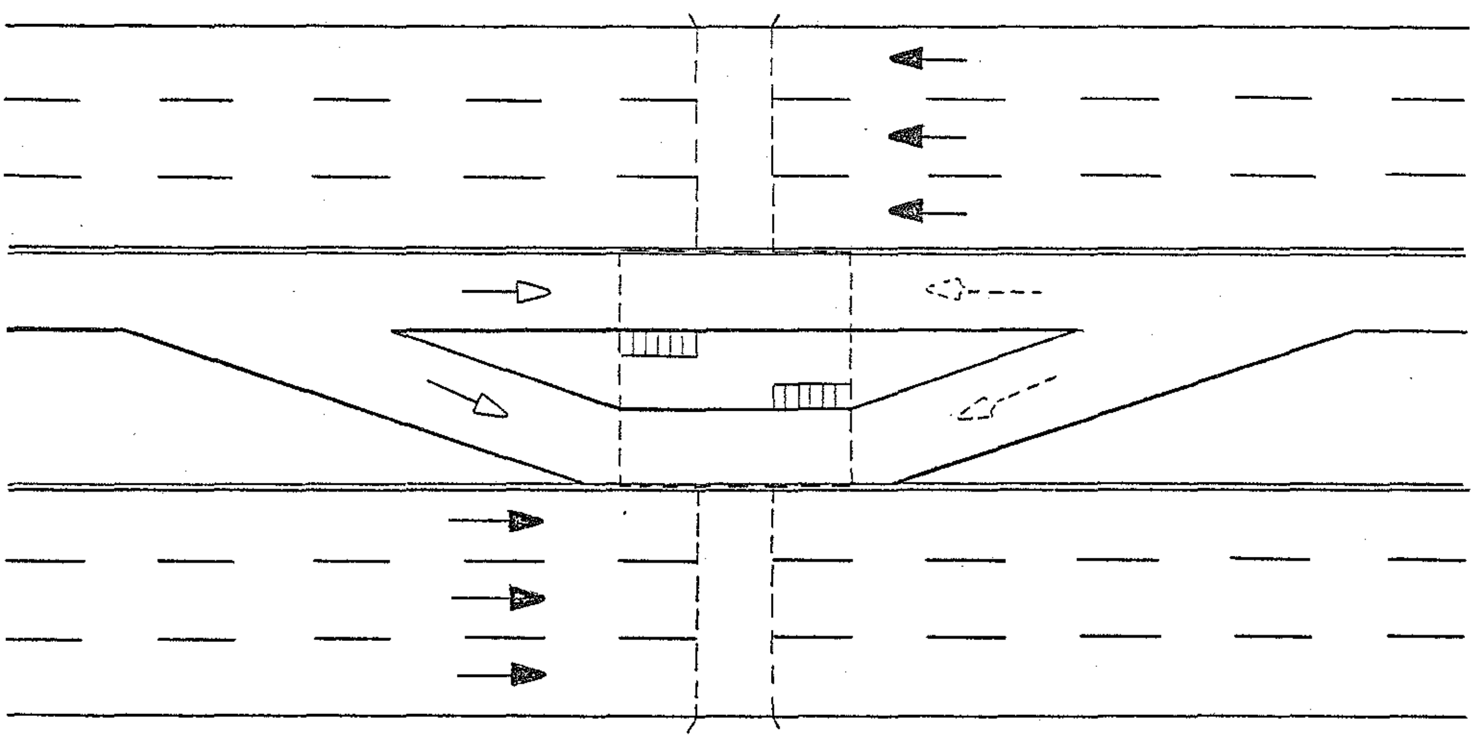

FIGURE 4 THREE-LANE MEDIAN

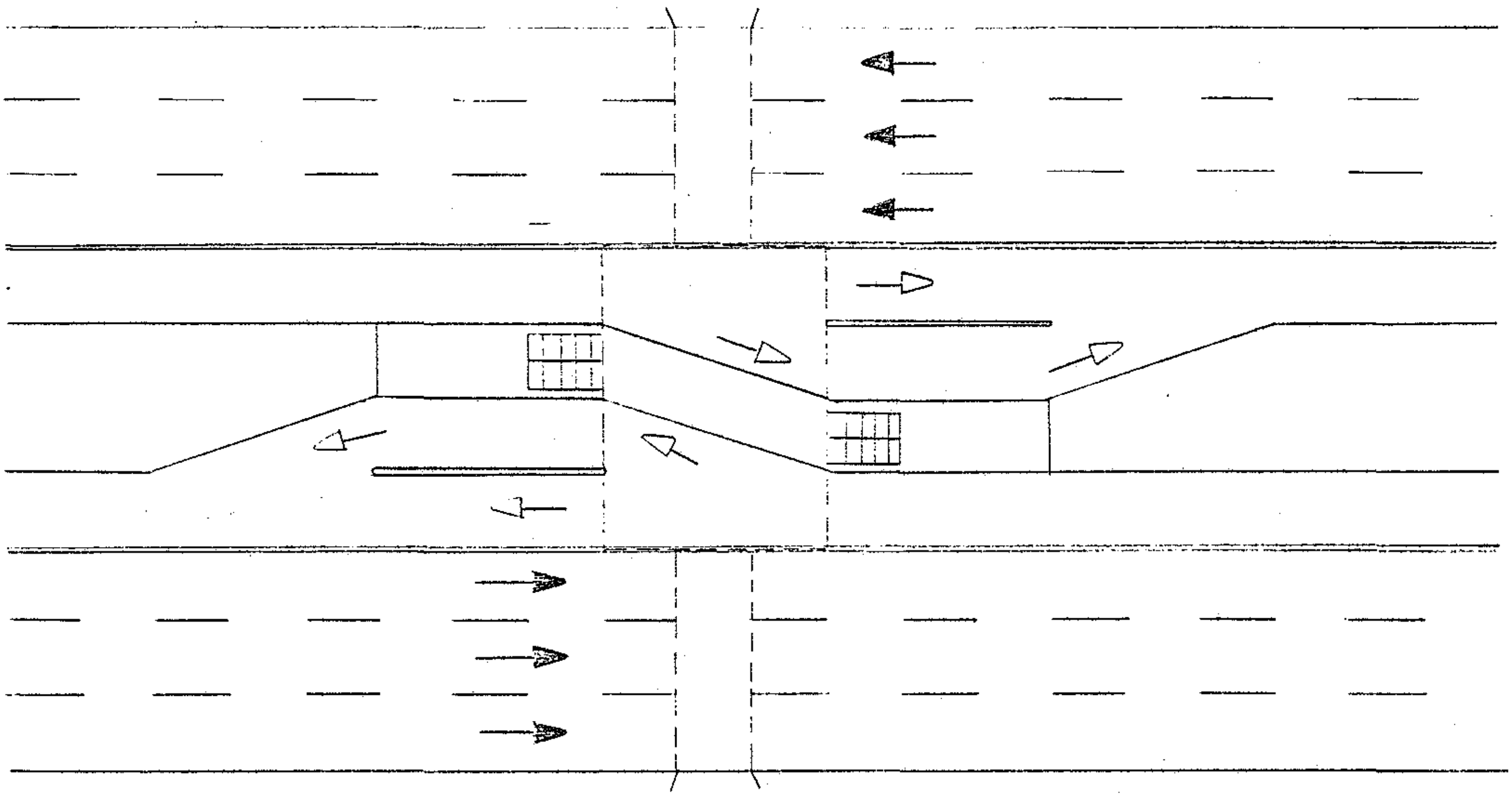

FIGURE 5 FOUR-LANE MEDIAN

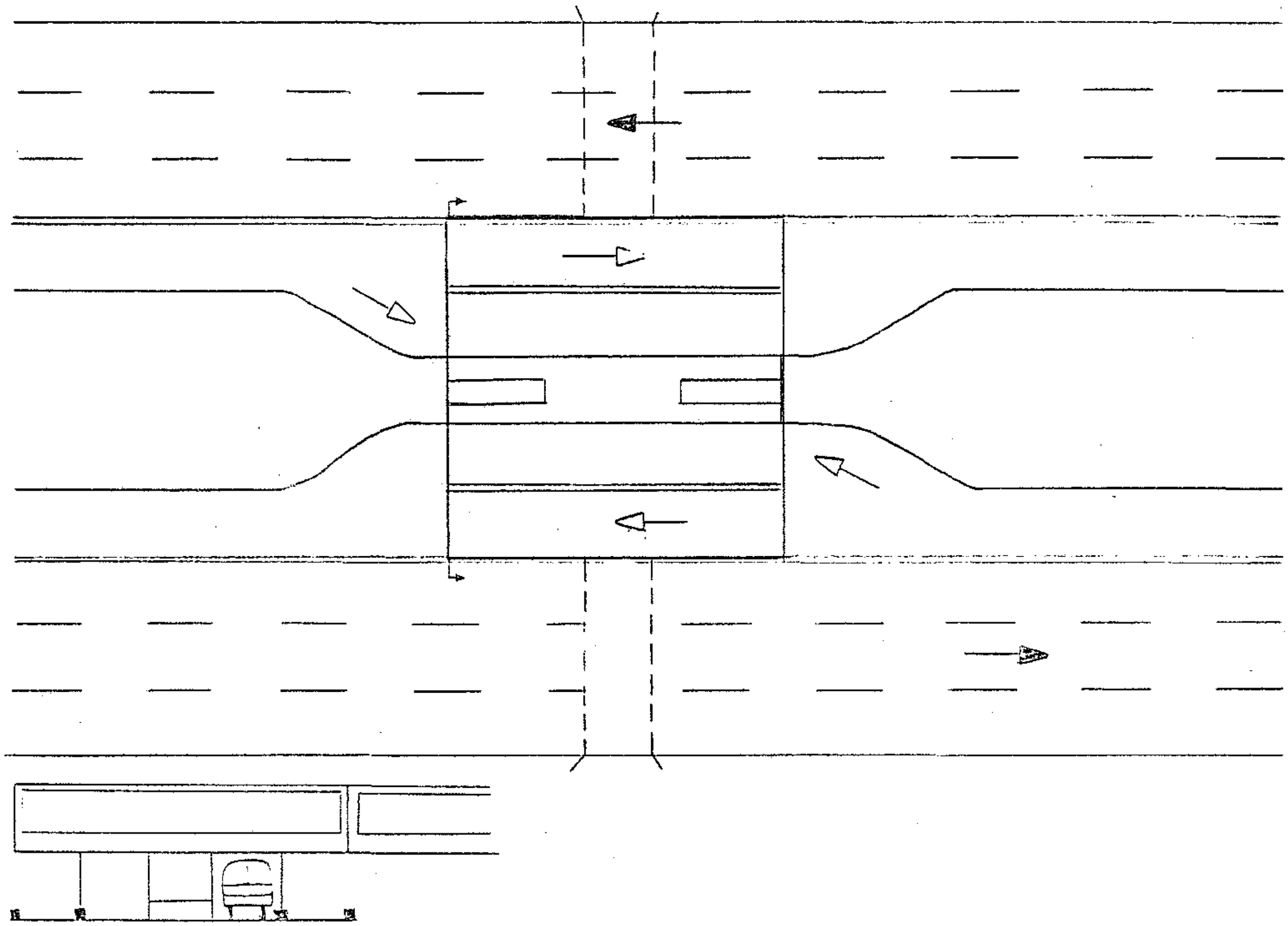

FIGURE 6 FIVE-LANE MEDIAN

• Along Service Drives - Where two-lane service drives parallel freeways, two bus implementation plans are possible. The curb lane of the service drive could be used as a priority bus lane (see Figure 7), or the freeway itself could be used by buses with stations on the service drives (see Figures 8 and 9).

The priority bus lane implementation is the simpler scheme. The curb lane of the service road would be appropriately delineated and signed to preclude use by other forms of traffic. Bus stops with curb cuts would be provided at the far-side of intersections freeing the near-side curb lane for right turning traffic. An alternate plan would provide curb cuts for right turning traffic with a specific area to cross the bus lane to gain access to the right turn queuing area. This crossing area would be appropriately signed to prevent blocking the bus lane. The right turn curb cut is the more desirable layout because the bus lane is not blocked.

Freeways can carry buses as part of the normal traffic mix. However, measures should be taken to minimize freeway delays which would affect bus schedules. Metered auto ramps would assure freeway speeds at or near the speed limit. Metered ramps create a queue of traffic waiting to enter the freeway; therefore, provisions must be made to assure that buses leaving the freeway to make stops or leaving the bus stops to return to the freeways do not encounter delays at these queues. These queues would be bypassed by "queue jumper" exclusive bus ramps. If the bus stop were provided at a major intersection with freeway on and off ramps, the "queue jumpers" would be implemented by widening the existing ramps and signing the widened areas to preclude all but bus traffic. Signing would also be provided to prevent the auto queue from blocking the bus ramps. Similarly, bus stops in "mid-block" locations, those not having freeway on/off ramps, would require the construction of exclusive bus ramps for access. Signing would be provided to prevent blockage of the ramps, assuring access to the stations. The service road stations would, in all cases, be of the far-side, curb-cut type.

• Arterials - Arterial streets provide distinct advantages as well as special problems for use by buses. Arterials are quite often the main transportation corridors in metropolitan areas. Exclusive bus lanes in these corridors would serve a large number of people and businesses. Cross traffic can be a problem with arterial bus lanes; however, measures can be taken to minimize conflicts.

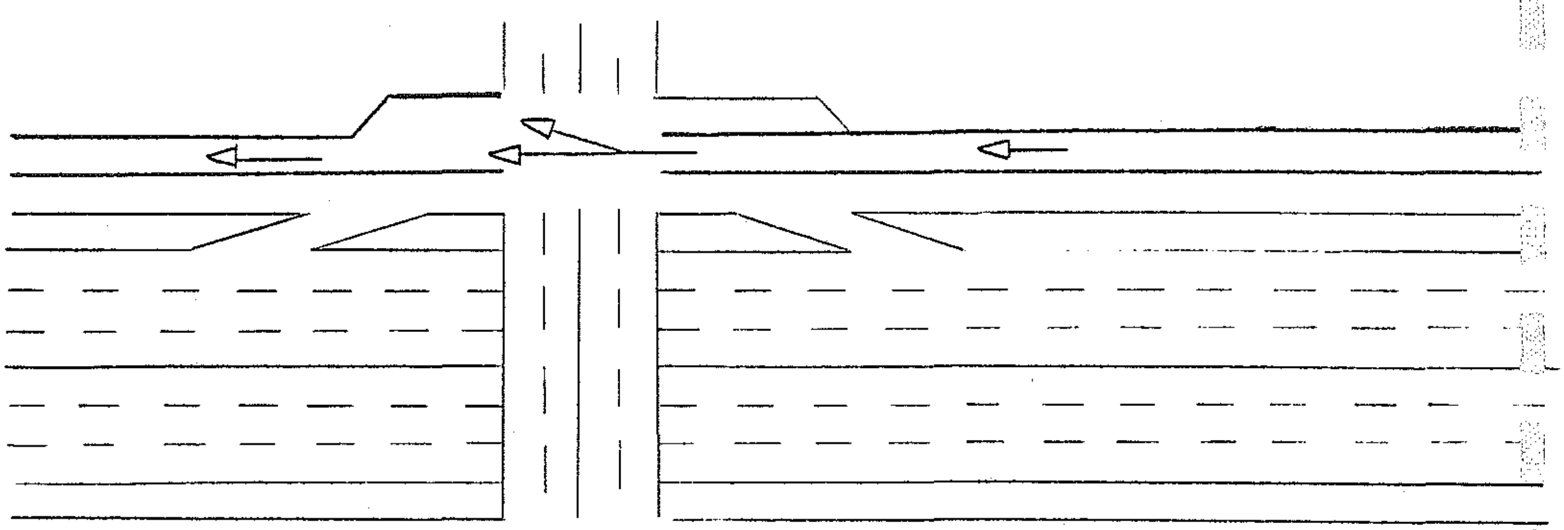

FIGURE 7 SERVICE ROAD CURB LANE

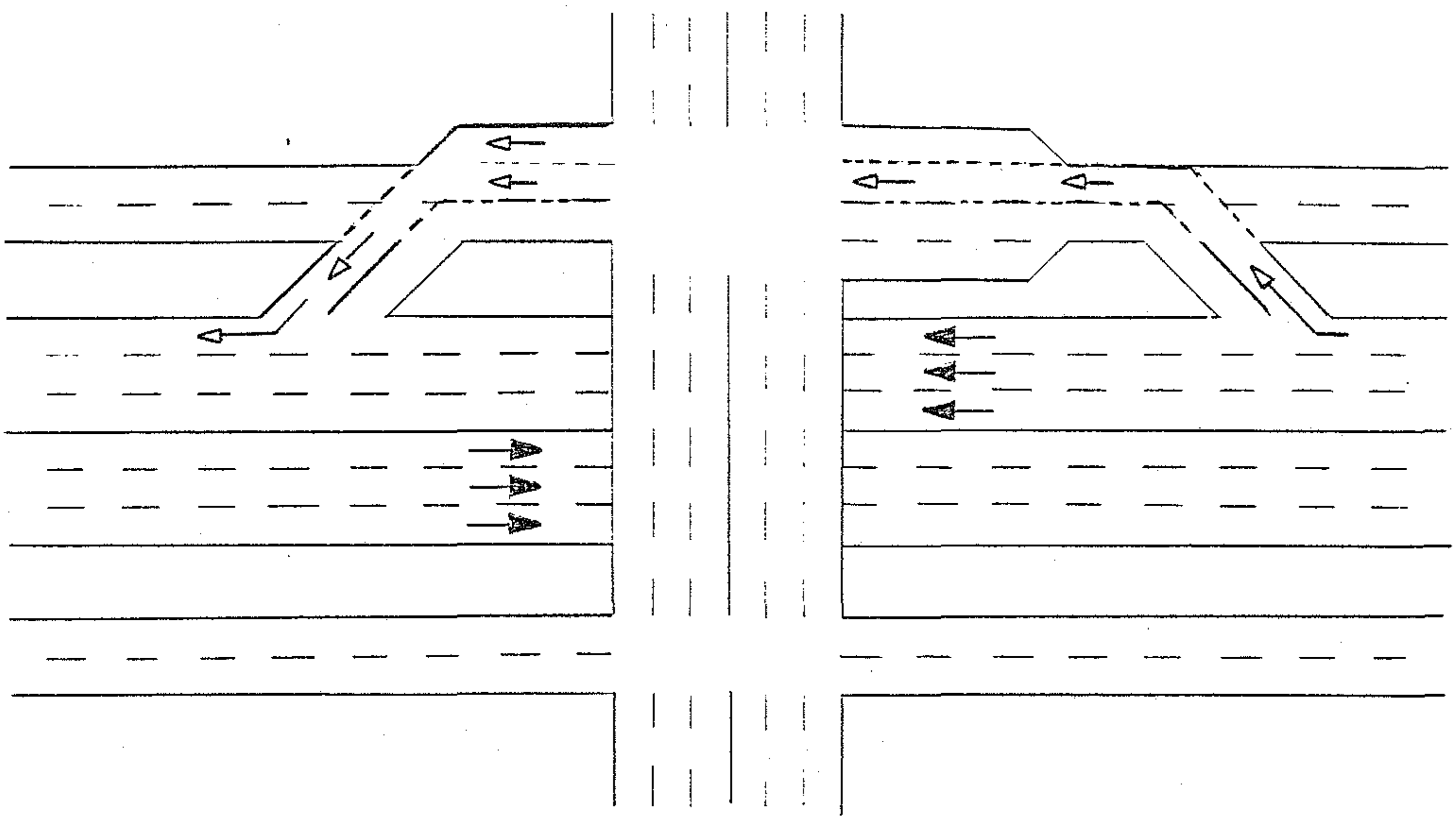

FIGURE 8 SERVICE ROAD BUS STOP

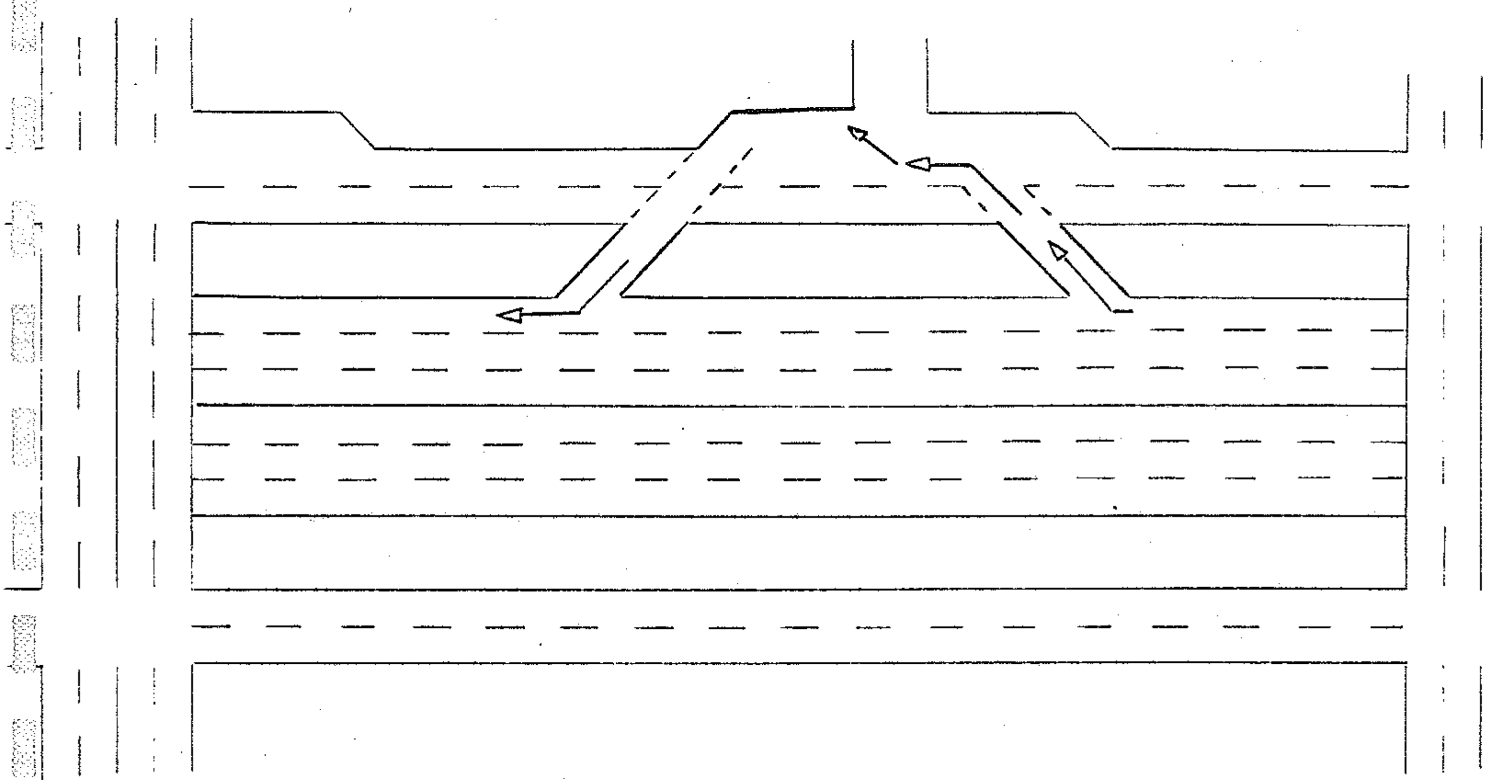

FIGURE 9 SERVICE ROAD MID-BLOCK BUS STOP

On arterial streets with medians at least two lanes wide, bus lanes can be constructed in the median to provide service in both directions (see Figure 10). The direction of travel would allow the buses to acquire and discharge passengers in the center of the median away from arterial traffic. On-line bus stops would be necessary unless a sufficiently wide median were available that cuts could be allowed for the stops. Specific traffic signals at intersections, including signals for the bus lane, would allow turns from the arterial streets across the bus lanes. Limiting turns across bus lanes should be considered to permit more rapid traffic flow on the bus lanes and arterial streets. To speed bus lane flow, preferential control of the traffic lights for the bus lane is desirable. For example, an extended green phase could be allowed for buses when commanded by drivers.

For arterials with only a narrow median divider or guardrail, contraflow lanes may be implemented (see Figure 11). These lanes would be clearly delineated and signed and would operate at all times. Bus stops would be far-side with curb cuts if possible. On-line stops would be made only if necessary. The contraflow lane would be self-enforcing. Disadvantages to this implementation include the loss of one arterial lane in each direction to traffic and some difficulty for left turning traffic across the bus lanes.

The third arterial bus lane implementation would place the buses in the curb lane following normal flow (see Figure 12). This type of implementation is relatively inexpensive but it does have basic disadvantages. It is very difficult to police; that is, if bus traffic is not sufficiently dense, other types of vehicles will encroach upon the lane. Right turns for arterial traffic are difficult and should be limited if possible. Curb cuts providing a storage queue for right turning vehicles are desirable. The area for right turning vehicles should be clearly marked to prevent vehicles from entering the bus lane prematurely. Far side stops would tend to simplify right turns.

- Bus Streets - As the name implies, bus streets are dedicated solely to bus traffic. No other vehicle types are normally permitted to traverse such streets. However, if necessary, local traffic, such as residents returning to their homes, may be granted limited access to the bus street. Bus streets generally run parallel to main traffic arteries, for example, on adjacent streets. Therefore, congestion on the main artery is relieved somewhat as a result of the decrease in bus usage, and no traffic lane on the artery are given up to exclusive bus use. In addition, a bus street is within a reasonable walking distance of the main

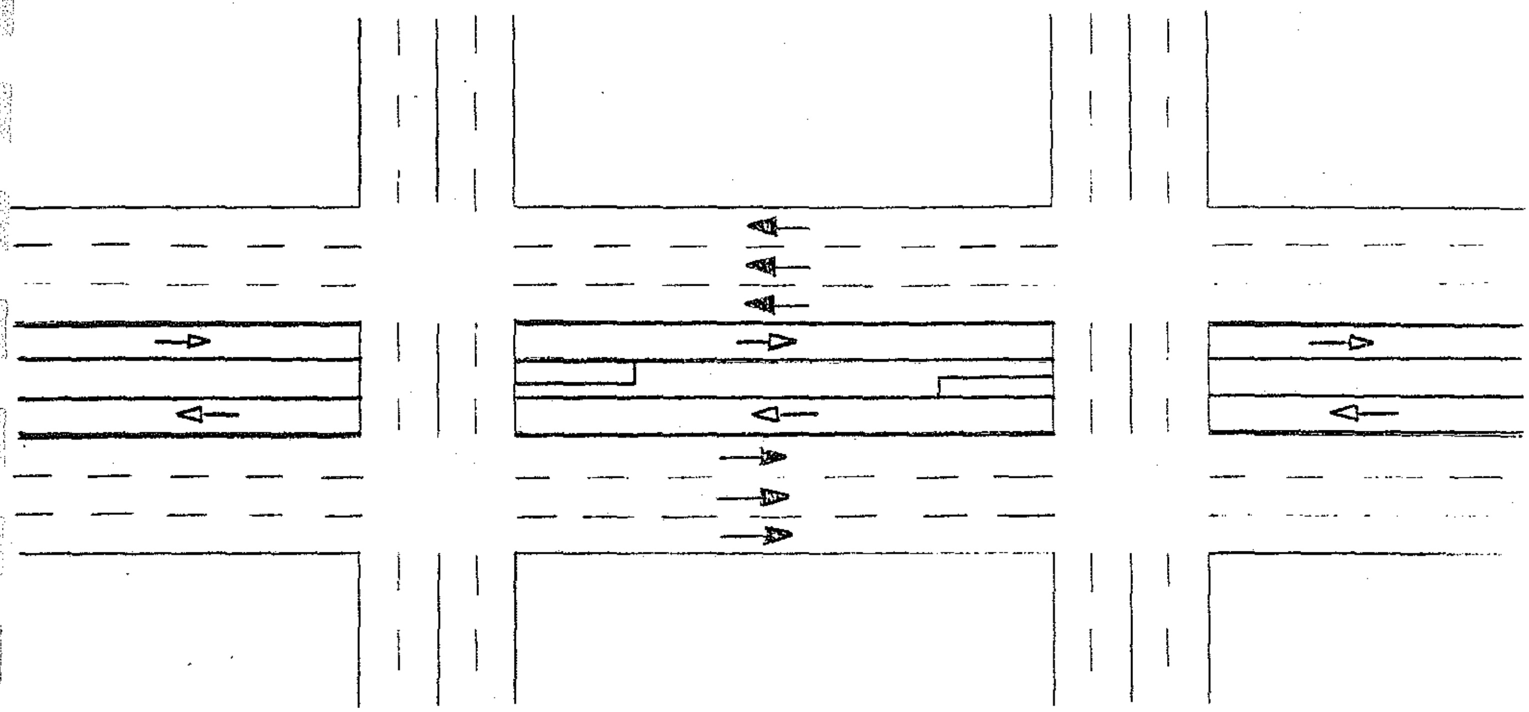

FIGURE 10 ARTERIAL WITH WIDE MEDIAN

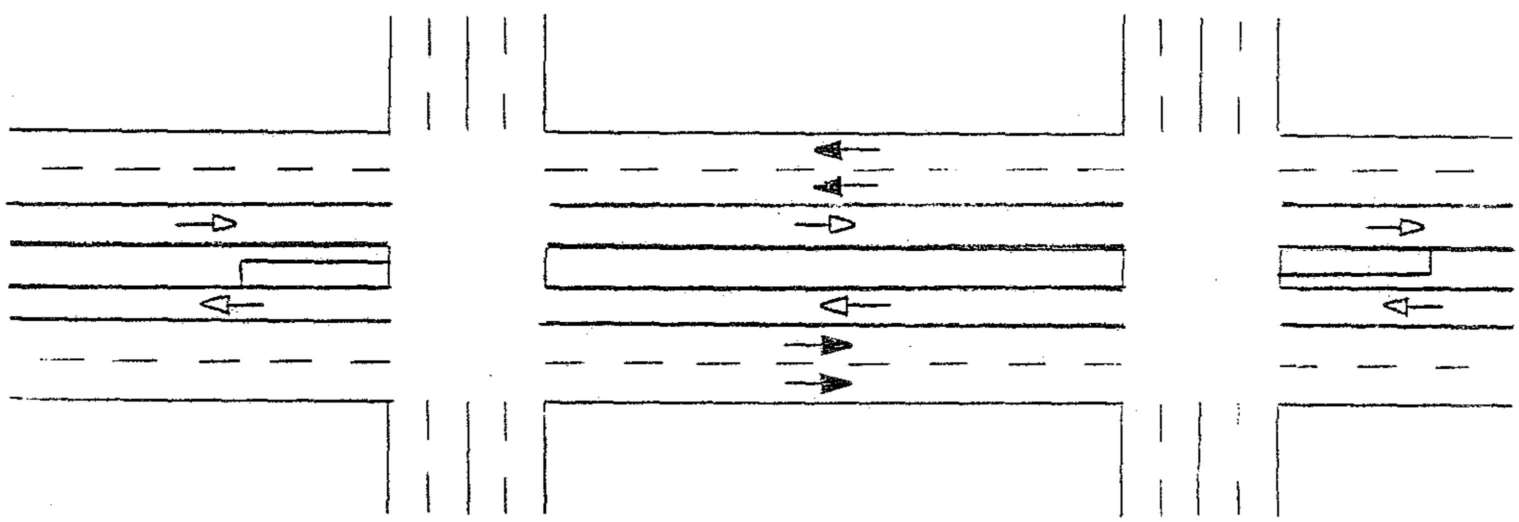

FIGURE 11 ARTERIAL CONTRAFLOW

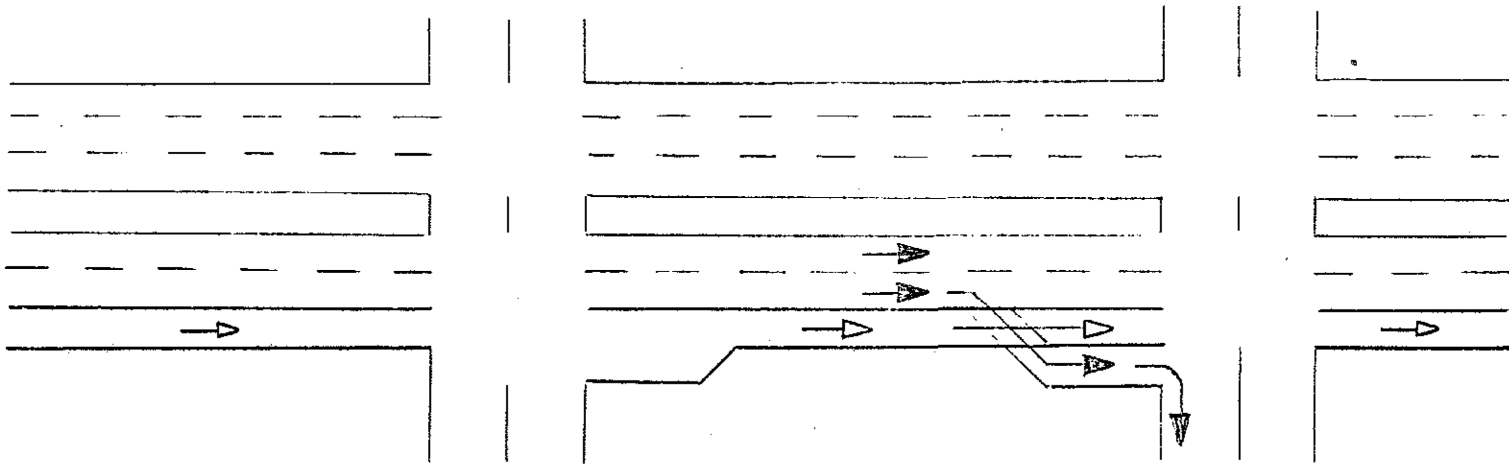

FIGURE 12 ARTERIAL CURB LANE

artery. Another solution is to provide exclusive busways/bus streets on railroad rights-of-way that are close to main arteries. Such land is already dedicated to transportation and, in cases where adequate space is available, busway implementation may be feasible.

• Contraflow - In addition to the contraflow lanes previously defined and discussed, rush-hour only contraflow lanes on freeways should be considered. (See Figure 13). This contra-flow lane is implemented by removing the lane adjacent to the median in the light traffic direction and allowing buses to use the lane in the direction opposite to normal traffic flow. Overhead signs, lane dividers, and other signs are necessary to inform motorists that the contraflow lane is in effect. These markings must be temporary, allowing normal freeway traffic flow when the contraflow lane is not required.

The advantage of the contraflow lane is that specific areas of heavy congestion can be bypassed by the bus traffic. Problems associated with the contraflow scheme include: traffic conflicts resulting from buses crossing freeway traffic to enter and exit the bus lane, some decrease in capacity, with the possibility of increased delays, for traffic in the light traffic direction, and the expense involved by marking the bus lane daily, placing and removing lane markers, changing signs, etc.

• Shared Lanes - Shared lanes have been mentioned previously. Priority bus lanes will, at times, be occupied by vehicles other than buses. These vehicles include local traffic on exclusive bus streets and right turning vehicles in curb bus lanes.

To encourage car pools, some priority bus lanes are open to automobiles carrying three or more passengers. This scheme should be considered where sufficient bus lane capacity is available.

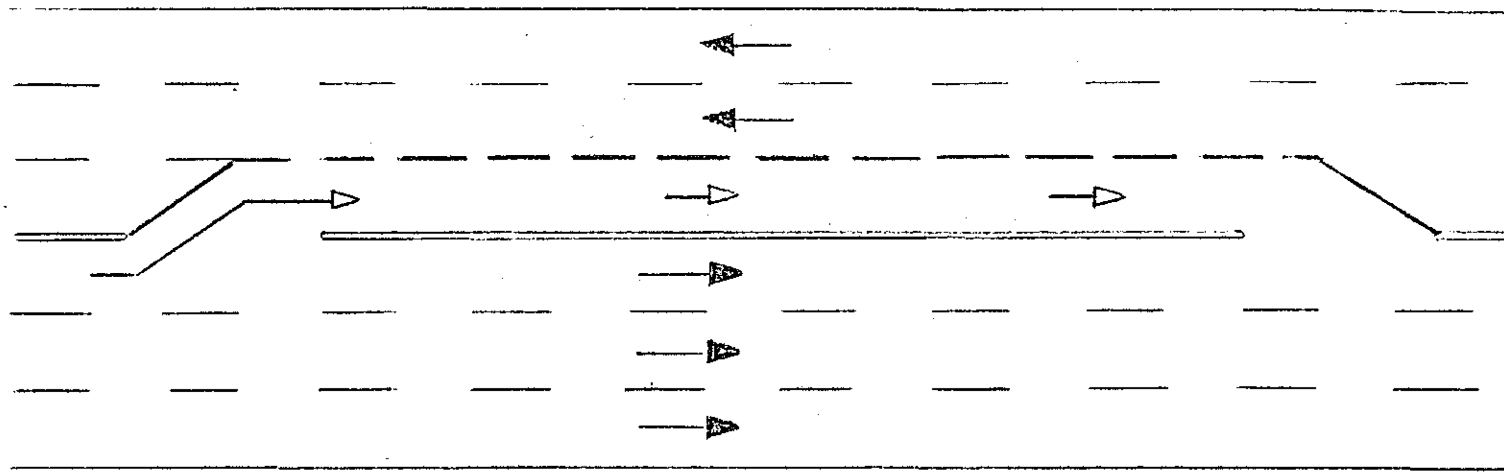

FIGURE 13 FREEWAY CONTRAFLOW

MINUTES OF MEETING CONCERNING

JEFFRIES EXPRESS BUS LANE PROJECT

Monday, April 11, 1977, 1:30 p.m.

The attendants were from the Federal Highway Administration: John Kliethermes, Ron Jones and Nelson Stark; from the Bureau of Urban and Public Transportation: John Kazenko; and from the Bureau of Transportation Planning: Ed Kazenko, Tom Johnson and G. Robert Adams. The meeting was called to discuss the Jeffries Express Bus Lane Project, particularly, in regard to the Federal Highway Administration's disapproval of preliminary engineering on the project. Issues relating to the denial of preliminary approval are as follows:

1. It will be necessary to have completion of the SEMTA alternative analysis or clarification as to the relationship of the Jeffries Express Bus Lane Project to that analysis.

2. The annual element of the TIP must be corrected to reflect that this will be a FHWA versus UMTA funded project.

3. Clarification of the availability of buses to operate on the Jeffries run is needed, particularly, as this relates to completion of the alternative analysis.

4. Concerns regarding the physical feasibility of the project, particularly as it relates to the use of 11-foot lanes, the Fisher Freeway connection from I-96 to Third Avenue, the removal of lanes for general travel and the Wyoming Station proposal must be evaluated in more detail.

A discussion of these issues ensued as well as consideration of the environmental requirements for this project. After the discussion, it was decided to take future action as follows:

1. The existing feasibility study funded by the Federal Highway Administration will be extended to consider the above stated physical problems and will be called a physical feasibility study. John Kazenko will prepare the appropriate documentation to extend the study.

2. The Environmental and Community Factors Division will prepare a basic environmental assessment necessary to make a determination as to whether this is a Major or Non-Major Federal Action. This assessment will include a review of the Diamond Lanes project in Los Angeles and will set forth the basic outline required to conduct a full project environmental assessment.

G. Robert Adams

Administrator

OFFICE MEMORANDUM

DATE: March 29, 1977

TO: Tom Johnson
Environmental and Community Factors

FROM: John Kazenko
Transit Systems Development and
Demonstration

SUBJECT: Exclusive Bus Facilities - Jeffries and Fisher Freeways

As per your verbal request, the proposed improvements to the above freeways are as follows:

<u>Jeffries Freeway (I-96)</u>

Improvements at Wyoming Avenue Location (project length - 3000 ft.)

1. Construction of U-turn bridge (service road to service road).

2. Construction of acceleration and deceleration lane and approaches to U-turn bridge in median.

3. Construction of transfer station in median.

Improvements at Scotten Boulevard Location (project length - 1500 ft.)

1. Construction of acceleration and deceleration lane and approach one side to Scotten Boulevard in median.

Improvements at I-96/I-75 Interchange (project length - 2000 ft.)

1. Construction of two ramp bridges in interchange area.

2. Construction of 24 foot ramp in interchange area.

<u>Fisher Freeway (I-75)</u>

Improvements on I-96 from I-96 to Third Street (project length - 6200 ft.)

1. Construct concrete safety barrier and bus lanes in 26 foot median.

2. Construct acceleration and deceleration lane and approach one side to Third Street in median.

If you require a more detailed dimension breakdown of bridges, please let me know.

John Kazenko
Transit Systems Development and
Demonstration

UPT:JK:sd

ENVIRONMENTAL ASSESSMENT FOR
NON-MAJOR ACTION DETERMINATION

Bus Rapid Transit in the Southfield/Jeffries Corridor

Construction of special median bus lanes and exclusive bus ramps at I-75 and Third Avenue; construction of exclusive bus ramps on I-96 at Scotten and at the Wyoming Transfer Station; and construction of ramp bridges on I-96 at I-75 and at the Wyoming Transfer Station -- all in Detroit. I82195 #12190 I-75 and I82123 #12189 (82124) I-96 Wayne County. A federally funded project.

This project proposes to reserve the inside lane from the intersection of the Southfield (M-39) and Jeffries (I-96) Freeway to the vicinity of the intersection of I-96 and the Fisher Freeway (I-75) for bus use exclusively. From the intersection of I-75 and I-96 Freeways, exclusive bus lanes would be constructed in the existing median of the I-75 Freeway for continued travel to the Detroit central business district (CBD). The special median bus lanes would be constructed within the existing 26 foot median of I-75. Two eleven foot lanes would be separated by a four foot wide barrier for safety.

In addition to the exclusive bus lanes on I-75, the following facilities would be constructed:

<u>Jeffries Freeway (I-96)</u>

Improvements at Wyoming Avenue Location (project length - 3000 ft.)

1. Construction of U-turn bridge (service road to service road).
2. Construction of acceleration and deceleration lane and approaches to U-turn bridge in median.
3. Construction of transfer station in median.

Improvements at Scotten Boulevard Location (project length - 1500 ft.)

1. Construction of acceleration and deceleration lane and approach one side to Scotten Boulevard in median.

Improvements at I-96/I-75 Interchange (project length - 2000 ft.)

1. Construction of two ramp bridges in interchange area.
2. Construction of 24 foot ramp in interchange area.

Fisher Freeway (I-75)

Improvements on I-96 from I-96 to Third Street (project length - 6200 ft.)

1. Construct concrete safety barrier and bus lanes in 26 foot median.
2. Construct acceleration and deceleration lane and approach one side to Third Street in median.

Conferences with Edward Kazenko, Manager, Metro Center Planning Section; Robert Kuehne, Planner, Mass Transportation Planning Section; and John Kazenko, Manager, Intermediate Level Transit; and, the Preliminary Design of Bus Rapid Transit in the Southfield/Jeffries Corridor, April, 1976, provided information for the preparation of this Environmental Assessment. A study by this Department indicated that a "significant" reduction in traffic volumes will not occur on the freeways because of the proposed project. Therefore, it can be expected that restricting automotive use of the inside lane will increase traffic congestion (lower the level of service) on the remaining lanes of I-96. However, traffic volumes on the remaining lanes are not expected to exceed design standards within the next five years. After that the Surveillance, Control and Driver Information (SCANDI) System should adequately handle any increase in traffic volumes. For this reason severe congestion should not occur on the Jeffries Freeway. The Fisher Freeway should not experience an increase in congestion, rather the construction of exclusive bus lanes should tend to reduce existing congestion. It is not anticipated that the proposed project will adversely affect traffic flow in the Detroit CBD or the New Center area. Many of the buses are presently entering the area. The Department expects the "loop" to provide a smoother flow of bus traffic in these areas. This will allow the City of Detroit better control of the total traffic flow in the area.

Construction of the exclusive bus ramps, ramp bridges, exclusive bus lanes, and transfer stations should not result in a significant impact. All construction activities will be confined to the existing right-of-way limits, and the Department will maintain a smooth traffic flow on the freeway system.

If the proposed project were to operate at its capacity--attracting a large percentage of the commuter traffic--significant land use changes could result. However, patronage of the system is not anticipated to be sufficient to produce significant land use changes in the region.

Based on this Environmental Assessment, it is our determination that this project will not have a significant impact on the quality of the human environment. It is recommended that a non-major action classification be assigned to this project.

Tom D. Johnson

OFFICE MEMORANDUM

DATE: January 26, 1977

TO: John P. Woodford
Director

FROM: Gerald J. McCarthy
Deputy Director - Highways

SUBJECT: I 82195 #12190 I-75 & I 82123 #12189 (82124) I-96 Wayne County
Construction of special median bus lanes and exclusive bus ramps at I-75 and Third Avenue; construction of exclusive bus ramps on I-96 at Scotten and at the Wyoming Transfer Station; and construction of ramp bridges on I-96 at I-75 and at the Wyoming Transfer Station - all in Detroit.

This is authorization to add the above-described projects to the current construction program. This authorization is in accordance with a memorandum from John Kazenko to Donald C. Rush dated January 17, 1977.

These projects are programmed to be financed with Interstate funds. The above action increases the Federal-Aid Interstate Construction Program by $216,000.

I 82195 #12190 I-75 — Construction of special median bus lanes and exclusive bus ramps at Third Avenue in Detroit.

The cost estimate is:

Preliminary Engineering			$	72,000
		TOTAL	$	72,000
Participation:	Federal		$	65,000
	State (GTF funds)			7,000 *
		TOTAL	$	72,000

I 82123 #12189 (82124) I-96 — Construction of exclusive bus ramps on I-96 at Scotten and at the Wyoming Transfer Station; and construction of ramp bridges on I-96 at I-75 and at the Wyoming Transfer Station in Detroit.

The cost estimate is:

Preliminary Engineering			$	144,000
		TOTAL	$	144,000
Participation:	Federal		$	130,000
	State			14,000 *
		TOTAL	$	144,000

These projects are for preliminary engineering only. Construction will be programmed at a later date.

* The non-federal share will be financed with General Transportation funds and will be handled by an intra-account transaction from UPTRAN to Highways.

G. J. McCarthy

Deputy Director - Highways

GJM: DCR: PET: JA: hw

cc: S. F. Cryderman (2)
T. R. Wiseman
D. Orne (2)
R. Hofmeister
D. Hooth
M. T. Ataman
D. C. Rush (5)
R. Mastin
W. Sines
W. MacCreery (4)
Dale Bock
J. H. Williams
W. Cox
J. Kazenko

To Jan Raad
Fred Sanborn

7 MARCH 77

Major - Non Major Action Determination

The attached projects do not appear to fall into the Class Action catagory at first review, and thus are being given to you to have Environmental Assessments prepared to support the determination for either Major or Non-Major Action. Since the Non-Major Actions will not receive further review, their assessments should be more complete than for Major Actions.

Please give these projects and their assessments directly to Bill Elliot for processing through the next Modal Subcommittee.

We will help explain the projects if necessary.

Win Stebbins

cc Bill Elliot

Fred: Mich: US-23 Monroe County WeighSta; M-153 Wayne Cty; M-85 parkinglots
Fed: M-78 (I-69) E Lansing 5 lanes; I-96 Wayne Cty bus lanes

Jan: Mich: M-20 Mt Pleasant; US-41 Marquette Cty; 4 local Govt Critical bridges Berrien, Sanilac, Menominee, Osceola
M-19 Sanilac Cty culvert
Fed: 3 local Govt Critical bridges: Branch, Huron, Ontonagon

OFFICE MEMORANDUM

DATE: January 26, 1977

TO: John P. Woodford
Director

FROM: Gerald J. McCarthy
Deputy Director - Highways

SUBJECT: I 82195 #12190 I-75 & I 82123 #12189 (82124) I-96 Wayne County Construction of special median bus lanes and exclusive bus ramps at I-75 and Third Avenue; construction of exclusive bus ramps on I-96 at Scotten and at the Wyoming Transfer Station; and construction of ramp bridges on I-96 at I-75 and at the Wyoming Transfer Station - all in Detroit.

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I 82195 #12190 I-75 — Construction of special median bus lanes and exclusive bus ramps at Third Avenue in Detroit.

The cost estimate is:

Preliminary Engineering			$	72,000
		TOTAL	$	72,000
Participation:	Federal		$	65,000
	State (GTF funds)			7,000 *
		TOTAL	$	72,000

I 82123 #12189 (82124) I-96

Construction of exclusive bus ramps on I-96 at Scotten and at the Wyoming Transfer Station; and construction of ramp bridges on I-96 at I-75 and at the Wyoming Transfer Station in Detroit.

The cost estimate is:

Preliminary Engineering			$	144,000
		TOTAL	$	144,000
Participation:	Federal		$	130,000
	State			14,000 *
		TOTAL	$	144,000

These projects are for preliminary engineering only. Construction will be programmed at a later date.

* The non-federal share will be financed with General Transportation funds and will be handled by an intra-account transaction from UPTRAN to Highways.

G J McCarthy
Deputy Director - Highways

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