PLANNING REPORT NO. 33

A PRIMARY TRANSIT SYSTEM PLAN FOR THE MILWAUKEE AREA

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

Special acknowledgement is due Mr. Otto P. Dobnick, SEWRPC Senior Planner and Mr. David P. Jukins, SEWRPC Senior Engineer for their contributions to the preparation of this report.

As depicted on the cover, the recommended primary transit system plan for the Milwaukee area will continue to place heavy reliance on bus-on-metered freeway rapid transit service using high-capacity articulated motor buses operating out of park-ride lots. The new plan also envisions the implementation of an initial light rail transit facility in the northwest corridor of Milwaukee County. Both light rail vehicles and motor buses would utilize a transit mall in downtown Milwaukee.

Photos courtesy of AC Transit; Metropolitan Transportation Development Board; SEWRPC; Wisconsin Department of Transportation, District 2; and Russell E. Schultz.

PLANNING REPORT
NUMBER 33

A PRIMARY TRANSIT SYSTEM PLAN FOR THE MILWAUKEE AREA

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This technical report, one in a series of four technical reports and one planning report documenting the findings of the Milwaukee area primary transit system alternatives analysis, conducted by the Regional Planning Commission, was financed through a joint planning grant from the U. S. Department of Transportation, *Urban Mass Transportation Administration*; the Wisconsin Department of Transportation; and Milwaukee County.

June 1982

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SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

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STATEMENT OF THE CHAIRMAN

At the specific request of the Milwaukee County Executive, the Southeastern Wisconsin Regional Planning Commission in March 1979 undertook a study to determine the best means of providing rapid transit service within the greater Milwaukee area. The principal objectives of this study were: 1) to identify those corridors within the greater Milwaukee area which can support fixed guideway transit facility development; and 2) to identify those transit modes which can best provide service within those corridors. These objectives required the Commission to reevaluate the feasibility of providing rapid transit service within the greater Milwaukee area by bus on freeway, bus on metered freeway, bus on reserved freeway lane, bus on busway, light rail transit, heavy rail rapid transit, and commuter rail.

The conduct of this study posed a complex and difficult challenge for two reasons. First, a wide range of rapid transit modes had to be considered, most of which do not currently operate and never have operated in the Region. This necessitated the undertaking of an extensive inventory of the state-of-the-art of rapid transit technology. Second, the many uncertainties which currently exist regarding future conditions in the Region which will affect the need for and use of public transit facilities had to be addressed. Accordingly, a new approach termed "alternative futures" was used for the first time at the metropolitan planning level. In order to evaluate the many primary transit modal alternatives under each of the sets of alternative future conditions considered, an extremely large number of alternative system plans required preparation, test, and evaluation.

This planning report summarizes the findings and recommendations of the entire rapid transit planning effort. If adopted by all concerned, the recommendations contained herein will amend one of the most important elements of the comprehensive plan for the physical development of the seven-county Southeastern Wisconsin Region—the mass transit element. The herein recommended rapid transit system plan, while continuing to place heavy reliance on the provision of rapid transit service by motor buses operating over a metered freeway system, also envisions the construction of an initial light rail transit line in the northwest corridor of Milwaukee County. Subsequent consideration would be given to constructing light rail transit lines in other Milwaukee corridors, as well as to instituting commuter rail service on a demonstration basis along certain routes. This plan therefore provides the greater Milwaukee area with a broader and more flexible range of transit technologies with which to meet public transit needs in the area than did the older plans, and permits an evolutionary approach to be taken to rapid transit development over time.

The recommendations set forth in this report for the development of a rapid transit system within the greater Milwaukee area are technically sound and attainable. The recommendations are, however, based on careful consideration of intangible as well as tangible benefits. Therefore, given the costs involved, implementation of the light rail and commuter rail aspects of the plan will require strong political leadership and commitment. Without such leadership and commitment, these rail-oriented recommendations will not come about, and the Region will have to continue to rely solely on the motor bus for transit service.

Respectfully submitted,

Alfred G. Raetz

Alfred G. Raetz
Chairman

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Chapter I

INTRODUCTION

THE REGIONAL PLANNING COMMISSION

The Southeastern Wisconsin Regional Planning Commission (SEWRPC) was created upon the unanimous petition of the seven county boards concerned in August 1960 under the provisions of Section 66.945 of the Wisconsin Statutes. It exists to serve and assist local, state, and federal units of government in planning for the orderly physical and economic development of the seven-county Southeastern Wisconsin Region comprised of Kenosha, Milwaukee, Ozaukee, Racine, Walworth, Washington, and Waukesha Counties (see Map 1). The Commission's role is entirely advisory and participation by local units of government in the work of the Commission is on a voluntary, cooperative basis.

The Commission is composed of 21 citizen members who serve without pay, three from each county of the Region. The powers, duties, and functions of the Commission are set forth in state enabling legislation. The Commission is authorized to employ experts and staff as necessary to execute its responsibilities. Funds necessary to support Commission operations are provided by member counties, with the budget apportioned among the seven counties on the basis of relative equalized assessed property valuation. The Commission is also authorized to request and accept aid in any form from all levels and agencies of government to accomplish its objectives and is authorized to deal directly with the state and federal governments for this purpose. The Commission, its committee structure, its staff organization, and its relationship to constituent units and agencies of government are shown in Figure 1.

COMMISSION FUNCTION

The Commission exists to serve and assist federal, state, and local units of government in finding practical solutions to areawide developmental and environmental problems which transcend the geographic and fiscal limitations of a single municipality or county. Accordingly, regional planning as conducted by the Commission has three principal functions:

1. Inventory—the collection, analysis, and dissemination of basic planning and engineering data on a uniform, areawide basis so that, in light of such data, the various levels and agencies of government and private investors operating within the Region can better make decisions concerning community development.

2. Plan Design—the preparation of a framework of both short- and long-range plans for the physical development of the Region, these plans being limited to functional elements having areawide significance. To this end, the Commission is charged by law with the function and duty of "making and adopting a master plan for the physical development of the Region." The permissible scope and content of this plan, as outlined in the enabling legislation, extend to all phases of regional development, implicitly emphasizing preparation of alternative spatial designs for land use and for supporting transportation and utility facilities.

3. Plan Implementation—the promotion of plan implementation through the provision of a center to coordinate the planning and plan implementation activities of the various levels and agencies of government in the Region and to introduce recommendations for resolution of areawide problems into the existing decision-making process.

The work of the Commission, therefore, is seen as a continuing planning process providing outputs of value to the making of development decisions by public and private agencies, and to the preparation of plans and plan implementation programs at the local, state, and federal levels. It emphasizes close cooperation among the governmental agencies and private enterprise responsible for land use development within the Region, and for the design, construction, operation, and maintenance of the supporting public works facilities. All Commission work programs are intended to be carried out within the context of a continuing planning program which provides for periodic reevaluation

Map 1

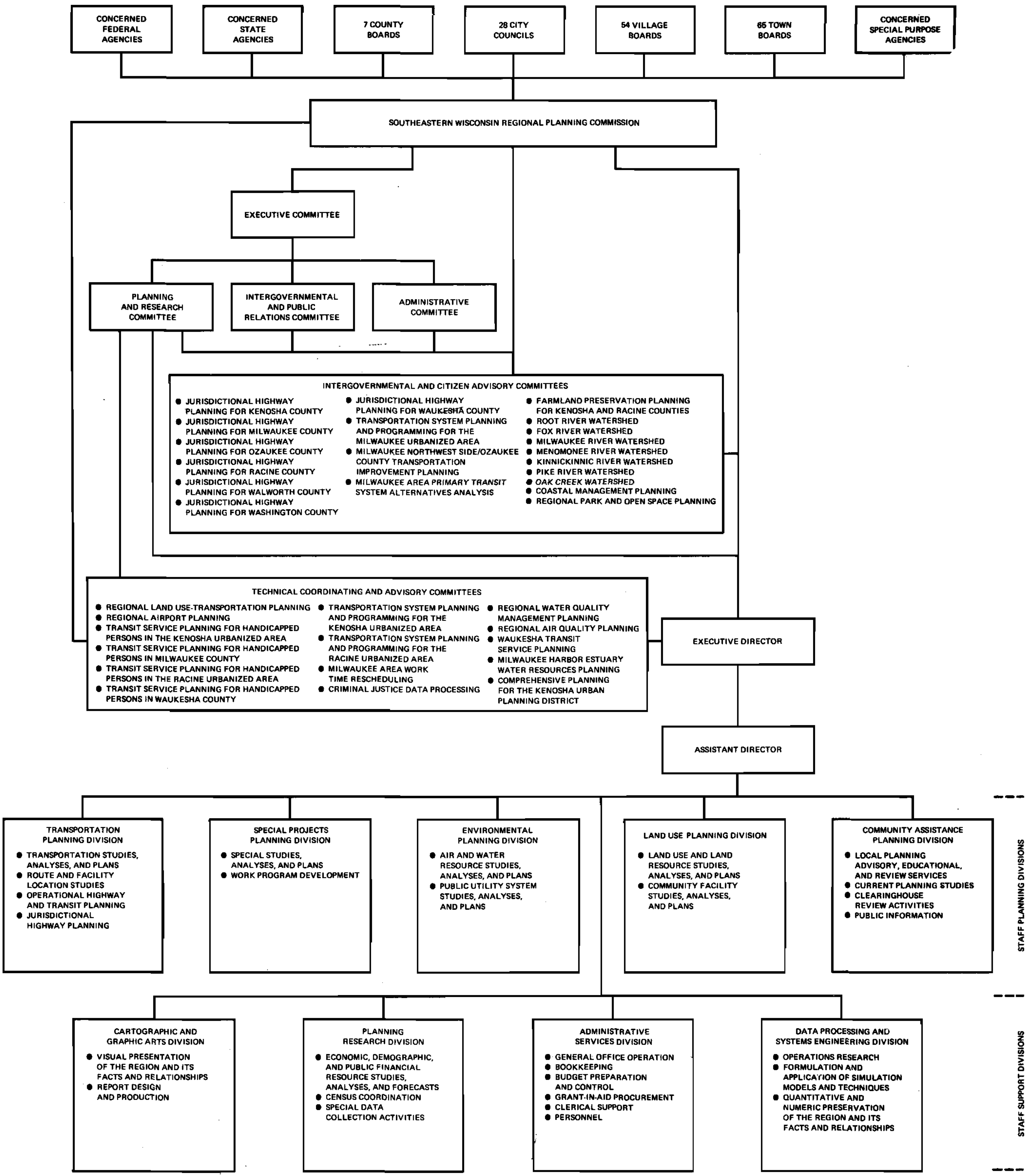
THE SOUTHEASTERN WISCONSIN REGION

The seven-county Southeastern Wisconsin Planning Region comprises a total area of about 2,689 square miles, or about 5 percent of the total land and inland water area of Wisconsin.

Source: SEWRPC.

Figure 1

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION ORGANIZATIONAL STRUCTURE



Source: SEWRPC.

of the plans produced and for the extension of planning information and advice necessary to convert the plans into action programs at the local, regional, state, and federal levels.

THE REGION

The seven counties that comprise the Southeastern Wisconsin Region, exclusive of Lake Michigan, have a total area of 2,689 square miles, or about 5 percent of the total area of Wisconsin. About 40 percent of the state population lives in these seven counties, which contain three of the seven and one-half standard metropolitan statistical areas (SMSA's) in Wisconsin. The Region contains about half the tangible wealth in Wisconsin as measured by equalized assessed property valuation, and represents the greatest wealth-producing area of the State, with about 42 percent of the State's labor force being employed within the Region. The Region contains 154 local units of government, exclusive of school and other special-purpose districts, and encompasses all or part of 11 major watersheds.

As shown on Map 1, there are three urbanized areas, as defined by the U. S. Bureau of the Census, within the Southeastern Wisconsin Region: Kenosha, Milwaukee, and Racine. Each of the urbanized areas is comprised of a large central city with a population of at least 50,000 and the surrounding area contiguous to the city which is devoted to intensive urban use. The intent of the U. S. Bureau of the Census in defining urbanized areas is to identify those areas which function as a single urban entity, and, as such, comprise a "true physical city."

REGIONAL TRANSPORTATION PLANNING WORK PROGRAMS TO DATE

The first major work program of the Commission directed toward the preparation of a framework of advisory plans for the physical development of the Southeastern Wisconsin Region was a regional land use-transportation study initiated in January 1963. That study was completed in December 1966 with the adoption by the Commission of a regional land use plan and a regional transportation plan (highway and transit) for southeastern Wisconsin. The findings and recommendations of the study were documented in SEWRPC Planning Report No. 7, The Regional Land Use-Transportation Study, Volume One, Inventory Findings: 1963; Volume Two, Forecasts and Alternative Plans: 1990; and Volume Three, Recommended Regional Land Use-Transportation Plans: 1990.

Subsequent to adoption of these long-range regional land use and transportation plans, the Commission, in cooperation with the constituent County Boards of Supervisors, prepared jurisdictional highway system plans for all seven counties in the Region.[1] These jurisdictional highway system plans, as well as the regional land use and transportation plans, have been formally adopted by the respective seven county boards, as well as by the Regional Planning Commission and the Wisconsin Department of Transportation.

In addition to these jurisdictional highway plans, the Commission has prepared, or assisted in the preparation of, and has adopted the Milwaukee Area Transit Plan,[2] the Racine Area Transit Devel-

[1] *See SEWRPC Planning Report No. 11, A Jurisdictional Highway System Plan for Milwaukee County formally adopted by the Commission on June 4, 1970; SEWRPC Planning Report No. 15, A Jurisdictional Highway System Plan for Walworth County, formally adopted by the Commission on March 1, 1974; SEWRPC Planning Report No. 17, A Jurisdictional Highway System Plan for Ozaukee County, formally adopted by the Commission on March 7, 1974; SEWRPC Planning Report No. 18, A Jurisdictional Highway System Plan for Waukesha County, formally adopted by the Commission on June 5, 1975; SEWRPC Planning Report No. 22, A Jurisdictional Highway System Plan for Racine County, formally adopted by the Commission on December 4, 1975; SEWRPC Planning Report No. 23, A Jurisdictional Highway System Plan for Washington County, formally adopted by the Commission on September 11, 1975; and SEWRPC Planning Report No. 24, A Jurisdictional Highway System Plan for Kenosha County, formally adopted by the Commission on September 11, 1975.*

[2] *See Milwaukee Area Transit Plan, prepared by the Milwaukee County Expressway and Transportation Commission in cooperation with the Southeastern Wisconsin Regional Planning Commission, and formally adopted by the Commission on March 2, 1972.*

opment Program,[3] and the Kenosha Area Transit Development Program.[4] These plans and programs have also been adopted by the appropriate implementing units of government, including Milwaukee County, the City of Racine, and the City of Kenosha, respectively. The transit development programs set forth in the later two plan elements have been fully implemented by the Cities of Racine and Kenosha, with attendant major increases in transit utilization.

The Commission has recently completed a major review, reevaluation, and revision of the adopted regional land use and regional transportation plans. The findings and recommendations of this review, reevaluation, and revision are documented in SEWRPC Planning Report No. 25, A Regional Land Use Plan and a Regional Transportation Plan for Southeastern Wisconsin: 2000, Volume One, Inventory Findings, and Volume Two, Alternative and Recommended Plans. The Commission has also completed a study of the transportation needs of the transportation handicapped, and has adopted a plan for meeting those needs in a cost-effective manner.[5] The Commission also annually updates its transportation systems management plan, which proposes for implementation short-range improvements aimed at maximizing the efficiency of the existing transportation system in the Milwaukee, Racine, and Kenosha urbanized areas.[6]

[3] *See SEWRPC Community Assistance Planning Report No. 3, Racine Area Transit Development Program: 1975-1979, formally adopted by the Commission on September 12, 1974.*

[4] *See SEWRPC Community Assistance Planning Report No. 7, Kenosha Area Transit Development Program: 1976-1980, formally adopted by the Commission on June 3, 1976.*

[5] *See SEWRPC Planning Report No. 31, A Regional Transportation Plan for the Transportation Handicapped in Southeastern Wisconsin: 1978-1982, formally adopted by the Commission on April 13, 1978.*

[6] *See, for example, SEWRPC Community Assistance Planning Report No. 26, A Transportation Systems Management Plan for the Kenosha, Milwaukee, and Racine Urbanized Areas in Southeastern Wisconsin: 1979, adopted by the Commission on December 7, 1978.*

CONSIDERATION OF A PRIMARY TRANSIT SYSTEM ALTERNATIVES ANALYSIS IN THE MILWAUKEE AREA

Primary, or rapid, public transportation service is defined as that component of the total urban public transportation system which provides the highest operating speeds and serves the longer trips along the most heavily traveled corridors in an urban area.[7] Under the initial regional land use and transportation planning effort conducted in the early 1960's, for the provision of primary transit service in the Milwaukee area it was determined that a bus rapid transit system would be superior to a heavy rail rapid transit system. This determination was based upon careful studies and analyses relating to the provision of rapid transit service in the principal east-west travel corridor emanating from the central business district of the City of Milwaukee.

Following the adoption of the initial regional transportation system plan, a more detailed evaluation of primary mass transportation technology for the Milwaukee area was conducted by Milwaukee County. This study, initiated in the late 1960's and documented in the Milwaukee Area Transit Plan,[8] revalidated the findings of the year

[7] *The other two components of the total urban public transportation system are the secondary, or express, and the tertiary, or local, levels of service. Secondary public transit service is that component of the urban public transit system which provides express transit service for trips of moderate length operating at lower operating speed but providing a higher level of accessibility than primary public transit service. Secondary public transit service is provided over arterial streets and highways, with stops generally located at intersecting transit routes and major traffic generators, and may be designed to provide "feeder" service to the primary service component of the public transit system. Tertiary public transit service is that component of the urban public transit system which provides either a local or a collection-circulation-distribution service for trips of generally short length operating at low operating speeds and providing the highest level of accessibility.*

[8] *See Milwaukee Area Transit Plan prepared for the Milwaukee County Expressway and Transportation Commission by Barton-Aschman Associates, Inc., June 1971.*

1990 regional transportation plan that a rapid transit system comprised of buses operating in mixed traffic on uncongested freeways and on separate transit rights-of-way in congested freeway corridors in the Milwaukee area would be more effective than heavy rail rapid transit systems. The Milwaukee Area Transit Plan additionally established that a bus rapid transit system would perform as good as or better than such "exotic" forms of transit as monorail and automated guideway transit.

The major regional land use and transportation plan reevaluation initiated in the early 1970's did not reexamine the issue of the most appropriate mass transit technology for the Milwaukee area. In the study design for the plan reevaluation effort, the Commission staff recommended—and the Technical Coordinating and Advisory Committee assisting the Commission in the work effort endorsed the recommendation—that consideration not be given in the plan reevaluation to forms of rapid transit other than those utilizing the motor bus as the vehicle. The Citizens Advisory Committee assisting the Commission in the plan reevaluation agreed with the Commission and the Technical Advisory Committee that no further consideration should be given to traditional "heavy" rail rapid transit. That Committee requested, however, that flexibility be retained in the plan reevaluation process so that consideration could be given to the evaluation of "light" rail rapid transit systems in certain heavy-demand travel corridors should the studies indicate a need for an exclusive right-of-way for transit purposes.

The plan reevaluation effort concluded with both the Technical and Citizens Advisory Committees agreeing that in order to minimize capital investment in transportation facilities, primary public transit service should be provided by motor buses operating in mixed traffic on freeways with freeway operational control. Accordingly, the new long-range transportation system plan as formally adopted by the Commission in June 1978 recommended the establishment of a freeway traffic management system, including extensive operational control through ramp metering with priority access for high-occupancy vehicles, including buses and carpools. The freeway traffic management system recommended was envisioned to be operated to maintain relatively free flow conditions on the freeways and to thereby enable buses to travel in mixed traffic on existing freeways at speeds approaching those that could be attained on the previously planned exclusive motor bus transitways, which were included in the 1990 plan and in alternatives considered under the plan reevaluation. Since the plan reevaluation concluded with a recommendation for the provision of primary transit service through buses on controlled freeways, the study effort gave no further consideration to light rail as a transit mode. During the final stages of the preparation of the second generation regional transportation system plan, however, local and national interest in light rail transit as a potentially attractive and effective primary mass transit technology began to surface. Light rail transit is a form of urban public transportation that can operate over city streets in mixed traffic, as well as over exclusive, grade-separated rights-of-way. Light rail transit can serve a wide range of passenger demand, as it can function using single-vehicle trains or multiple-vehicle trains. The electric power supply to light rail transit is usually provided by overhead wire, but a third rail supply is possible in grade-separated operations. Light rail is also flexible in the loading of passengers as it can load riders from both street and platform levels.

National interest in light rail is evidenced by studies of light rail in Vancouver, Baltimore, Detroit, and Portland. In Edmonton, Buffalo, Calgary, Pittsburgh, and San Diego, light rail systems are in various stages of construction and/or operation. In addition, existing light rail systems are being refurbished in Boston, San Francisco, and Philadelphia. National interest in light rail is further evidenced in policy statements issued by the U. S. Department of Transportation, Urban Mass Transportation Administration, encouraging localities interested in improving the quality of their transportation service to consider light rail as an alternative.

Community interest in light rail transit in the Milwaukee area was clearly evidenced by a call for a light rail feasibility study in a transportation policy paper issued by the Milwaukee County Executive, William F. O'Donnell, in August 1977, and culminated in his specific request of the Commission in January 1978 to prepare a prospectus for a feasibility study of a light rail transit system in the Milwaukee urbanized area. This request was received by the Commission on February 6, 1978, whereupon the Commission directed the Commission staff to undertake the preparation of the requested prospectus.

In order to actively involve the agencies most concerned with transit system development in the Region in the preparation of the prospectus, as well as to bring the knowledge of individuals possessing broad experience in the planning, design, construction, operation, maintenance, and use of mass transit facilities to bear on the question, the Commission further acted on February 6, 1978, to create a Light Rail Transit Study Prospectus Steering Committee. Membership on this Committee, which was chaired by former City of Milwaukee Mayor Frank P. Zeidler, is set forth in Appendix A.

Following preparation of a draft light rail feasibility study prospectus and review of the prospectus by the steering committee, the Commission staff met with the staff of the U. S. Department of Transportation, Urban Mass Transportation Administration (UMTA), to discuss potential funding of the proposed study by the UMTA. It was indicated in that meeting that a study limited to consideration of the light rail mode and any recommendations from such a limited study would not be eligible for federal financial assistance. The UMTA recommended that the proposed study be expanded to fully meet the requirements of an "alternatives analysis," which are set forth in Appendix B.

An "alternatives analysis" is a requirement of the UMTA for urbanized areas that propose the development of fixed guideway transit systems in their long-range plans and anticipate subsequent UMTA capital funding of such systems. The intent of the requirement is to ensure that federal mass transportation capital investment funds are effectively utilized by requiring urbanized areas proposing fixed guideway transit to investigate and establish the cost-effectiveness of a wide range of transit alternatives, thereby identifying the most cost-effective course of action. An alternatives analysis consists of two phases, both based on a 15-year time horizon.

The first phase has three basic objectives, all of which are intended to provide products which lead into the second phase of the alternatives analysis. The first objective is to identify those corridors, if any, within the analysis area in which the provision of fixed guideway transit service can be justified within 15 years. The second objective is to identify those transit modes, selected from a wide range of alternatives, which merit additional detailed consideration for application in the identified corridors in phase two of the analysis. The third objective is to develop a set of alternative plan evaluation tools, including travel demand forecasting procedures, a cost-effectiveness evaluation methodology, and a citizen involvement mechanism, which can be used in the second phase of the alternative analysis.

The second phase of the alternatives anlaysis is intended to investigate in detail the corridors and transit technology alternatives identified in phase one, using the tools established in that phase. The analysis conducted must provide evaluative information, including an environmental impact assessment, necessary to the selection of a course of action and to making a sound investment decision in each identified corridor.

The light rail feasibility study, as proposed in the draft prospectus, did not meet the requirements of an alternatives analysis because the proposed study was limited to an investigation of the feasibility of light rail transit, and did not include the examination of a wide range of transit and travel corridor alternatives. The study, as initially outlined in the draft prospectus, proposed the examination of light rail, comparing this mode to existing, currently planned, and previously planned motor bus transit alternatives. It also proposed that the identification of major travel corridors in the Milwaukee area, to be considered in the study as possibilities for light rail transit, be based on previous transportation planning efforts of the Commission, and not require further extensive analysis. The limiting of the light rail feasibility study to an analysis involving only the light rail and motor bus alternatives, as well as the use of previously defined major travel corridors, was believed sound because previous extensive transportation planning efforts which had established the motor bus as the superior mode of public transit for the Milwaukee urbanized area had, while ruling out heavy rail and "exotic" modes, neglected light rail transit, and had indicated potential travel corridors which could accommodate fixed guideway transit. The cost of conducting the proposed feasibility study was substantially less than that of an alternatives analysis. However, in order to qualify for federal funding of the study itself and to not jeopardize potential federal funding for any fixed guideway system which might be found feasible, the draft light rail feasibility study prospectus was revised to meet the requirements of a phase one UMTA alternatives analysis.

THE MILWAUKEE AREA PRIMARY TRANSIT SYSTEM ALTERNATIVES ANALYSIS PROSPECTUS

On August 11, 1978, the Prospectus Steering Committee approved the revised prospectus and recommended its adoption by the Regional Planning Commission.[9] The Commission adopted the prospectus on September 14, 1978. The prospectus, as approved by the Committee and the Commission, represented the first step toward the conduct of a primary transit system alternatives analysis in the Milwaukee area. The prospectus documented the need for the study; specified the scope and content of the required work; recommended the most effective method for establishing, organizing, and accomplishing the work; recommended a time sequence and schedule for the work; provided sufficient cost data to permit the development of an initial budget; and recommended an allocation of costs among the various levels and units of government concerned.

Need for a Primary Transit System Alternatives Analysis in the Milwaukee Urbanized Area

Five factors were identified in the prospectus as dictating the need for a primary transit system alternatives analysis in the Milwaukee area:

1. The Need to Reconsider Previously Planned Primary Transit Service—The potential for providing modified bus rapid transit service to a large sector of Milwaukee County under the new regional transportation system plan was lost when the Park Freeway-West and the Stadium Freeway-North "gap closure" were eliminated from the new system plan by the Regional Planning Commission. In addition, according to the new transportation system plan, portions of two freeway segments planned to carry modified bus rapid transit, the Stadium Freeway-South and the Lake Freeway, will not be constructed for at least 10 years, and then only after a further evaluation reestablishes their need. Furthermore, whether the freeway traffic management system required to provide reasonable operating speeds for buses in modified rapid transit service can be, or will be, implemented in the Milwaukee urbanized area is uncertain because further study of its impacts and feasibility is required prior to its implementation. Consequently, the ability of the currently planned primary mass transportation service to effectively compete with the private automobile is uncertain at this time. Thus, investigation of the costs and benefits of a more attractive primary transit service is warranted.

2. Potential Availability of Suitable Corridors—Another factor contributing to the need for a study of primary transit system alternatives is the potential availability of suitable corridors for the development of fixed guideway transit facilities. These potentially suitable corridors include: a number of present or former railroad rights-of-way, emanating in a radial fashion from the central business district of the City of Milwaukee, including portions of the former Chicago North Shore & Milwaukee Electric Railroad right-of-way; the cleared rights-of-way for the Park Freeway-East and Park Freeway-West and portions of the Stadium Freeway-South and Lake Freeway; and power transmission line corridors owned by the Wisconsin Electric Power Company, some of which once served as rights-of-way for the electric interurban railway lines of the Milwaukee Electric Railway and Light Company. Appropriately designed fixed guideway transit facilities in such railroad, cleared freeway, and power transmission line corridors could be developed more cheaply than elsewhere and with a minimum of community disruption and detrimental environmental impact. Some types of mass transit also are capable of operating in boulevard medians and in reserved lanes on streets and highways. These rights-of-way represent a potential resource for innovative transit facility and service development that should be examined closely in an analysis of primary transit system alternatives.

3. Transportation Dependence on Motor Fuel—One advantage of certain primary transit system alternatives, including light and heavy rail systems, is their electrical propulsion system. Light rail and heavy rail systems, unlike automobile and motor bus systems, are not necessarily dependent upon petroleum-based motor fuels, but can derive their

[9] *See SEWRPC Prospectus Report, Milwaukee Area Primary Transit System Alternatives Analysis Prospectus, formally adopted by the Commission on September 14, 1978.*

power from a central power plant which can be fueled with coal, nuclear power, or other nonpetroleum-based energy sources. Because short-term motor fuel shortages could occur at any time and because long-term supplies of petroleum-based motor fuel may become both costly and limited, and because the conservation of petroleum-based motor fuels is a national objective, the potential energy impacts and the financial feasibility of alternative primary transit systems in the Milwaukee urbanized area deserve examination.

4. Public Interest in Rail Transit—Another factor contributing to the need for a study of primary transit system alternatives in the Milwaukee urbanized area at this time is the local and national interest in light rail as an alternative mode of transportation. As already noted, light rail was not evaluated under either the initial regional transportation system planning effort, the Milwaukee Area Transit Plan, or the recently completed regional transportation system plan reevaluation.

   Current local interest in light rail may be viewed as a rediscovery of the quality of service provided by the extensive electric interurban and street railway systems that operated in the Milwaukee area until about 25 years ago. A renewed technical and national interest in light rail is evidenced by the encouragement of the development of light rail technology by the U. S. Department of Transportation, Urban Mass Transportation Administration. In addition, the UMTA, in 1975, issued a policy statement concerning federal support of light rail which indicates its belief that light rail holds promise as an economical, versatile, and environmentally attractive form of mass transportation which deserves "serious consideration by localities interested in improving the quality of their transportation service."

5. Benefits of Exclusive Guideway Transit—Other factors contributing to the need for an analysis of primary transit alternatives in the Milwaukee urbanized area are the possible advantages of a transit system that would utilize exclusive rights-of-way or guideways in rapid or primary and, to a lesser extent, secondary or express and tertiary or local transit operations. Such exclusive operation would have the ability to offer a faster and more reliable mass transit mass transit service which, accordingly, would potentially increase transit ridership and reduce automobile travel and thus reduce the associated negative impacts of the latter on air quality, energy supply, and street and highway capacity.

In addition to the above-stated factors contributing to the need for a primary transit system alternatives analysis, there are several potential, but as yet uncertain, impacts relating to rail transit improvements that should be explored. These include: 1) the ability to increase transit ridership by providing an intrinsically more attractive service than the motor bus; 2) the ability of improved transit service, especially exclusive guideway service, to concentrate and direct land use development and redevelopment; and 3) the ability of improved transit service to reduce environmental intrusions within certain travel corridors. These three potential impacts were not included in the prospectus as factors directly contributing to the need for the study; however, they are illustrative of issues that necessarily will arise in the course of the study.

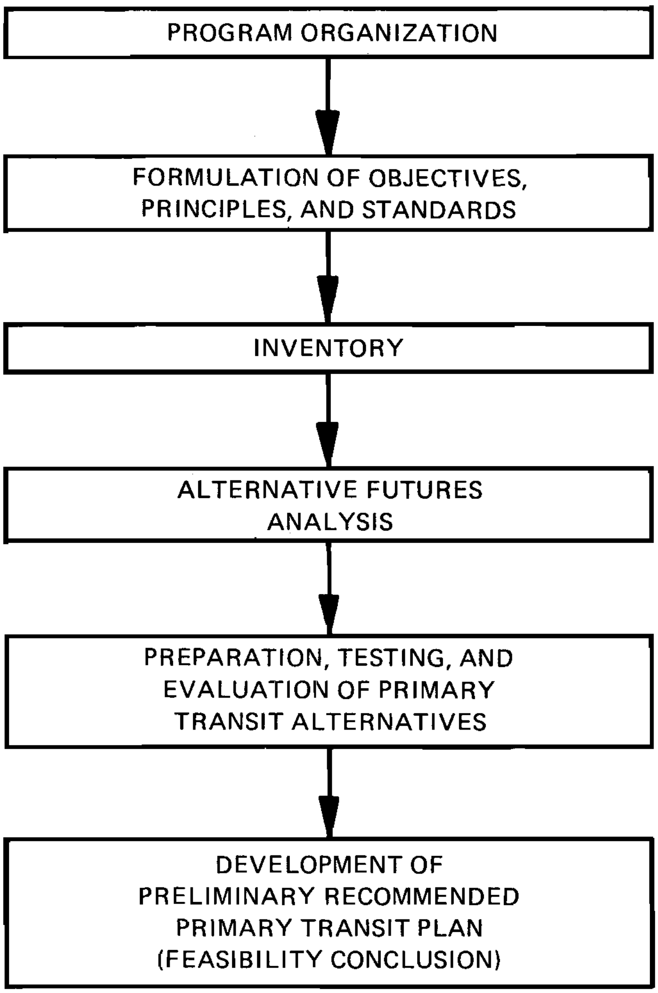
MILWAUKEE AREA PRIMARY TRANSIT SYSTEM ALTERNATIVES ANALYSIS PLANNING PROCESS

In order to ensure that the alternatives analysis is developed to include all practical issues in investigating transit system alternatives to the adopted regional plan, a detailed planning process was outlined in the prospectus to guide the conduct of the study.

The study was recommended to employ a six-step planning process by which the principal factors affecting the feasibility of primary transit service can be accurately described, the complex movement of passengers and vehicles over alternative primary and related secondary and tertiary transit systems simulated, and the effects of different courses of action concerning transit system development evaluated. The six steps in the process are (see Figure 2): 1) program organization; 2) formulation of primary transit system development objectives, principles, and standards; 3) inventory; 4) alternative futures analysis; 5) preparation, testing, and evaluation of alternatives; and 6) development of a recommended primary transit plan, and a resultant feasibility conclusion for the development of fixed guideway transit in the Milwaukee area.

Figure 2

THE MILWAUKEE AREA PRIMARY TRANSIT SYSTEM ALTERNATIVES ANALYSIS PLANNING PROCESS



Source: SEWRPC.

The alternatives analysis planning process represents a modification of previous land use-transportation planning efforts conducted by the Regional Planning Commission. Traditionally, after the necessary program organization, the Commission has proceeded to the formulation of objectives and standards; the collection and analysis of necessary planning information and data; the development of population and employment forecasts; the preparation, testing, and evaluation of alternative land use plans and, following the selection and adoption of a recommended land use plan, the preparation, test, and evaluation of alternative transportation plans supporting the adopted land use plan; and the selection and adoption of a recommended transportation plan. The modification to this traditional Commission process is the substitution of the concept of alternative futures for the development of forecasts.

The traditional Commission approach to system planning which requires the development of a single forecast of a most probable future is the most efficient, and works well in periods of socioeconomic stability, when historic trends can be anticipated to continue relatively unchanged over the plan design period. However, during periods of major change in social and economic conditions, when there is uncertainty as to whether historic trends will continue, an approach other than the traditional approach to systems planning is required. With respect to public transit needs, substantial uncertainty exists today over the future price and availability of energy, and particularly of petroleum-based motor fuel; future automobile technology and cost of automobile travel; future economic growth and change in the nation, the north-central states, the State, and the Region; future lifestyles, particularly with regard to family type and size and residential preferences; and the future size and distribution of population and economic activity in the Milwaukee area.

Accordingly, a modified approach to systems planning has been adopted by the Commission. This approach, known as alternative futures, has been utilized to a limited extent at the national level for public and quasi-public planning purposes, but has not been used as yet at the regional level. Under this approach, the development, test, and evaluation of alternative system plans is based not upon a single forecast of most probable future conditions, but rather upon a number of alternative future conditions chosen to represent the range of such conditions which may be expected to occur over the plan design period. The purpose of this approach is to permit the evaluation of the performance of alternative system plans under a variety of possible future conditions in order to identify those alternatives that perform well under a wide range of such conditions. The alternative futures used under this approach are selected to represent the reasonable extremes of a range of future conditions on the assumption that alternative system plans which perform well under the extremes of a range will also perform well at intermediate points in the range. In this way, "robust" system plans that can be expected to remain viable under greatly varying future conditions can be identified.

Specifically, under the alternative futures planning approach applied in this study, land use and transportation system plans are developed and evaluated in the context of two possible scenarios of the future. The scenarios are intended to reflect upper and lower extremes in future conditions affecting transportation system use and development, including regional population and economic activity and the cost and availability of energy. For each future scenario, centralized and decentralized land use plan configurations are designed for the Region. The former consist of planned land use development patterns consistent with pre-1950 regional development trends, and with land use plans adopted by the Commission and promoted for implementation in the Region since 1966. The latter consist of essentially unplanned land use development patterns consistent with recent regional development trends. Alternative primary transit system plans are then designed, tested, and evaluated under each of the four resulting alternative futures—the centralized and decentralized land use configurations of the upper extreme future scenario and the centralized and decentralized land use configurations of the lower extreme future scenario. Those alternative system plans which work well under all futures are then identified so that "robust" system plans which can be expected to remain viable in the uncertain future can be recommended for implementation.

It should be noted that this alternative futures approach requires an expansion of the level of staff work and attendant budget over traditional Commission long-range system planning efforts. This is because the single forecast population and employment levels prepared for the traditional Commission long-range system planning were developed by selecting from a range of possible future population and employment levels, the single-most probable forecast levels believed to be most representative of probable future conditions. The selection and use of such single forecast values was dictated by budgetary and staff time limitations that precluded the preparation of alternative system plans for a number of alternative population and economic activity levels spanning the range of possible future conditions.

Program Organization

Phase one of the alternatives analysis, program organization, began following the funding of major portions of the study by the U. S. Department of Transportation, Urban Mass Transportation Administration, on March 6, 1979. A study design memorandum was prepared to guide the course of the study in sufficient detail to ensure maximum coordination between participants and the efficient use of funds and personnel, as well as to ensure that the study elements would progress in an orderly and expeditious manner toward a sound conclusion. In addition, in the program organization stage the Steering Committee that guided the preparation of the study prospectus was expanded as recommended in the prospectus to a Citizens, Intergovernmental, and Technical Coordinating and Advisory Committee to guide the conduct of the study itself (see Appendix A).

Objectives, Principles, and Standards

The formulation of primary transit system development objectives is an essential task which must be accomplished before the alternative primary transit system plans can be prepared and evaluated. The objectives must not only be clearly stated and logically sound, but must be related in a demonstrable way to alternative primary transit system proposals so as to permit the evaluation of the alternatives and the identification of the best alternative from among those evaluated. Only if the objectives are clearly relatable to the evaluation of alternative primary transit systems and subject to objective testing can alternatives be successfully developed and evaluated. To accomplish this, logically conceived and well-expressed objectives must be translated into quantifiable standards to provide the basis for plan preparation, testing, and evaluation.

Inventory

Reliable basic planning and engineering data are essential to the development of alternative primary transit system plans and to their evaluation. Inventory, consequently, is the first operational step in the alternatives analysis process. Fortunately, the recent regional land use and transportation system plan reevaluation effort produced a comprehensive planning data base which, when supplemented by the inventory of the state-of-the-art in transit system technology and the availability of existing rights-of-way, is sufficient to support the alternatives analysis.

Analyses and Alternative Futures

Analyses of probable future conditions, as well as inventories of historic and existing conditions, are necessary to the development and evaluation of alternative primary transit system plans. Probable future population and economic activity levels are used to develop future land use patterns, which are in turn translated into probable future demands for transportation facilities and services. These demands are then applied to existing and planned transportation facilities and services.

The aforementioned alternative futures approach is employed at this stage of the process. Four alternative future land use plans are developed within the context of two possible future scenarios concerning the future development of the planning area. One such scenario focuses on the type of external conditions that would result in moderate growth in regional population and employment levels; the other focuses on the type of external conditions that would result in stable or declining regional population and employment levels. For each of these scenarios, two regional land use plans are prepared. The two land use plans under each future differ primarily in their degree of centralization, with one land use plan under each future reflecting a centralized urban development pattern and the other a decentralized pattern.

Transportation Plan Preparation, Test, and Evaluation

For each of the four alternative futures, alternative primary transit system plans are designed, tested, and evaluated. The rapid transit alternatives initially considered include all rapid transit technologies which are found to be proven and available. The initial plans for these technologies provide service to the maximum extent practicable in all major corridors of travel demand in the Milwaukee area. Those rapid transit technologies, and the extent of facilities and services, shown through quantitative test and evaluation to be cost-effective are subject to more detailed test and evaluation under each future. Based upon such quantitative test and evaluation of the rapid transit alternatives under each future, and upon consideration of the intangible benefits of each alternative, a rapid transit plan is recommended for adoption and implementation.

Conclusion as to Feasibility

Phase one of the alternatives analysis ends with a feasibility conclusion with respect to the development of fixed guideway rapid transit facilities and services in the Milwaukee area based upon the recommended plan. That plan may be a "two-tier" plan. Those primary transit plan elements—services and/or transportation systems management strategies—and/or capital facilities which perform well under all or most alternative futures and which, when added to the existing transportation system, function as a true system comprise the "lower tier" of the plan and are recommended for immediate detailed, mode-specific design and implementation. Those primary transit elements which perform well under some futures are included in the "upper tier" of the plan and are recommended for possible or deferred implementation. Nothing is to be done to accomplish upper tier plan elements during the plan life other than those actions necessary to preserve the possibility of implementing them at some time in the future, such as the preservation of cleared or undeveloped transit rights-of-way. The decision to continue the study to the second phase of detailed, mode-specific, design planning rests with all levels of concerned government and the general public.

Public Involvement

Public involvement is recognized as an important element of the alternatives analysis, and a wide range of public involvement mechanisms, including an advisory committee structure, the preparation and distribution of informational literature, and public informational meetings and public hearings, are used in the study in reaching the necessary decisions.

SCHEME OF PRESENTATION

The major findings and the conclusion of the Milwaukee area primary transit system alternatives analysis, phase one, are presented in summary form in this report. Because of the broad scope as well as complex technical nature of this study, it was decided to use a series of technical reports to fully document the technical aspects of the work, and to present summaries of these technical reports as chapters in this planning report. In this way, it was reasoned, the planning report would become a more readable and therefore more useful product. The technical report series, therefore, acts as a supplement to this planning report, detailing the technical work of the alternatives analysis.

Chapter II of this report presents the primary transit system development objectives, principles, and standards. A summary of inventory findings for the Milwaukee area is presented in Chapter III, including those related to population, employment, land use, the natural resource base, travel patterns, and the existing transportation system. Chapter III is supported by a technical report which presents these data in detail. Chapter IV is a summary of an inventory of the state-of-the-art of primary transit technologies; this chapter is also supported by a detailed technical report. Chapter V presents a summary of a technical report documenting the alternative futures developed as a basis for the primary transit system planning. Chapter VI presents a summary of a technical report which documents the preparation, testing, and evaluation of alternative primary transit system plans. Chapter VII presents the recommended plan, Chapter VIII summarizes the actions necessary to implement that plan. The concluding chapter provides a summary of the study findings and recommendations.

This report can only summarize the large volume of information generated in the primary transit system alternatives analysis effort. Although the presentation in published form of all the data used in the study is impractical due to the magnitude and complexity of the information generated, supporting data are available in the technical report series and in the files of the Commission.

SUMMARY

An important component of the public transportation system of any urbanized area is the primary transit system; that is, that system which provides the highest operating speeds and serves the longer trips within the most heavily traveled corridors of the urbanized area. In the Milwaukee urbanized area, such service is presently provided by motor coaches operating in mixed traffic over freeways. In some other urbanized areas, motor coaches are also used, but operate over exclusive busways. Yet other urbanized areas use various forms of rail transit to provide primary service, including light rail transit, heavy rail rapid transit, and commuter rail. The consideration of which of these modes can best serve the transportation needs of an area rightly deserves periodic reexamination and reconsideration.

The alternatives analysis study, the findings and recommendations of which are the subject of this report, is intended to provide this reconsideration. The study was prompted by a specific request on the part of the Milwaukee County Executive, William F. O'Donnell, that the Regional Planning Commission undertake a light rail feasibility study. Such a single mode-specific study, however, was not considered comprehensive enough by the U. S. Department of Transportation, Urban Mass Transportation Administration. The regulations of that agency require as a prerequisite for the approval and funding of any fixed guideway transit system development the completion of an "alternatives analysis" which examines all possible modes of primary transit service. Accordingly, the requested light rail feasibility study was expanded as documented herein to examine a full range of alternative modes and corridors as well as to examine possible service improvements that could build toward the eventual implementation of these modes through the evolutionary development of the primary transit system.

Five factors combine to contribute to the need for this study:

1. The need to reconsider the best means of providing primary transit service in certain subareas of the Milwaukee urbanized area as a result of the elimination of certain previously planned freeway segments which would have carried the primary transit service for those subareas;

2. The potential availability of active and abandoned railroad rights-of-way and electric power transmission corridors, and of cleared freeway rights-of-way through certain subareas of the Milwaukee urbanized area, potentially suitable for the location of fixed guideway transit facilities;

3. The need to reconsider the potential serviceability and financial feasibility of the existing and planned future motor bus transit system in the Milwaukee urbanized area in light of the rising cost and potential shortages of petroleum-based motor fuels;

4. Public interest in light rail transit as an alternative primary transit mode in Milwaukee; and

5. The attractiveness of the potential benefits of any fixed guideway primary transit system.

The findings and recommendations presented herein are developed through the application of a planning process consisting of the following six steps: 1) program organization; 2) formulation of primary transit system development objectives, principles, and standards; 3) inventory; 4) analyses and alternative future studies; 5) preparation, testing, and evaluation of alternatives; and 6) conclusion as to feasibility. The alternatives analysis is based upon a consideration of "alternative futures" for the Milwaukee area. More specifically, the study uses two sets of alternative regional population and employment levels, together with associated projections of key factors affecting urban land use development patterns and attendant travel habits and patterns, to reflect two scenarios of future conditions in the Region. One scenario reflects a future of moderate population and employment growth, and the other reflects a future of moderate population and employment decline. For each of these two scenarios, both a centralized and a decentralized land use plan is prepared. Each of these four land use plans constitutes an alternative future for the Milwaukee urbanized area. Four alternative transportation system plans are then developed, one for each alternative future, based upon analyses of the travel habits and patterns likely to be attendant to each alternative land use plan. These plans and analyses are to indicate which primary transit modes are the most promising for the Milwaukee area under a wide variety of possible future conditions of population and employment, land use development, and energy costs. Upon completion of this "alternative futures" analysis, a decision will be made as to whether results justify termination of the study or completion of the study, in phase two, through detailed, mode-specific, corridor-level design planning, together with studies of system costs, potential financing, and social, economic, and environmental impacts.

Chapter II

OBJECTIVES, PRINCIPLES, AND STANDARDS

INTRODUCTION

Planning is a rational process for formulating and meeting objectives. The formulation of objectives is, therefore, an essential task which must be undertaken before plans can be prepared and subsequently evaluated. Objectives guide the preparation of alternative plans and, when converted to specific measures of plan effectiveness—termed standards—provide the structure for comparing and selecting from among the alternatives. Because planning objectives provide this basis for plan preparation and selection, the formulation of objectives is a particularly critical, as well as necessary, step in the planning process.

The formulation of objectives essentially involves a formal definition of the needs which alternative plans should aim to satisfy. Any set of objectives reflects an underlying value system related to the problem being defined and addressed. The diverse and often conflicting nature of personal values concerning transportation complicates the task of objective formulation in this study and makes it one of the most difficult tasks in the planning process.

Recognizing that any set of planning objectives implicitly reflects an underlying value system, the Commission, since its inception, has provided for the involvement of interested and knowledgeable public officials, technicians, and private citizens in its planning programs. This participation by elected and appointed officials and by citizen leaders in the planning process, particularly in the formulation of objectives, is implicit in the structure and organization of the Southeastern Wisconsin Regional Planning Commission itself. Moreover, through the establishment of advisory committees to assist the Commission and its staff in the conduct of regional planning programs, the Commission has attempted to provide an even broader opportunity for the active participation of public officials and private interest groups in the regional planning process.

The use of advisory committees has been, and still appears to be, the most practical and effective way available to involve public officials, technicians, and citizen leaders in the transportation planning process and to arrive in an open and cooperative manner at decisions and action programs which can shape the future development and present management of the Region's transportation system. Only through the accumulated knowledge, experience, views, and values of the various advisory committee members concerning the transportation system can a meaningful expression of the desired direction, magnitude, and quality of future transportation system development be obtained.

The advisory committee structure established by the Commission for the preparation of this primary transit system alternatives analysis has been described in Chapter I of this report. One of the major tasks of the Advisory Committee was to assist in the formulation of primary transit system development objectives and supporting planning principles and standards.

The primary transit system objectives formulated for this alternatives analysis and adopted by the Advisory Committee are similar to the long-range transportation system objectives adopted under the recent major regional land use-transportation plan reevaluation.[1] The strong parallel between Milwaukee area primary transit system objectives and regional long-range transportation system objectives is based on the belief that transportation planning objectives, not only for transportation systems but for their system elements, such as primary public transit, essentially serve to define formally the basic needs which transportation facilities and services should satisfy, such as personal mobility, economic efficiency, environmental quality, and public safety. Therefore, objectives defined for a regional transportation system should be similar to objectives defined for any of its specific elements, addressing the same basic needs.

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[1] *See Chapter II of SEWRPC Planning Report No. 25, A Regional Land Use and a Transportation Plan for Southeastern Wisconsin: 2000, Volume Two, Inventory Findings, May 1978.*

BASIC CONCEPTS AND DEFINITIONS

The term "objective" is subject to a wide range of interpretation and application, and is closely linked to other terms often used in planning work which are equally subject to a wide range of interpretation and application. Therefore, in order to provide a common frame of reference, the following definitions have been adopted for use in Commission planning efforts:

1. Objective: a goal or end toward attainment of which plans and policies are directed.

2. Principle: a fundamental, primary, or generally accepted tenet used to support objectives and prepare standards and plans.

3. Standard: a criterion used as a basis of comparison to determine the adequacy of plan proposals to attain objectives.

4. Plan: a design which seeks to achieve agreed-upon objectives.

5. Policy: a rule or course of action used to ensure plan implementation.

6. Program: a coordinated series of policies and actions to carry out a plan.

Although this chapter deals only with the first four of these terms, an understanding of the interrelationship among the foregoing definitions and the basic concepts which they represent is essential to the following discussion of objectives, principles, and standards.

OBJECTIVES

In order to be useful in the primary transit system alternatives analysis, objectives must be logical, stated clearly, and, to the extent feasible, derived from local values. Moreover, objectives must be related in a demonstrable and measurable way to alternative primary transit systems in order to facilitate objective tests of, and selection from among, alternative plans. The quantification of objectives for alternative plan preparation, testing, and selection is facilitated by complementing each specific objective with a set of quantifiable standards. These standards are, in turn, directly relatable to a planning principle which supports the chosen objective. The following primary transit system objectives have been adopted by the Commission after careful review by, and upon the recommendation of, the advisory committee:

1. A primary transit system which, through its location, capacity, and design, serves to promote sound land use development, meeting the travel demand generated by desirable future land uses as well as by existing land uses.

2. A transportation system which is economical and efficient, satisfying all other objectives at the lowest possible cost.

3. A primary transit system which provides the appropriate service needed by all residents of the planning area.

4. A primary transit system which minimizes disruption of existing neighborhood and community development, including adverse effects upon the property tax base, and which minimizes the deterioration and/or destruction of the natural resource base.

5. A primary transit system which facilitates quick and convenient travel between component parts of the urbanized area, offering an effective and attractive alternative to travel by private automobile.

6. A primary transit system which reduces accident exposure and provides for increased travel safety.

7. A primary transit system with a high aesthetic quality whose major facilities have proper visual relation to the landscape and cityscape.

PRINCIPLES AND STANDARDS

Complementing each of the foregoing primary transit system objectives is a planning principle and a set of planning standards. These are set forth in Table 1. Each set of standards is directly relatable to the planning principle, as well as to the objective, and serves to facilitate quantitative application of the objective in plan design, testing, and evaluation. The planning principle, moreover, supports each specific objective by asserting its validity.

The planning standards adopted herein fall into two groups—comparative and absolute. The comparative standards, by virtue of their nature, can be applied only through a comparison of alternative plan proposals. Absolute standards can be applied individually to each alternative plan proposal, since they are expressed in terms of relative or desirable values.

OVERRIDING CONSIDERATIONS

In the application of the planning standards and in the preparation of the alternative primary transit system plans, several overriding considerations must be recognized. First, it must be recognized

Table 1

PRIMARY TRANSIT SYSTEM OBJECTIVES, PRINCIPLES, AND STANDARDS

OBJECTIVE NO. 1

A primary transit system which, through its location, capacity, and design, serves to promote sound land use development, meeting the travel demand generated by desirable future land uses as well as by existing land uses.

PRINCIPLE

The primary transit system, as part of an integrated transit and overall transportation system, serves to interconnect the various land use activities within the planning area, thereby providing the attribute of accessibility essential to the support of these activities. Through its effect on accessibility, the regional primary transit system can be used to support and induce development in desired locations.

STANDARDS

1. The primary transit system should provide service within the planning area such that a maximum number of residents of the urbanized area are within:

   a. 30 minutes overall travel time[a] by transit, including the portion of the trip made on primary, secondary, and tertiary transit, of at least 40 percent of the urbanized area's employment opportunities;

   b. 35 minutes overall travel time by transit, including the portion of the trip made on primary, secondary, and tertiary transit, of at least three major retail and service centers;[b]

   c. 40 minutes overall travel time by transit, including the portion of the trip made on primary, secondary, and tertiary transit, of a medical center;[c]

   d. 40 minutes overall travel time by transit, including the portion of the trip made on primary, secondary, and tertiary transit, of a major park and outdoor recreation area;[d]

   e. 40 minutes overall travel time by transit, including the portion of the trip made on primary, secondary, and tertiary transit, of a technical or vocational school, college, or university; and

   f. 60 minutes overall travel time by transit, including the portion of the trip made on primary, secondary, and tertiary transit, of a scheduled air transport facility.

2. The accessibility provided by the regional transit system should be adjusted to the land use plan by providing a higher relative accessibility to areas in which higher density development is planned than to areas in which low-density development is planned and to those areas which should be protected from development.

3. The accessibility provided by the primary transit system to the Milwaukee central business district should be maximized.

Table 1 (continued)

OBJECTIVE NO. 2

A transportation system which is economical and efficient, satisfying all other objectives at the lowest possible cost.

PRINCIPLE

The total resources of the planning area are limited, and any undue investment in transportation facilities and services must occur at the expense of other public and private investments; therefore, total transportation costs should be minimized for the desired level of service.

STANDARDS

1. Transportation system operating and capital investment costs should be minimized.

2. The direct benefits derived from transportation system improvements should exceed the direct costs of such improvements.

3. The total amount of energy, and the total amount of energy per passenger mile consumed in constructing and operating the total transportation system of which the transit system is an integral part, and particularly petroleum-based fuels, should be minimized.

4. At any given fare level the net[e] capital and operating cost per primary transit ride should be minimized.

5. The marginal cost of providing additional primary transit capacity and of attracting additional primary transit ridership in terms of the net total and net operating cost per seat-mile and per rider, should be minimized.

OBJECTIVE NO. 3

A primary transit system which provides the appropriate service needed by all residents of the planning area.

PRINCIPLE

An adequate level of transportation service is required by all segments of the population to support essential economic and social activities, and to achieve economy and efficiency in the provision of transportation services. The public transportation system supplies additional passenger transportation system capacity which can alleviate peak loadings on highway facilities in heavily traveled corridors and assist in reducing the demand for land necessary for parking facilities at major regional land use activities. Primary transit service is that component of the public transportation system which provides the highest operating speeds and serves the longest trips along the most heavily traveled corridors in an urbanized area.

STANDARDS

1. The provision of primary mass transit service should be considered in high-density travel corridors where such service will save a minimum of one minute per mile of travel over alternative local transit service and where average in-vehicle trip length is four miles or longer.

2. The number of residents of the urbanized area served by primary transit should be maximized. Urban residential land shall be considered as served by primary transit when such land is within one-half mile walking or three-mile driving distance, or within 15 minutes by feeder bus, of the primary mass transit service.[f]

3. Primary transit routes should be arranged to minimize transfers which would discourage transit use.

4. Primary transit facilities should be located, designed, and operated so as to provide adequate transit vehicle capacity to meet existing and potential travel demand. The average maximum load factor[g] should not exceed 1.00 in primary transit service.

Table 1 (continued)

5. Operating headways[h] for primary transit service should be designated to provide service at intervals capable of accommodating passenger demand at the recommended load standards, but should not exceed 30 minutes and should be less when needed to provide service capable of meeting transit demand during weekday peak periods.

6. Primary transit stops within the planning area should be located at line termini and at distances of one-half mile or more on line-haul sections.

7. In the central business district, primary transit routes should be located so as to maximize the number of users who need walk no more than one-quarter mile to a stop.

8. Sufficient off-street automobile parking facilities should be provided at park-and-ride primary transit stations to accommodate the total parking demand generated by trips which change from auto to mass transit modes at each station.

9. Primary transit stops should be located, designed, and operated so as to provide protection from inclement weather, to promote ready access by feeder transit service, and to provide to the greatest extent practicable modal interface with other forms of personal and public transportation service.

10. The primary transit system should be designed, implemented, and operated so as to enhance the overall reliability of the public transit system.

11. The number of jobs in the urbanized area served by primary transit should be maximized. A job shall be considered as served by primary transit if it is within one-half mile walking distance or a 15-minute feeder bus ride of a primary transit stop.

12. The primary transit system should be designed such that, when considered with secondary and tertiary transit services, primary and total transit ridership is maximized.

OBJECTIVE NO. 4

A primary transit system which minimizes disruption of existing neighborhood and community development, including adverse effects upon the property tax base, and which minimizes the deterioration and/or destruction of the natural resource base.

PRINCIPLE

Primary transit can be a tool to promote sound urban development and redevelopment. Also, the social and economic costs attendant to the disruption and dislocation of homes, businesses, industries, and communication and utility facilities as well as the adverse effects on the natural resource base can be minimized through the proper location and design of primary mass transit facilities and terminals.

STANDARDS

1. The proper use of land for, and adjacent to, primary transit facilities should be maximized and the disruption of future development minimized through advance reservation of rights-of-way for primary transit facilities.

2. The penetration of neighborhood units and of neighborhood facility service areas by primary transit routes should be minimized.

3. The dislocation of households, businesses, industries, and public and institutional buildings by the reconstruction of existing, or the construction of new, primary transit facilities and terminals should be minimized.

4. The amount of land used for primary transit and terminal facilities should be minimized.

5. The primary transit system should be located and designed so as to minimize the exposure of the Region's population to harmful, as well as annoying, noise levels.[i]

Table 1 (continued)

6. The destruction of historic buildings and of historic, scenic, scientific, archaeological, and cultural sites as caused by the reconstruction of existing, or the construction of planned, primary transit facilities and terminals should be minimized.

7. The primary transit system should be located, designed, and operated so as to minimize the amount of air pollutants generated by the entire transportation system.

OBJECTIVE NO. 5

A primary transit system which facilitates quick and convenient travel between component parts of the urbanized area, offering an effective and attractive alternative to travel by private automobile.

PRINCIPLE

To support the everyday activities of business, shopping, and social intercourse, a primary transit system which provides for reasonably fast, convenient travel is essential. Automobile travel, while offering an admittedly high degree of personal mobility, comfort, and convenience, can result, particularly in corridors of high travel demand, in traffic congestion and excessive air pollutant emissions and motor fuel consumption. Effective and attractive high-quality primary transit service has the potential to directly reduce the traffic congestion and associated personal delay, energy consumption, and air pollution through its use by previous automobile users attracted to primary transit. If this removal of automobile drivers and passengers from congested streets and highways is significant, primary transit can also reduce the congestion-induced delay, motor fuel consumption, and air pollution of those automobile users and trucks which choose to remain on the street system. Such an achievement would be important, because congestion increases the cost of transportation, and can thereby adversely affect the attractiveness of an area for residential life, and for the location and operation of businesses and industries.

STANDARDS

1. Primary transit service within a planning area should connect and serve:[j]

   a. major retail and service centers;

   b. major industrial centers;[k]

   c. major medical centers;

   d. major park and outdoor recreation areas;

   e. vocational schools, colleges, and universities;

   f. scheduled air transport terminals; and

   g. high-density residential areas.

2. Primary transit and total transit passenger hours of travel per trip within the urbanized area should be minimized.

3. Primary transit and total transit passenger miles of travel per transit trip within the urbanized area should be minimized.

4. Primary transit and total transit vehicle miles of travel per trip within the urbanized area should be minimized.

5. Adequate capacity and a sufficiently high level of geometric design should be provided to achieve the following minimum overall travel speeds based on average weekday conditions:

Table 1 (continued)

Primary Mass Transit System Component	Minimum Overall Travel Speed by Area (miles per hour)	
	Central Business District	Other
Primary	10	30

6. Primary transit service should be provided to reduce congestion on arterial streets and highways in order to maintain a desirable level of transportation service between component parts of the planning area.

7. The primary transit system should be designed, implemented, and operated so as to attract the maximum proportion of travelers currently using automobiles.

OBJECTIVE NO. 6

A primary transit system which reduces accident exposure and provides for increased travel safety.

PRINCIPLE

Accidents take a heavy toll in life, property damage, and human suffering; contribute substantially to overall transportation costs; and increase public costs for police and welfare services. Therefore, every attempt should be made to reduce both the incidence and severity of accidents.

STANDARDS

1. The percentage of total person travel in the planning area that uses public transit service should be maximized.

2. The total transit ridership in the planning area that uses primary transit service provided over exclusive guideways should be maximized.

3. The primary transit system should be designed, implemented, and operated so as to maximize personal safety.

OBJECTIVE NO. 7

A primary transit system with a high aesthetic quality whose major facilities have proper visual relation to the landscape and cityscape.

PRINCIPLE

Beauty in the physical environment is conducive to the physical and mental health and well-being of people; and, as major features of the landscape and cityscape, transportation facilities have a significant impact on the attractiveness of the total environment.

STANDARDS

1. Primary transit facility construction plans should be developed using sound geometric, structural, and landscape design standards which consider the aesthetic quality of the transportation facilities and of the areas through which they pass.

2. Primary transit facilities should be located so as to avoid destruction of visually pleasing buildings, structures, and natural features and to avoid interference with vistas to such features.

Table 1 (continued)

[a] *Overall travel time is defined as the total door-to-door time of travel from origin to destination, including the time required to arrive at the vehicle and leave the vehicle as well as route travel time.*

[b] *Major retail and service centers, as defined by the Commission, are those retail and service lands within designated community central business districts, strip shopping districts, and shopping centers which meet at least five of the following six criteria: 1) two or more department stores; 2) 10 or more additional retail and service establishments; 3) a combined average annual sales totaling $30 million or more; 4) a combined net site area of 20 acres or more; 5) the attraction of 3,000 shopping trips or more on an average weekday; and 6) accessibility to a population of at least 100,000 in a radius of 10 miles, or 20 minutes one-way travel time.*

[c] *Medical centers, as defined by the Commission, are those medical complexes having at least 600 beds, providing at least 30 types of medical service, and having at least 250 attending full-time or part-time physicians.*

[d] *Major park and outdoor recreation areas, as defined by the Commission, are those public multiple-use outdoor recreation sites having an area of 250 acres or more.*

[e] *Net operating costs are the gross operating costs less fare box revenues.*

[f] *Commission studies of the primary transit service currently provided in the Milwaukee area, the "Freeway Flyer," indicate that existing riders willing to access the "Freeway Flyer" service by walking are within a distance of one-third mile or less, and by driving, are within a distance of three miles or less.*

[g] *The average maximum load factor is defined as the ratio of the number of passengers carried on public transit vehicles past the maximum load point of any route to the seating capacity of vehicles past that point in the peak flow direction during the operating period. Average maximum load factors may vary for different forms of primary services technology. Therefore, while a maximum load factor of 1.00 represents an ideal maximum load level in many system configurations, the factor will be reviewed on the basis of specific mode recommendations.*

[h] *The term "operating headway" is defined as the time between vehicles operating over fixed routes and schedules.*

[i] *Annoying noise levels are defined as the maximum desirable outside noise level for residences, public buildings, and parks based on studies and standards of the U. S. Department of Transportation. Those noise levels considered to be annoying were established as those generated by transportation facility use which exceed 70 dBA at least 10 percent of the time at the exterior of buildings adjacent to the facility. Noise levels considered to be harmful have been established as those which exceed 85 dBA at least 50 percent of the time.*

[j] *The terms "connect" and "serve" used together are defined as the linking of major trip destinations by one or more scheduled routes.*

[k] *Major industrial centers, as defined in the Commission's adopted regional land use plan, are those contiguous U. S. Public Land Survey quarter sections having 250 acres or more of net industrial land or a minimum of 3,500 industrial employees.*

Source: SEWRPC.

that an overall evaluation of primary transit system alternatives must be made on the basis of cost. Such analysis may show that the attainment of one or more of the objectives or supporting standards is beyond the economic capability of the planning area and, therefore, that the objectives or standards cannot be met practically and must be either modified or eliminated. Second, it must be recognized that it is unlikely that any one alternative plan proposal will meet all of the objectives and standards completely, and that the extent to which each objective, along with its supporting standards, is met, exceeded, or violated must therefore serve as a measure of the ability of an alternative plan to achieve the objective. Third, it must be recognized that certain objectives and standards may conflict, requiring resolution through compromise, and that meaningful plan evaluation may take place only through the comprehensive assessment of each of the alternative plans against all of the objectives and standards. Fourth, one of the prime considerations in the planning and design of any urban system, but particularly a primary transit system, is the need to carefully consider the flexibility of the resulting system.

Three types of flexibility can be considered with respect to a primary transit system: operational flexibility, or the ability of the system to operate in a variety of environments—exclusive guideway or mixed traffic, line-haul or collector-distributor, surface/subway/elevated, and single-vehicle or multiple-vehicle; technological flexibility, or the ability of the system to accommodate significant changes in technology including different vehicle type, control systems, and collector-distributor systems, among others; and configurational flexibility, or the ability of the system configuration to be altered to respond to unanticipated changes in urban development and/or travel demand. In addition, the primary transit system should be sufficiently flexible to avoid severe disruption from unusual events such as interrupted energy supply, inclement weather, or accidents.

While the alternative futures planning process employed in the alternatives analysis was specifically designed to produce a flexible primary transit system plan that would function well under a variety of possible future conditions, and while it is recognized that flexibility as defined above is only one of the desirable characteristics of a primary transit system and that in some circumstances a certain amount of flexibility must be "traded off" during the design of the system for other attributes, such as reduced capital or operating cost, flexibility is a very important consideration in the planning and design of a primary transit system. Flexibility should thus be maximized under any specific set of conditions.

The final consideration in preparing primary transit system alternative plans is that the plans must be designed to meet the transportation needs of those portions of the elderly and physically and mentally disabled population that are transportation handicapped, except where specialized transportation services are planned to be provided to adequately meet those needs.

SUMMARY

This chapter has presented a set of primary transit system development objectives, principles, and standards developed and adopted by the study advisory committee and the Commission itself to guide the alternatives analysis through plan preparation, testing, and evaluation. The seven specific objectives have been developed in the context of the regional transportation system plan objectives, principles, and standards previously adopted by the Regional Planning Commission.

The standards which support the seven specific alternatives analysis objectives provide important guidelines for subsequent primary transit planning efforts, facility design efforts, and related plan implementation efforts. This chapter thus documents the guiding objectives and supporting standards which the recommended primary transit system plan is intended to meet, and the criteria by which implementation policies and programs can be designed to carry out the plan recommendations and ensure compatability and consistency between primary transit system improvements and the regional transportation system plan.

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Chapter III

INVENTORY FINDINGS

INTRODUCTION

Considerations important to any middle- to long-range transportation system planning effort are the characteristics of the planning area which establish its travel demand levels and patterns. Accordingly, one of the important steps in the Milwaukee area primary transit system alternatives analysis involved the collation of pertinent factual data on population and economic activity levels and characteristics; land use patterns; travel habits and characteristics; and transportation system facilities and services. The data were largely obtained from inventories completed under the continuing planning program of the Regional Planning Commission, updated as necessary and possible. These data are used in the primary transit system planning effort principally to provide the understanding essential to proper consideration of possible future demographic, economic, and land use changes in the planning area, and to the sound selection of the best primary transit system plan from among the alternatives to be considered.

This chapter provides a summary of the salient inventory findings documented in greater detail in SEWRPC Technical Report No. 23, Transit-Related Socioeconomic, Land Use, and Transportation Conditions and Trends in the Milwaukee Area. The basic inventory findings are presented in this chapter and in the technical report at three levels of geographic detail: for the Southeastern Wisconsin Region as a whole; for each of the seven counties comprising the Region; and, for certain types of data, for certain subareas of Milwaukee County of particular concern to any transit planning effort. The basic inventory findings are presented for the entire Region because the factors that influence land use development, travel habits and patterns, and transportation system needs operate over the entire Region, which, accordingly, is a sound socioeconomic unit for many types of planning, including transportation system planning, encompassing, as it does, the entire commutershed of the greater Milwaukee area. The basic inventory data are also presented for each of the seven counties comprising the Region. This permits special consideration of Milwaukee County, the major existing transit service area within the seven-county Region, and of that part of the Milwaukee urbanized area to which the provision of urban transit service is currently limited. As already noted, certain of the basic inventory data are also presented by subareas of Milwaukee County. These areas represent important concentrations of transit trip origins and destinations, such as the central business district of the City of Milwaukee. It should be recognized that although not presented herein, much of the population, economic activity, land use, and travel habit and pattern data displayed at the regional and county levels is also available in the Commission files for small geographic areas, including minor civil divisions, planning analysis areas, traffic analysis zones, U. S. Public Land Survey system quarter sections, and census tracts.

DEMOGRAPHIC ACTIVITY

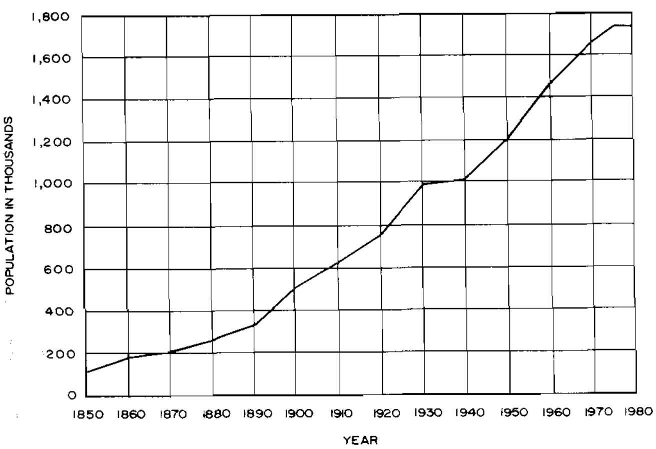
Population Size

The population of the Southeastern Wisconsin Region has increased every decade since 1850, when the first federal census of population was taken, as shown in Figure 3 and Table 2. By 1970 the resident population of the Region totaled approximately 1,756,100 people, or about 1 percent of the total population of the nation and about 40 percent of the total population of the State. Population growth within the Region was especially rapid from 1940 to 1970. From 1940 to 1950, the population of the Region grew by about 173,000 people, or by about 16.2 percent. From 1950 to 1960, the population grew by about 333,000 people, or by about 26.8 percent, an historic peak; and from 1960 to 1970, the population grew by about 182,000 people, or by about 11.6 percent. These large increases in the population were primarily the result of natural increase—that is, of the excess of births over deaths—and not of in-migration which, while a factor, was not the predominant one.

Since 1970, however, population growth within the Region has virtually halted. In 1978 the resident population of the Region was estimated at 1,770,500 people, only 14,400 people, or about 1 percent, more than in 1970. Declines in fertility partially account for this greatly reduced rate of

Figure 3

POPULATION TRENDS IN THE REGION: 1850-1978



Source: SEWRPC.

population growth since 1970. Since 1970, however, and particularly since 1975, net out-migration has become a significant component of population change in the Region. It is estimated that net out-migration from the Region between 1970 and 1978 totaled over 70,000 people.

Population Distribution

From 1900 to 1930, the highest rates of population increase occurred in the three urban counties of Milwaukee, Kenosha, and Racine, as shown in Table 3. Since 1930, however, the counties outlying Milwaukee County, notably Ozaukee, Washington, and Waukesha Counties, have experienced the highest rates of population increase. From 1960 to 1970, the three urban counties of Kenosha, Milwaukee, and Racine together experienced a decrease in their proportion of the total regional population—from 81 percent in 1960 to 76 percent in 1970. The percentage of the total regional population in these three urban counties is estimated to have further declined to 71 percent in 1978. Between 1970 and 1978, the resident population of Milwaukee County is estimated to have decreased by about 100,000 persons, while the proportion of the regional population in Milwaukee County decreased from about 60 percent to 54 percent.

Population Characteristics

Since 1960 the age structure of the regional population has been changing toward that of an older, more mature population. The racial composition of the population has also been changing, with a greater proportion of the population being comprised of nonwhites, although whites still comprised approximately 90 percent of the total regional population in 1978. In Milwaukee County, still the most populous county in the Region, whites comprised approximately 85 percent of the total resident population of 960,000 in 1978.

Table 2

POPULATION TRENDS IN THE REGION, WISCONSIN, AND THE UNITED STATES: 1850-1978

	Region			Wisconsin			United States			Regional Population as a Percent of:	
		Change From Preceding Time Period			Change From Preceding Time Period			Change From Preceding Time Period			
Year	Population	Absolute	Percent	Population	Absolute	Percent	Population	Absolute	Percent	Wisconsin	United States
1850	113,389	- -	- -	305,391	- -	- -	23,191,876	- -	- -	37.1	0.49
1860	190,409	77,020	67.9	775,881	470,498	154.1	31,443,321	8,251,445	35.6	24.5	0.60
1870	223,546	33,137	17.4	1,054,670	278,789	35.9	38,448,371	7,005,050	22.6	21.2	0.58
1880	277,119	53,573	24.0	1,315,497	260,827	24.4	50,155,783	11,707,412	30.1	21.2	0.55
1890	386,774	109,655	39.6	1,693,330	377,833	28.7	62,947,714	12,791,931	25.5	22.8	0.61
1900	501,808	115,034	29.7	2,069,042	375,712	22.2	75,994,575	13,046,861	20.7	24.2	0.66
1910	631,161	129,353	25.8	2,333,860	264,818	12.8	91,972,266	15,977,691	21.0	27.0	0.69
1920	783,681	152,520	24.2	2,632,067	298,207	12.8	105,710,620	13,738,354	14.9	29.8	0.74
1930	1,006,118	222,437	28.4	2,929,006	306,939	11.7	122,775,046	17,064,426	16.1	34.2	0.82
1940	1,067,699	61,581	6.1	3,137,587	198,581	6.8	131,669,587	8,894,541	7.2	34.0	0.81
1950	1,240,618	172,919	16.2	3,434,575	296,988	9.5	151,325,798	19,656,211	14.9	36.1	0.82
1960	1,573,620	333,002	26.8	3,952,771	518,196	15.1	179,323,175	27,997,377	18.5	39.8	0.88
1970	1,756,086	182,466	11.6	4,417,933	465,162	11.8	203,184,772	23,861,597	13.3	39.7	0.86
1975	1,788,346	32,260	1.8	4,581,701	163,768	3.7	212,245,000	9,060,228	4.5	39.0	0.84
1978	1,771,492	16,854	- 0.94	4,652,755	70,754	1.6	217,391,000	5,146,000	2.4	38.1	0.81

Source: SEWRPC.

Table 3

POPULATION DISTRIBUTION IN THE REGION BY COUNTY: SELECTED YEARS 1900-1978

County	1900		1930		1960		1970		1978		Change 1960-1970		Change 1970-1978	
	Population	Percent of Region	Population	Percent of Region	Population	Percent of Region	Population	Percent of Region	Population	Percent of Region	Absolute	Percent	Absolute	Percent
Kenosha	21,707	4.3	63,277	6.3	100,615	6.4	117,917	6.7	125,808	7.1	17,302	17.2	7,891	6.7
Milwaukee . . .	330,017	65.8	725,263	72.1	1,036,047	65.8	1,054,249	60.1	960,993	54.2	18,202	1.7	- 93,256	- 8.8
Ozaukee	16,363	3.3	17,394	1.7	38,441	2.5	54,461	3.1	69,914	3.9	16,020	41.7	15,353	28.4
Racine	45,644	9.1	90,217	9.0	141,781	9.0	170,838	9.7	177,337	10.0	29,057	20.5	6,499	3.8
Walworth. . . .	29,259	5.8	31,058	3.1	52,368	3.3	63,444	3.6	69,058	3.9	11,076	21.1	5,614	8.8
Washington . .	23,589	4.7	26,430	2.6	46,119	2.9	63,839	3.6	83,282	4.8	17,720	38.4	19,443	30.5
Waukesha . . .	35,229	7.0	52,350	5.2	158,249	10.1	231,338	13.2	285,100	16.1	73,089	46.2	53,762	23.2
Region	501,808	100.0	1,005,989	100.0	1,573,620	100.0	1,756,086	100.0	1,771,492	100.0	182,466	11.6	15,406	0.88

Source: SEWRPC.

The number of households in the Region continues to grow at a greater rate than does the resident population, reflecting an overall decrease in the number of persons per household. From 1950 to 1960, the number of households in the Region increased by 111,400, or 31 percent. From 1960 to 1970, the number of households increased by 70,600, or 15 percent. From 1970 to 1975 the number of households is estimated to have increased by 39,000, or 7.3 percent. The average number of persons per household within the Region decreased from 3.36 in 1950 to 3.30 in 1960 to 3.20 in 1970, and is estimated to have further declined to 3.04 in 1975. This decline in average household size has occurred in all seven counties of the Region, as shown in Table 4. In Milwaukee County, the average household size decreased from 3.34 in 1950 to 3.21 in 1960 to 3.04 in 1970, and to an estimated 2.82 in 1975. The results of special censuses taken in some civil divisions in the Region since 1970 all indicate that the trend of decreasing household size is continuing.

From 1950 to 1960, total regional personal income increased by 71.4 percent—from $2,299 million in 1950 to $3,941 million in 1960, measured in constant 1967 dollars. From 1960 to 1970, total regional personal income further increased by nearly 32 percent—from $3,941 million in 1960 to $5,189 million in 1970. Meanwhile, per capita income in the Region increased by 35 percent between 1950 and 1960 and by 18 percent between 1960 and 1970—from $1,853 in 1950 to $2,505 in 1960 to $2,954 in 1970, again expressed in constant 1967 dollars. The 59 percent rate of increase in regional per capita income from 1950 to 1970 was less than the national and state rates of increase over this same period of 82 and 81 per-

Table 4

NUMBER OF HOUSEHOLDS AND PERSONS PER HOUSEHOLD IN THE REGION BY COUNTY: 1950, 1960, AND 1970

County	Number of Households					Number of Persons per Household			Percent of Total Population Living in Households		
				Percent Change							
	1950	1960	1970	1950-1960	1960-1970	1950	1960	1970	1950	1960	1970
Kenosha	21,958	29,545	35,468	34.6	20.0	3.36	3.36	3.26	98.0	98.9	98.1
Milwaukee . . .	249,232	314,875	338,605	26.3	7.5	3.34	3.21	3.04	95.4	97.5	97.6
Ozaukee	6,591	10,417	14,753	58.0	41.6	3.51	3.65	3.66	99.0	98.9	99.1
Racine	31,399	40,736	49,796	29.7	22.2	3.37	3.39	3.35	96.5	97.5	97.7
Walworth. . . .	12,369	15,414	18,544	24.6	20.3	3.25	3.28	3.16	96.6	96.5	92.3
Washington . .	9,396	12,532	17,385	33.4	38.7	3.55	3.64	3.63	98.5	98.8	98.9
Waukesha . . .	23,599	42,394	61,935	79.6	46.1	3.51	3.66	3.66	96.3	98.0	98.0
Region	354,544	465,913	536,486	31.4	15.1	3.36	3.30	3.20	95.9	97.7	97.6

Source: SEWRPC.

cent, respectively. The level of per capita income in the Region, however, has remained consistently higher than the state and national levels.

The average household income in the Region in 1970 was $9,672, expressed in 1967 dollars. Household income is more closely correlated with transit use and tripmaking than is per capita income. Similar to historical changes in regional per capita income, the percentage change in regional average household income was only 14 percent between 1960—when the average household income was $8,310—and 1970 significantly lower than the 30 percent change experienced between 1950—when the average household income, measured in constant 1967 dollars, was $6,344—and 1960.

ECONOMIC ACTIVITY

Labor Force

Between 1950 and 1970, the Region's labor force increased from about 540,100 people to about 744,500 people—an overall increase of 204,400 people, or about 38 percent. Between 1970 and 1978, the labor force increased to 891,700 people—an increase of about 147,200 people, or 20 percent—while the regional population increased by only 1 percent. The increases in the Region's labor force since 1950 are partially a result of the increase in the regional labor force participation rate since 1950. The labor force participation rate in 1950 was about 57 percent and by 1970 had reached 59 percent. Over this same period of time, female labor force participation increased from 32 percent to 36 percent, while male participation decreased from 82 percent to 76 percent.

Employment

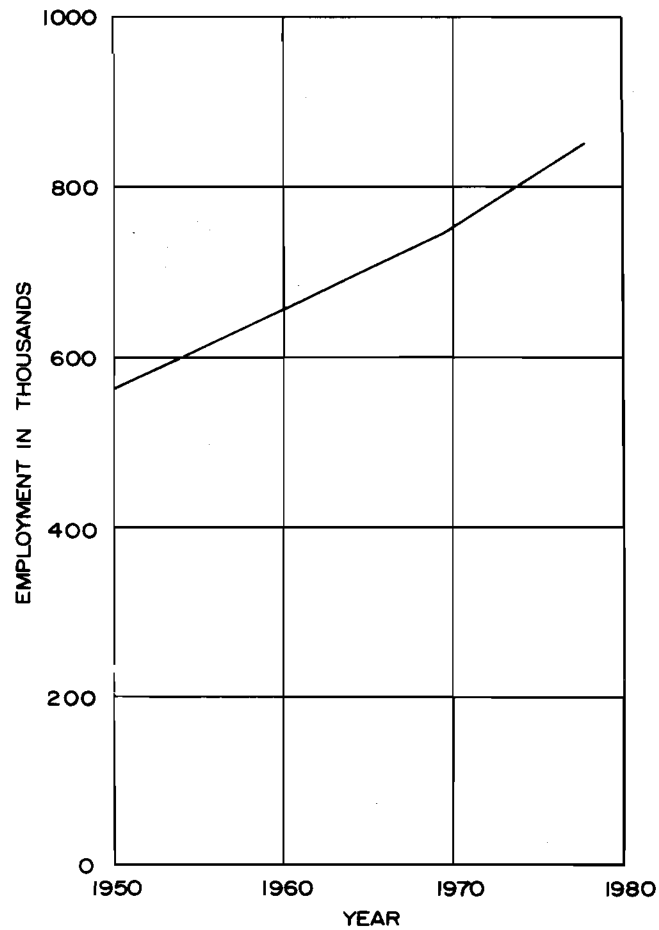
Between 1950 and 1970, the number of jobs in the Region increased by 188,900, or by 34 percent, over the 1950 level of 552,700 jobs, as shown in Figure 4 and Table 5. Between 1970 and 1978, the number of jobs increased by 110,200, or by 15 percent, over the 1970 level of 741,600 jobs, again despite the fact that the resident population increased by only 14,400 persons, or by about only 1 percent, over this same period.

Employment Distribution

Like population, jobs have shown a trend toward decentralization, as shown in Table 6. In 1950, 79 percent of the economic activity of the Region, as measured by jobs, was located in Milwaukee County. The proportion of the economic activity of the Region located in Milwaukee County had declined to 75 percent in 1960 and to 69 percent in 1970 and 66 percent in 1978. Waukesha County experienced the largest proportional regional increase in jobs—from 4 percent in 1950, to 5 percent in 1960, to 9 percent in 1970, and to about 11 percent in 1978. The number of jobs located in Milwaukee County, however, has continued to increase—from 438,100 jobs in 1950, to 486,200 jobs in 1960, to 510,900 jobs in 1970, and to 562,200 jobs in 1978, the attendant rates of increase being 11, 5, and 10 percent, respectively, for these periods.

Figure 4

REGIONAL EMPLOYMENT: 1950-1978



Source: SEWRPC.

Employment Characteristics

The structure of the regional economy has historically been, and continues to be, heavily concentrated in manufacturing, although this concentratioconcentration has diminished over time, as shown in Table 7. In 1950 about 246,000 jobs, or about 45 percent of the total jobs in the Region, were in manufacturing. By 1960 the number of manufacturing jobs had decreased to 276,000 jobs, or to 43 percent of the total regional

Table 5

EMPLOYMENT TRENDS IN THE REGION, WISCONSIN, AND THE UNITED STATES: SELECTED YEARS 1950-1978

County	Employment				Change 1950-1960		Change 1960-1970		Change 1970-1978	
	1950	1960	1970	1978	Absolute	Percent	Absolute	Percent	Absolute	Percent
Kenosha	27,700	40,100	39,200	44,500	12,400	44.8	- 900	- 2.2	5,300	13.5
Milwaukee	438,100	486,200	510,900	562,200	48,100	11.0	24,700	5.1	51,300	10.0
Ozaukee	6,200	9,500	17,900	23,800	3,300	53.2	8,400	88.4	5,900	33.0
Racine	43,200	48,500	61,900	74,800	5,300	12.3	13,400	27.6	12,900	20.1
Walworth	12,300	18,300	24,200	28,900	6,000	48.8	5,900	32.2	4,700	19.4
Washington	9,700	14,500	20,300	24,700	4,800	49.5	5,800	40.0	4,400	21.7
Waukesha	15,500	30,800	67,200	92,900	15,300	98.7	36,400	118.2	25,700	38.2
Region	552,700	647,900	741,600	851,800	95,200	17.2	93,700	14.5	110,200	14.9
Wisconsin	1,348,100	1,582,800	1,842,400	2,191,000	234,700	17.4	259,600	16.4	348,600	18.9
United States	58,911,000	65,798,500	78,662,000	94,373,000	6,887,500	11.7	12,863,500	19.5	15,711,000	20.0

Source: U. S. Department of Labor; Wisconsin Department of Industry, Labor and Human Relations; and SEWRPC.

Table 6

DISTRIBUTION OF JOBS IN THE REGION BY COUNTY: SELECTED YEARS 1960-1978

County	1950		1960		1970		1978		Change in Distribution (percent)			
	Jobs	Percent	Jobs	Percent	Jobs	Percent	Jobs	Percent	1950-1960	1960-1970	1950-1970	1970-1978
Kenosha	27,700	5.0	40,100	6.2	39,200	5.3	44,500	5.2	1.2	- 0.9	0.3	- 0.1
Milwaukee	438,100	79.3	486,200	75.0	510,900	68.9	562,200	66.0	- 4.3	- 6.1	- 10.4	- 2.9
Ozaukee	6,200	1.1	9,500	1.5	17,900	2.5	23,800	2.8	0.4	1.0	1.4	0.3
Racine	43,200	7.8	48,500	7.5	61,900	8.2	74,800	8.8	- 0.3	0.7	0.4	0.6
Walworth	12,300	2.2	18,300	2.8	24,200	3.3	28,900	3.4	0.6	0.5	1.1	0.1
Washington	9,700	1.8	14,500	2.2	20,300	2.7	24,700	2.9	0.4	0.5	0.9	0.2
Waukesha	19,500	2.8	30,800	4.8	67,200	9.1	92,900	10.9	2.0	4.3	6.3	1.8
Region	552,700	100.0	647,900	100.0	741,600	100.0	851,800	100.0	- -	- -	- -	- -

Source: U. S. Bureau of the Census; Wisconsin Department of Industry, Labor and Human Relations; and SEWRPC.

employment, and by 1970 to approximately 251,000 jobs, or to about 34 percent of the total. By 1978 the number of manufacturing jobs had increased slightly to 257,800, but as a proportion of total jobs had declined to about 30 percent.

In particular, private services and governmental services and education have grown in relative importance in the regional economy since 1950, along with wholesale and retail trade. The private services group has experienced a rapid growth in jobs, nearly doubling from 1960 to 1978, and by 1978 represented approximately 26 percent of total regional employment, as compared with 18 percent in 1960 and 14 percent in 1950. These changes being experienced in the economic structure of the Region are similar to changes being experienced in the national economy. Both nationally and regionally, the economy has become less manufacturing-oriented and more service-oriented.

NATURAL RESOURCES AND PUBLIC UTILITY BASE

Air Pollution

Air pollution problems exist in the highly developed portions of the Region, particularly in the central areas of the Region's three largest cities: Kenosha, Milwaukee, and Racine. Atmospheric levels of carbon monoxide, particulate matter, sulphur dioxide, and hydrocarbons and ozone approach, and at times exceed, the national ambient air quality standards established by the U. S. Environmental Protection Agency. This air

Table 7

REGIONAL EMPLOYMENT BY MAJOR EMPLOYMENT CATEGORY: 1960-1978

Major Industry Group	1960		1970		1978	
	Employment	Percent of Total Employment	Employment	Percent of Total Employment	Employment	Percent of Total Employment
Agriculture	12,900	2.0	10,600	1.4	9,500	1.1
Construction and Mining	28,800	4.4	24,000	3.2	28,600	3.4
Manufacturing						
Food and Kindred Products	21,300	3.3	18,900	2.5	20,500	2.4
Printing and Publishing	13,800	2.1	14,900	2.0	14,500	1.7
Primary Metals	19,400	3.0	22,500	3.0	17,600	2.1
Fabricated Metals	18,300	2.8	24,600	3.3	32,700	3.8
Nonelectrical Machinery	58,800	9.1	68,100	9.2	73,800	8.7
Electrical Equipment	40,900	6.3	36,500	4.9	37,300	4.4
Transportation Equipment	33,400	5.1	22,000	3.0	20,500	2.4
Other Manufacturing	70,700	10.9	43,500	5.9	40,900	4.8
Manufacturing Subtotal	276,600	42.7	251,000	33.8	257,800	30.3
Wholesale Trade	18,700	2.9	32,000	4.3	39,200	4.6
Retail Trade	90,200	13.9	111,200	15.0	124,600	14.6
Transportation, Communication, and Utilities	35,100	5.5	36,000	4.9	37,300	4.4
Finance, Insurance, and Real Estate	23,000	3.5	31,200	4.3	36,800	4.3
Private Services[a]	114,500	17.7	166,900	22.5	223,400	26.2
Government Services and Education	48,100	7.4	78,700	10.6	94,600	11.1
Total Employment	647,900	100.0	741,600	100.0	851,800	100.0

[a] *Includes the self-employed and domestic household workers.*

Source: Wisconsin Department of Industry, Labor and Human Relations; and SEWRPC.

pollution is the result of commercial and industrial activities, transportation movements, waste burning, power generation, and space heating. The recently completed regional air quality attainment and maintenance plan recommends short- and long-term improvements in regional public transit service to help achieve the ambient air quality standards for carbon monoxide and hydrocarbon/ozone.

Climate

The Region's mid-continent location, far removed from the moderating effect of the oceans, gives it a typical continental-type climate characterized primarily by a continuous progression of markedly different seasons and a large range temperature over the year. Low temperatures during the winters are accentuated by prevailing cold northwesterly winds; while high temperatures during the summers are reinforced by the warm southwesterly winds common during that season.

Total precipitation in the Region averages 2.5 inches per month, ranging from a low of 1.3 inches in February to a high of 3.9 inches in June. The greatest amount of snow and sleet—an average of 11.9 inches—is received during the month of January. From December through March, an average of eight inches of snow and sleet is received per month. Snow cover in the Milwaukee area is most likely during the months of December, January, and February. The climate, and particularly its severe winter aspects, has important implications for the design, operation, maintenance, and use of transit facilities.

Soils

The highly complex soil pattern of the Region, marked by extreme variability and intermingling of soils, together with the widespread occurrence of soils poorly suited for urban development, indicates a continuing need for basing regional and local development plans on the results of detailed soil surveys. About one-fourth of the total area of the Region is covered by soils poorly suited for urban development, even with public sanitary sewer service, while about 60 percent of the Region is covered by soils poorly suited for residential development utilizing conventional onsite sewage disposal systems. Transportation system planning should seek to encourage intensive urban development only in areas covered by soils suitable for such use, and should seek to discourage nonagricultural uses of prime agricultural lands.

Recently, state-supported research has resulted in the development of new onsite soil absorption sewage disposal systems designed to overcome natural soil limitations with respect to permeability, high groundwater tables, and shallow bedrock. These new systems utilize mechanical facilities to pump septic tank effluent through a distribution system placed in fill on top of the natural soil. Should the use of these new systems be permitted by the State on a widespread basis in future years, soil limitations for onsite sewage disposal would no longer serve as a constraint on regional settlement patterns, thereby permitting substantial additional areas of the Region to be developed for urban use without centralized sanitary sewerage systems.

Water Quality

Stream water quality has been markedly deteriorated by human activities within the Region, and evidence of persistently severe stream and inland lake pollution is found in all of the 11 watersheds of the Region. Deteriorated surface water quality in turn impairs or negates the aesthetic and recreational water uses sought by an expanding segment of the Region's population. Based upon an examination of stream sampling data collected since 1963, it is apparent that stream water quality conditions have neither markedly improved nor deteriorated since that time, despite significant urban growth and development. It would appear, therefore, that efforts over the past decade to improve stream water quality have had a positive effect, since it is logical to assume that without such efforts stream water quality would have continued to deteriorate. Failure to adjust land use and transportation system development patterns to reflect the point and nonpoint source water pollution abatement needs of the Region can, however, be expected to lead to a further deterioration of surface water and groundwater quality conditions.

Woodlands

Woodlands assist in maintaining a unique natural relationship between plants and animals, reduce storm water runoff, contribute to atmospheric oxygen and water supply, aid in reducing soil erosion and stream sedimentation, provide the resource base for the forest product industries, and provide valuable recreational opportunities as well as a desirable aesthetic setting for attractive rural and urban development. In 1970 woodlands in the Region covered a total combined area of about 125,300 acres, or approximately 7 percent of the total area of the Region. Over 91,700 acres, or 73 percent of the total, were located in Walworth, Washington, and Waukesha Counties. Milwaukee County, had the smallest amount of woodlands of any county in the Region, about 3,200 acres.

Wetlands

Wetlands constitute a valuable recreational resource; support a wide variety of desirable forms of plant and animal life; assist in reducing storm water runoff, stablilizing streamflows, and enhancing stream water quality; function as nutrient and sediment traps; and provide aesthetically pleasing vistas on the landscape. In 1970 water and wetlands areas covered about 180,800 acres of the Region, or about 10 percent of the area of the Region, with over 124,500 acres, or 69 percent, being located in Walworth, Washington, and Waukesha Counties.

Wildlife Habitat

Wildlife habitat areas provide an important recreational resource, aid in controlling harmful insects and other noxious pests, and are a valuable aesthetic asset to southeastern Wisconsin. Wildlife habitat areas may be expected to change over time, such areas being both destroyed by urban development and created through reforestation, construction of impoundments and wetland areas, and the restoration of lands formerly used for agriculture to "natural" uses. In 1970 wildlife habitat areas covered approximately 259,800 acres, or 15 percent of the total area of the Region. Over 192,500 acres, or 74 percent of the wildlife habitat, were located in Walworth, Washington, and Waukesha Counties.

Outdoor Recreation Sites

In 1973 there were 1,348 public and nonpublic outdoor recreation sites with a combined total area of nearly 56,000 acres in the Region. In addition to providing recreational facilities, publicly owned sites permanently reserve lands for public use. The 787 publicly owned sites identified in 1973 totaled

29,140 acres in area. Almost half of the total sites are city-owned, and over two-thirds of the total acreage is county-owned. Milwaukee County alone owns 13,786 acres of park and related open space land, or about 47 percent of all publicly owned acreage in the Region.

Environmental Corridors

The most important elements of the underlying and sustaining regional natural resource base, including the best remaining woodlands; wetlands; surface water and associated undeveloped shorelands and floodlands; wet or poorly drained soils; wildlife habitat; significant topography and geologic formations; groundwater recharge areas; and historic, scenic, and scientific sites, are found to occur in essentially linear patterns. These patterns have been termed by the Commission "environmental corridors." Such corridors occupy a total area of about 534 square miles, or 20 percent of the total area of the Region. The preservation and protection of these corridors will do much not only to maintain a good environment for life within the Region, but also to preserve the unique cultural and natural heritage and natural beauty of the Region. Failure to properly adjust land use development to these environmental corridors and to prevent the intrusion of intensive urban development into the corridors will inevitably result in the loss of the best remaining potential park and related open space sites, the deterioration or destruction of the best remaining wildlife habitat, the destruction of significant physiographic and geologic formations, the loss of water impoundment areas and reduction of groundwater recharge areas, the loss of the best remaining woodlands, the continued deterioration of surface water and groundwater quality within the Region, and increasing flood damages.

From 1963 to 1970, about 4,000 acres of primary environmental corridor land, or about 1 percent of the total corridor area, were lost to urban development—particularly residential development, which increased by about 3,000 acres in the corridors. Significant steps have been taken, however, by the state and local units of government toward permanent preservation of the primary environmental corridor lands as recommended in the adopted regional land use plan. By 1970, about 202 square miles, or about 38 percent of the total corridor area, were considered to be permanently preserved by virture of either public ownership for park use or protective floodland zoning. An additional 73 square miles of corridor, representing nearly an additional 14 percent of the total corridor area, were considered to be temporarily preserved through private park development or through such tools as conservancy and park zoning, exclusive agricultural zoning, and country estate zoning.

Subcontinental Divide

A subcontinental divide traverses the Region in a generally northwesterly-southeasterly direction and separates the Region into two major drainage areas: one flowing in an easterly direction and discharging into Lake Michigan, a part of the Great Lakes-St. Lawrence River drainage system; and one draining in a generally south and southwesterly direction, a part of the Mississippi River drainage system. This major geographic feature is of great importance to any consideration of water-related public utility systems within the Region. Numerous small streams and rivers which traverse the Region west of this divide all have relatively limited upstream drainage areas and relatively low flows during dry weather. Consequently, the capacities of these streams for liquid waste disposal and assimilation are severely limited. Pollution loads transmitted to these rivers must be carefully adjusted to the dry weather waste assimilation capacities of the rivers if serious environmental problems are to be avoided and multiple use of the streams permitted. The problem of waste disposal in the area west of the divide is further aggravated by soil conditions in that a relatively high percentage of the area is covered by soils unsuitable for conventional septic tank soil absorption sewage disposal systems.

Sanitary Sewers

Public utility systems are one of the most important and permanent elements of urban growth and development. Of particular importance to regional development is centralized sanitary sewerage. In 1975, centralized sanitary sewer service was provided to about 353 square miles, or about 13 percent of the total area of the Region. About 1.54 million persons in the Region, or about 86 percent of the total population of the Region, were served by public sanitary sewers in 1975.

Water Resources

The Region is unique with respect to water resources in that there are four principal natural sources of supply: surface water east of the subcontinental divide as provided primarily by Lake Michigan; surface water west of the subcontinental divide as provided by the inland streams and lakes; shallow groundwater in the glacial till and connected limestone aquifers; and groundwater in the generally deep sandstone aquifer. Urban development in the Region east of the subcontinental divide can readily utilize both Lake Michigan and the groundwater aquifers as a source of supply, but urban development west of that divide must depend primarily upon the two groundwater aquifers. Plans which influence the regional settlement pattern, as well as plans for water supply development within the Region, should recognize this important fact.

LAND USE

Historic Urban Growth

From 1850 to 1950, urban development within the Region occurred in a fairly compact pattern, forming concentric rings of relatively high-density urban development contiguous to, and outward from, the existing urban areas, as shown on Map 2. The form and structure of urban development in the Region, however, changed dramatically after 1950, with such development occurring since then in a highly diffused pattern at relatively low densities and marked by a proliferation of noncontiguous clusters of urban and suburban development.

Urban Population Density

Urban population density within the Region peaked in 1920, when the overall population density of the developed urban area of the Region was over 11,300 persons per square mile. Since 1920 urban population density in the Region has declined as a result of changes in the pattern of urban development. This decline in population density was greatest between 1950 and 1963, when the overall population density of the developed urban area of the Region declined from 8,544 persons per square mile to 4,807 persons per square mile. The annual decline in urban population density from 1950 to 1963 approximated 3 percent, or about 288 persons per square mile per year.

This trend of decline in urban population density continued from 1963 to 1970, as the population density of the developed area of the Region decreased to 4,355 persons per square mile. The annual rate of decline in population density, however, slowed during this time period to about 1 percent, or about 65 persons per square mile per year.

It appears that this trend of declining urban population density in the Region has slowed somewhat since 1970. The only decline in urban density within the Region in this most recent period has occurred in Milwaukee County, which has continued to experience both a decline in population and an increase in urban land. Urban population densities within the other six counties of the Region are estimated to have remained basically unchanged since 1970.

Urban Land Use Distribution by Type

In 1970 urban land use in the Region accounted for nearly 19 percent of the total regional land area, as shown in Table 8. Residential uses occupied the greatest portion of this urban land use, accounting for approximately 156,266 acres, or 9 percent of the total area of the Region and 48 percent of the developed urban area of the Region. Land uses for transportation, communication, and utilities accounted for 109,407 acres, or 6 percent of the total area and 33 percent of the developed urban area of the Region. Total land area devoted to commercial and industrial uses amounted to only 16,566 acres, or 1 percent of the total area of the Region and 5 percent of the developed urban area, yet supported over 80 percent of the jobs in the Region. Governmental and institutional land uses accounted for 16,618 acres, or 5 percent of the total urban area of the Region. Recreational land uses accounted for 28,996 acres, or 2 percent of the total area of the Region. Approximately 1.4 million acres, or the remaining 81 percent of the total area of the Region, were devoted to nonurban land uses in 1970, including 1.0 million acres in agricultural use.

Recent Changes in Land Use

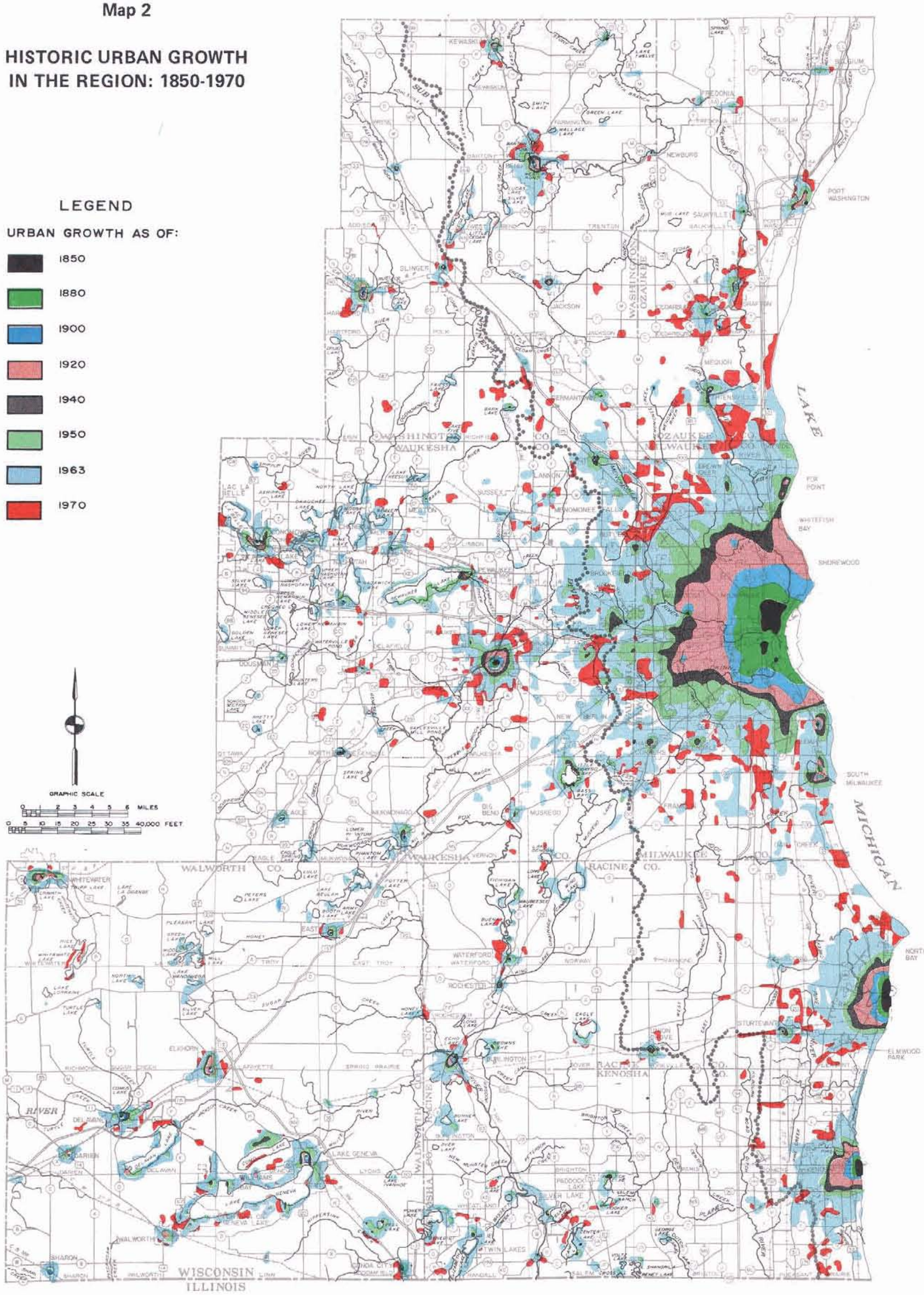
Between 1970 and 1978, a total of 29,500 acres of land in the Region, or about 46 square miles, were platted for future residential use, as shown on Map 3 and in Table 9. This development activity created 35,745 lots, of which 25,002, or 70 percent, were proposed to be provided with centralized sanitary sewer service. In Milwaukee County, almost 3,000 acres of land were platted for future residential use. Virtually all of these lands were proposed to be sewered, and most of the proposed subdivisions were located in the extreme northern and southern portions of the County.

TRAVEL HABITS AND PATTERNS

Personal travel is an orderly, regular, and measurable occurrence, evidenced by recognizable travel patterns. Recognition of those patterns and travel aspects which demonstrate a high degree of repetitiveness is a prerequisite to an understanding of probable future personal travel behavior and, con-

Map 2

HISTORIC URBAN GROWTH IN THE REGION: 1850-1970



Urban development within the Region occurred in a fairly dense and compact pattern until about 1950, with new urban development occurring at relatively high densities in concentric rings contiguous to, and outward from, the existing urban areas and long-established mass transit, utility, and community facility systems. Soon after World War II, however, the character of urban growth in the Region began to change to a much more diffused pattern of development, with relatively low densities and widespread proliferation of clusters of noncontiguous development. Between 1963 and 1970, 57 square miles of land were converted from rural to urban use within the Region, a rate of approximately eight square miles per year. The continuation of this sprawl pattern of land use development threatens further destruction of prime agricultural lands and the creation of scattered enclaves of urban development in otherwise rural areas that will be difficult to serve economically, if at all, with necessary public utilities and services, including mass transit services.

Source: SEWRPC.

Table 8

DISTRIBUTION OF EXISTING LAND USE BY TYPE: 1970

County	Urban Land Use															
	Residential[a]		Commercial		Industrial[b]		Transportation[c]		Governmental[d]		Recreation		Total Urban Land Use	
	Acres	Percent of Total Area	Acres	Percent of Total Area	Acres	Percent of Total Area	Acres	Percent of Total Area	Acres	Percent of Total Area	Acres	Percent of Total Area	Acres	Percent
Kenosha	13,477	7.4	504	0.3	811	0.5	8,927	5.0	1,324	0.7	2,672	1.5	27,715	15.5
Milwaukee	45,632	29.4	2,875	1.9	4,899	3.2	35,431	22.9	7,490	4.8	9,924	6.4	106,251	68.6
Ozaukee	12,321	8.2	330	0.2	444	0.3	8,054	5.4	940	0.6	1,657	1.1	23,746	15.8
Racine	16,625	7.6	575	0.3	1,099	0.5	12,442	5.7	1,744	0.8	2,585	1.2	35,070	16.1
Walworth	13,408	3.6	593	0.2	827	0.2	12,020	3.3	1,192	0.3	4,275	1.2	32,215	8.8
Washington	11,525	4.1	299	0.1	434	0.2	11,286	4.1	919	0.3	1,664	0.6	26,127	9.4
Waukesha	43,278	11.6	1,341	0.4	1,525	0.4	21,247	5.7	3,009	0.8	6,219	1.7	76,619	19.6
Region	156,266	9.1	6,517	0.4	10,039	0.6	109,407	6.3	16,618	1.0	28,296	1.7	327,143	19.1

County	Rural Land Use							
	Agriculture		Open Lands[e]		Total Rural Land Use		Total Land Use	
	Acres	Percent of Total Area	Acres	Percent of Total Area	Acres	Percent	Acres	Percent of Total
Kenosha	113,930	64.0	36,455	20.5	150,385	84.5	178,100	100.0
Milwaukee	28,607	18.4	20,206	13.0	48,813	31.4	155,064	100.0
Ozaukee	100,491	67.0	25,776	17.2	126,237	84.2	150,013	100.0
Racine	147,207	67.7	35,284	16.2	182,491	83.9	217,561	100.0
Walworth	261,744	70.8	75,923	20.4	337,367	91.2	369,982	100.0
Washington	186,466	66.9	66,141	23.7	252,607	90.6	278,734	100.0
Waukesha	201,676	54.3	93,351	25.1	295,027	79.4	371,646	100.0
Region	1,040,121	60.4	353,136	20.5	1,393,257	80.9	1,721,100	100.0

[a] *Includes all residential area, developed and under development.*

[b] *Includes all manufacturing, wholesaling, and storage.*

[c] *Includes off-street parking areas of more than 10 spaces.*

[d] *Includes institutional lands.*

[e] *Includes woodlands, quarries, and water and wetlands, as well as other open lands.*

Source: SEWRPC.

sequently, to sound transportation planning under the Milwaukee area primary transit system alternatives analysis.[1]

Certain travel habits and patterns bear special significance for primary transit planning, including the quantity, purpose, mode, and time of day in which travel occurs. A basic understanding of these characteristics of travel behavior is essential to the consideration of future alternative primary transit system plans in this study. Existing and historical trends in travel habits and patterns help to identify the trips which primary transit in the Milwaukee area may be expected to serve, and provide an indication of the degree of change in modal choice that development of a primary transit system can be reasonably expected to bring about.

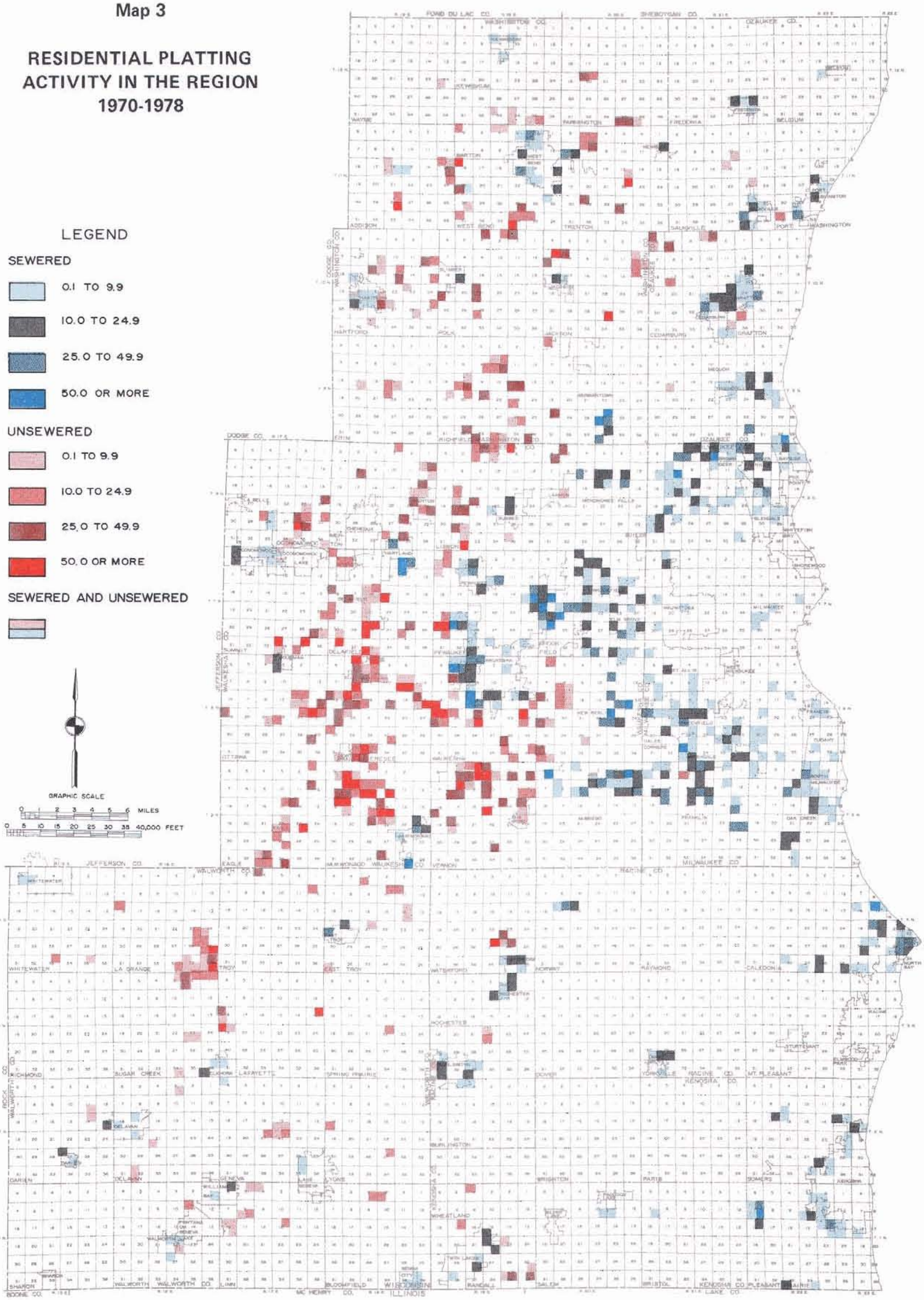
Quantity of Travel

On an average weekday in 1972, nearly 4.5 million person trips and 3.4 million vehicle trips were made within southeastern Wisconsin by residents

[1] *It should be noted that, although the findings of the Commission's regional inventory of travel conducted in the year 1972 are presented in this chapter, along with comparisons of the findings of this inventory with those of a similar inventory conducted in the year 1963, travel habits and patterns of the Region for the current year, as well as for any future year, can be simulated using the Commission's existing battery of travel simulation models, given estimates or forecasts, as appropriate, of demographic, economic, and land use activity within the Region for the appropriate year.*

Map 3

RESIDENTIAL PLATTING ACTIVITY IN THE REGION 1970-1978



Of the seven counties in the Region, the highest level of residential subdivision platting activity between 1970 and 1978 occurred in Waukesha County, where almost 16,400 acres of land were platted for residential development. The platting activity in Washington County, 4,000 acres between 1970 and 1978, was widely scattered throughout the County. In Milwaukee County, almost 3,000 acres of land were platted for future residential use. Subdivisions platted in Milwaukee County were typically small in area, reflecting the fact that many subdivisions are of an "in-fill" nature, providing for the development of the remaining parcels of vacant land within a highly developed urban area. Within Walworth County, more than 1,800 acres were platted. In Ozaukee County, the residential platting activity was primarily centered on existing municipalities. In Kenosha County, about 800 acres of residential development were platted, principally around the fringes of the City of Kenosha. In Racine County, about 1,500 acres of residential development were platted on the northern fringe of the City of Racine. It may be concluded from this map that the development of lands platted between 1970 and 1978 will contribute to the proliferation of scattered unsewered residential development throughout much of the Region.

Source: SEWRPC.

Table 9

RESIDENTIAL PLATTING ACTIVITY IN THE REGION BY COUNTY: 1970-1978

County	Total Subdivisions 1970-1978			Subdivision Area 1970-1978[a]						Total Lots					
				Sewered		Unsewered		Total		Sewered		Unsewered		Total	
	Sewered	Unsewered	Total	Acres	Percent	Acres	Percent	Acres	Percent	Number	Percent	Number	Percent	Number	Percent
Kenosha	64	8	72	809	81	185	19	994	100	1,957	92	160	8	2,117	100
Milwaukee . . .	249	3	252	2,951	99	40	1	2,991	100	6,292	99	76	1	6,368	100
Ozaukee	73	10	83	979	73	355	27	1,334	100	1,847	91	193	9	2,040	100
Racine	97	7	104	1,532	86	237	14	1,769	100	3,153	94	191	6	3,344	100
Walworth. . . .	30	54	84	275	15	1,560	85	1,835	100	622	37	1,065	63	1,687	100
Washington . .	51	94	145	832	20	3,347	80	4,179	100	1,960	49	2,017	51	3,977	100
Waukesha . . .	182	225	407	5,074	31	11,319	69	16,393	100	9,171	57	7,041	43	16,212	100
Region	746	401	1,147	12,452	42	17,043	58	29,495	100	25,002	70	10,743	30	35,745	100

[a] *Includes all residential subdivision acreage, including local streets, utilities, and open space.*

Source: SEWRPC.

of the Region, an increase of 25 percent over the 3.6 million person trips made within the Region on an average weekday in 1963. The number of person trips made on an average weekday increased from 2.2 trips per capita in 1963 to 2.5 trips per capita in 1972, and from 7.3 to 7.9 trips per household. Part of this increase in tripmaking can be attributed to the increases in automobile availability and personal income within the Region over that time period. The amount of tripmaking by people in a household is strongly correlated to the number of automobiles available to the household, the income level of the household, and the number of people in the household.

Mode of Travel

Internal trips within the Region were made principally by private automobiles in 1972. Automobile driver trips alone accounted for 64 percent of total internal travel in 1972, as compared with 60 percent in 1963; while auto passenger trips accounted for an additional 27 percent of the total in 1972, the same as in 1963. Of the remaining modes, public transit trips accounted for 4 percent of total travel in 1972 as compared with 13 percent in 1963; school bus trips for 4 percent in 1972 as compared with 3 percent in 1963; and trips by all other modes together (taxi and truck passenger trips and motorcycle trips) for less than 0.5 percent in 1972, as compared with 1 percent in 1963. Transit usage was found to be highest in trips made to the Milwaukee central business district (CBD) in 1972, where 22 percent of all trips entering, leaving, or made within the area were made on public transit. This compares with 37 percent of all CBD travel in 1963.

While the substantial overall increases in tripmaking from 1963 to 1972 were found to be accompanied by sharp declines in public transit use, there are indications that this decline has stabilized or reversed. In the Milwaukee urbanized area, transit ridership declined from 90 million revenue passengers in 1963 to 52 million in 1972, or from 84 to 50 rides per capita. Since then, however, only slight declines were recorded, and in 1977 an estimated 48.5 million revenue passengers were served, equivalent to about 51 rides per capita. Total transit ridership in the Milwaukee area increased between 1977 and 1978 to 52.6 million trips per year, if the 1978 estimated ridership is adjusted to discount the effects of a two-month transit strike. In the Racine and Kenosha urbanized areas, the pattern of sharp decline in transit ridership also appears to have been reversed.

Purpose of Travel

Trips having either an origin or destination at home constituted over 80 percent of total internal travel in the Region in both 1963 and 1972. Next in importance were trips to work, which accounted for 16 percent of total internal travel in 1972 and 18 percent in 1963. The remaining trip purposes, including personal business, shopping, social-recreational, and trips to attend school, accounted for 43 percent of total internal travel in 1972 and 41 percent in 1963. It is apparent that future travel facility and service requirements within the Region will be determined largely by the amount and location of future residential development. Also important will be the principal areas to which these trips are attracted for work, shopping, and other purposes. These trip destinations are largely concentrated in the Milwaukee central business district and in the major industrial, institutional, and commercial centers located throughout the Milwaukee area and, to a lesser extent, in the central business districts and industrial and commercial centers of the other large cities of the Region.

Time Pattern of Travel

The hourly distributional patterns of internal travel indicate that the timing of travel during the day remained quite similar between 1963 and 1972, both in the proportion and times of peak periods and in the proportion of trips by trip purpose during given time periods (see Figures 5 and 6). Of the morning and evening peak-hour movements, trips to and from work comprised 44 percent of the total in 1972 and 47 percent in 1963. Meeting this peaked demand for trips to and from work is one of the primary transportation problems within the Region.

EXISTING TRANSPORTATION FACILITIES AND SERVICES

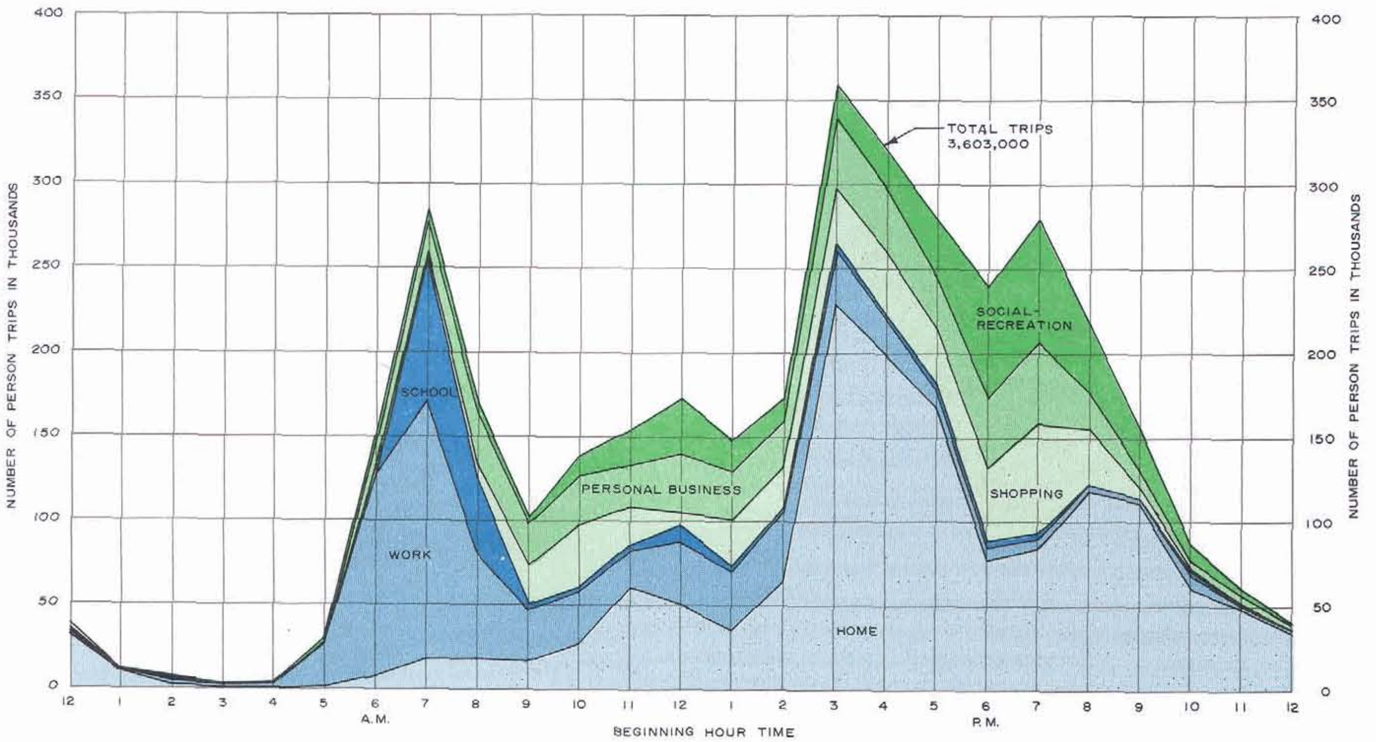
Any transportation system planning effort must include an examination of the supply of, as well as of the demand for, transportation facilities and services. The examination of demand is achieved through travel inventories and travel simulation model studies, while the examination of supply is achieved through an inventory of the location, capacity, and use of the existing transportation system. Location, capacity, and utilization inventories are necessary to establish the characteristics of the existing transportation system so that its existing and future deficiencies can be determined and used to guide primary transit system plan preparation, testing, and evaluation.

Arterial Street System

In 1978 the entire street and highway system of the Region was composed of 10,440 miles of facilities. Of this total, 3,290 miles, or 32 percent, were classified by primary function as arterials, and the remaining 7,150 miles, or 68 percent, were classified as collector and land access streets. Freeways comprised about 7 percent of the total arterial mileage. Between 1963 and 1978 total street and highway mileage within the Region increased by 1,606 miles, or by about 18 percent; arterial street mileage increased by 347 miles, or about 12 percent; and freeway mileage increased by 176 miles, or over 300 percent.

Figure 5

HOURLY VARIATION OF AVERAGE WEEKDAY INTERNAL PERSON TRIPS IN THE REGION BY TRIP PURPOSE AT DESTINATION: 1963



Source: SEWRPC.

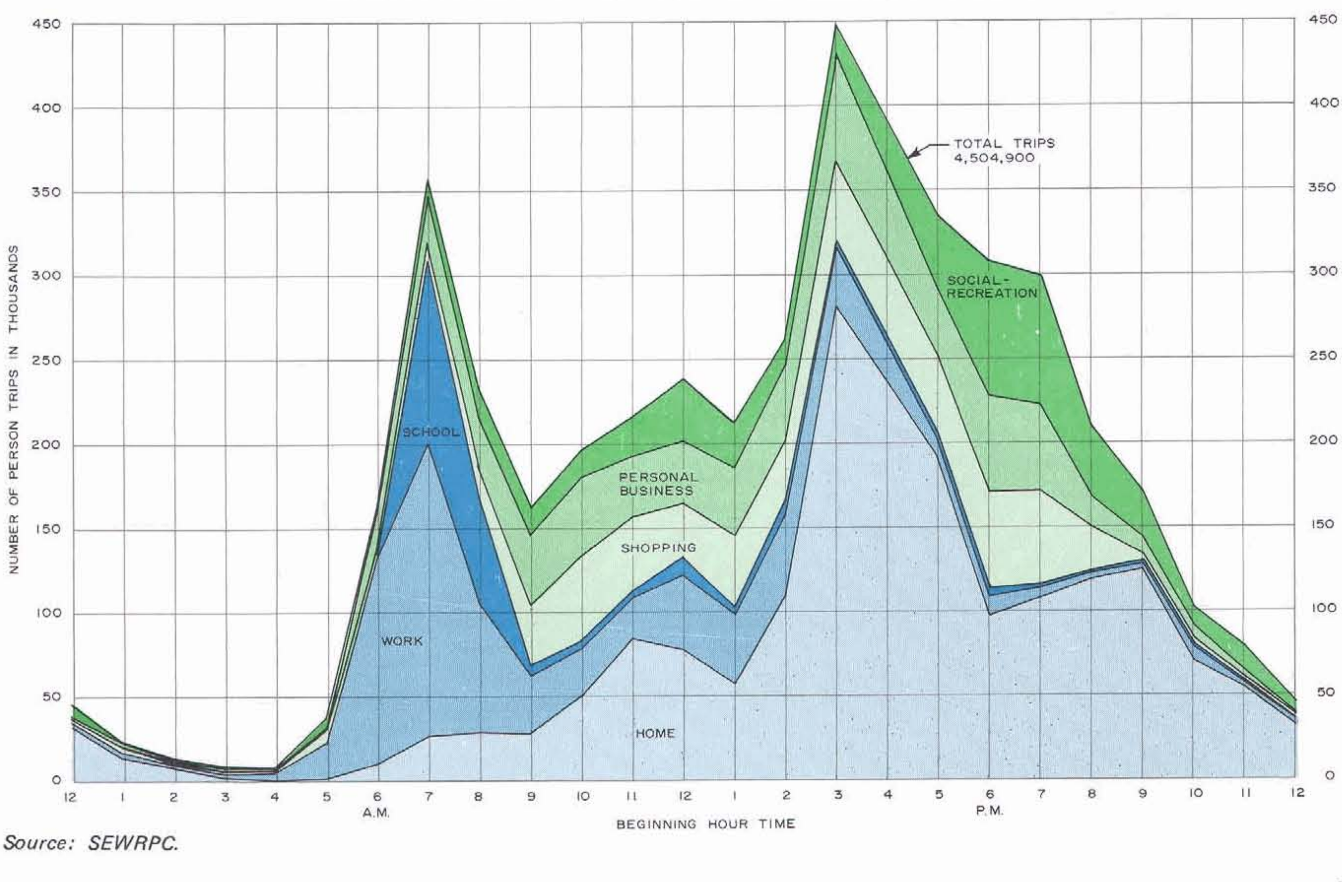
Freeways and expressways, while comprising less than 7 percent of the arterial street and highway mileage in 1972, carried approximately 31 percent of the total arterial travel in that year. As measured by the continuing traffic counting programs conducted by the Wisconsin Department of Transportation and the City of Milwaukee, freeway utilization in Milwaukee County increased, in some cases substantially, between 1972 and 1978, as shown on Map 4. Substantial increases in standard arterial street and highway traffic volumes between 1972 and 1978 primarily occurred on facilities in the outlying areas of Milwaukee County. However, minor decreases in traffic volumes have been observed recently on some freeway facilities and on some arterial streets in central parts of Milwaukee County.

In 1972 about 5 percent of the arterial street mileage of the Region was operating over design capacity. About two-thirds of this arterial system mileage was located in the three urbanized counties of the Region: Milwaukee, Racine, and Kenosha[2] (see Map 5). Of the arterial mileage in Milwaukee County, 8 percent was operating over design capacity in 1972.

[2] *An arterial facility operating at its design capacity experiences some constraints on speed and lane changing, and some delays behind turning vehicles at controlled intersections. An arterial facility operating over its design capacity experiences continuous speed and maneuvering restrictions, momentary stoppages, necessary speed changes, and backups and delays behind turning vehicles at intersections for more than one traffic signal cycle. Traffic breakdowns can occur at any time on arterial facilities operating over design capacity, particularly when any abberration on the facility occurs, such as inclement weather conditions or an accident or maintenance operation. Traffic breakdown conditions include traffic delays of more than one signal cycle at controlled intersections, frequent traffic stoppages, and substantially lowered speeds.*

Figure 6

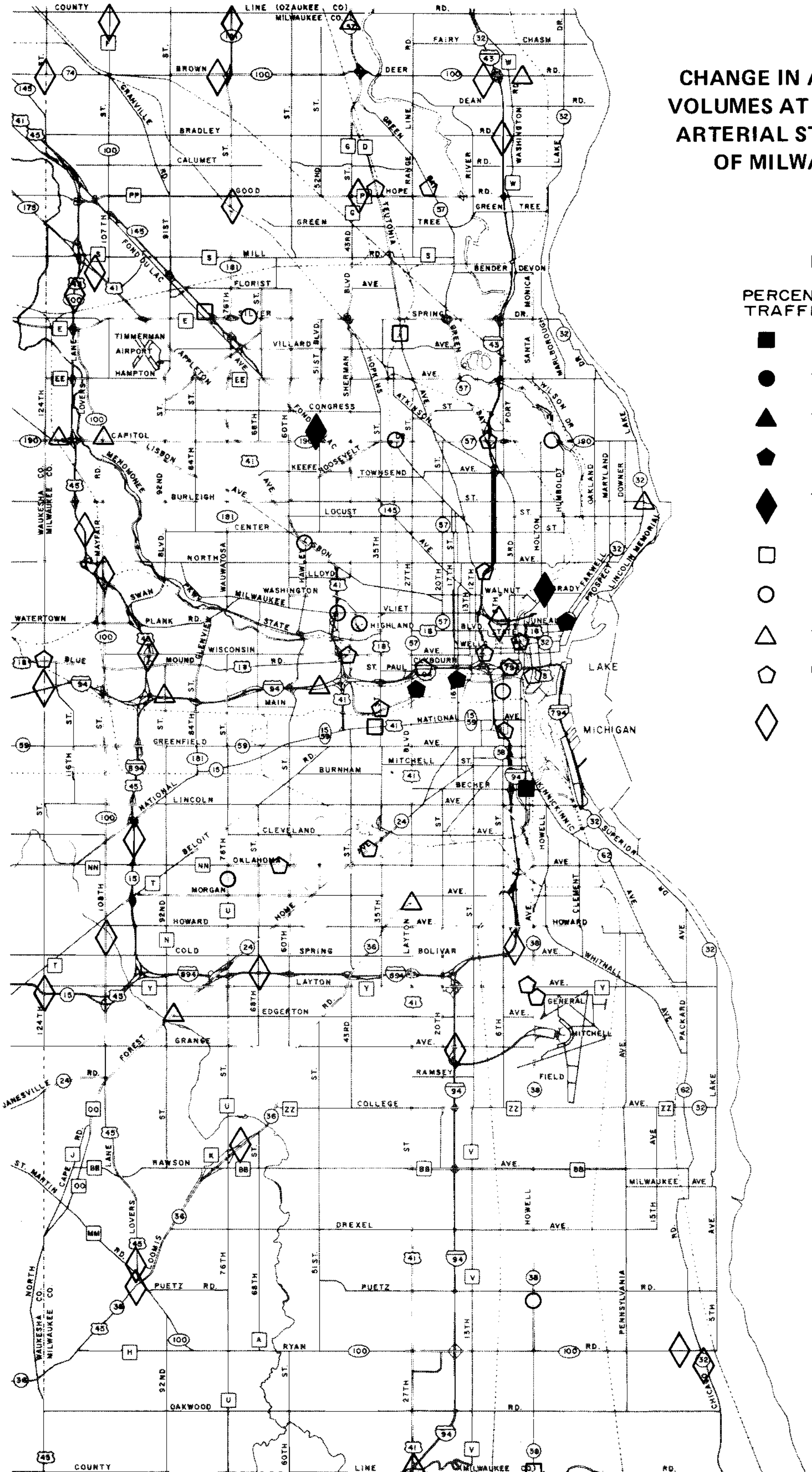
HOURLY VARIATION OF AVERAGE WEEKDAY INTERNAL PERSON TRIPS IN THE REGION BY TRIP PURPOSE AT DESTINATION: 1972



Source: SEWRPC.

Map 4

CHANGE IN AVERAGE WEEKDAY TRAFFIC VOLUMES AT SELECTED LOCATIONS OF THE ARTERIAL STREET AND HIGHWAY SYSTEM OF MILWAUKEE COUNTY: 1972-1978

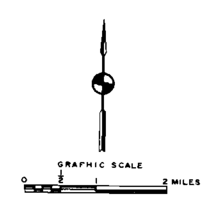


1972–1978

LEGEND

PERCENT CHANGE IN AVERAGE WEEKDAY TRAFFIC VOLUMES:

- ■ LESS THAN -20.1
- ● -10.1 TO -20.0
- ▲ -6.1 TO -10.0
- ⬟ -2.1 TO - 6.0
- ◆ -0.1 TO - 2.0
- □ 0.0 TO 2.0
- ○ 2.1 TO 6.0
- △ 6.1 TO 10.0
- ⬠ 10.1 TO 20.1
- ◇ GREATER THAN 20.1



Freeways and expressways, while constituting less than 7 percent of the arterial street and highway mileage in 1972, carried approximately 31 percent of the total arterial travel. As measured by traffic counting programs conducted by the Wisconsin Department of Transportation and the City of Milwaukee, travel on freeways and expressways in Milwaukee County increased between 1972 and 1978. General increases in standard arterial street and highway traffic volumes between 1972 and 1978 were also observed. Substantial increases in standard arterial volumes occurred in outlying portions of Milwaukee County, as shown above.

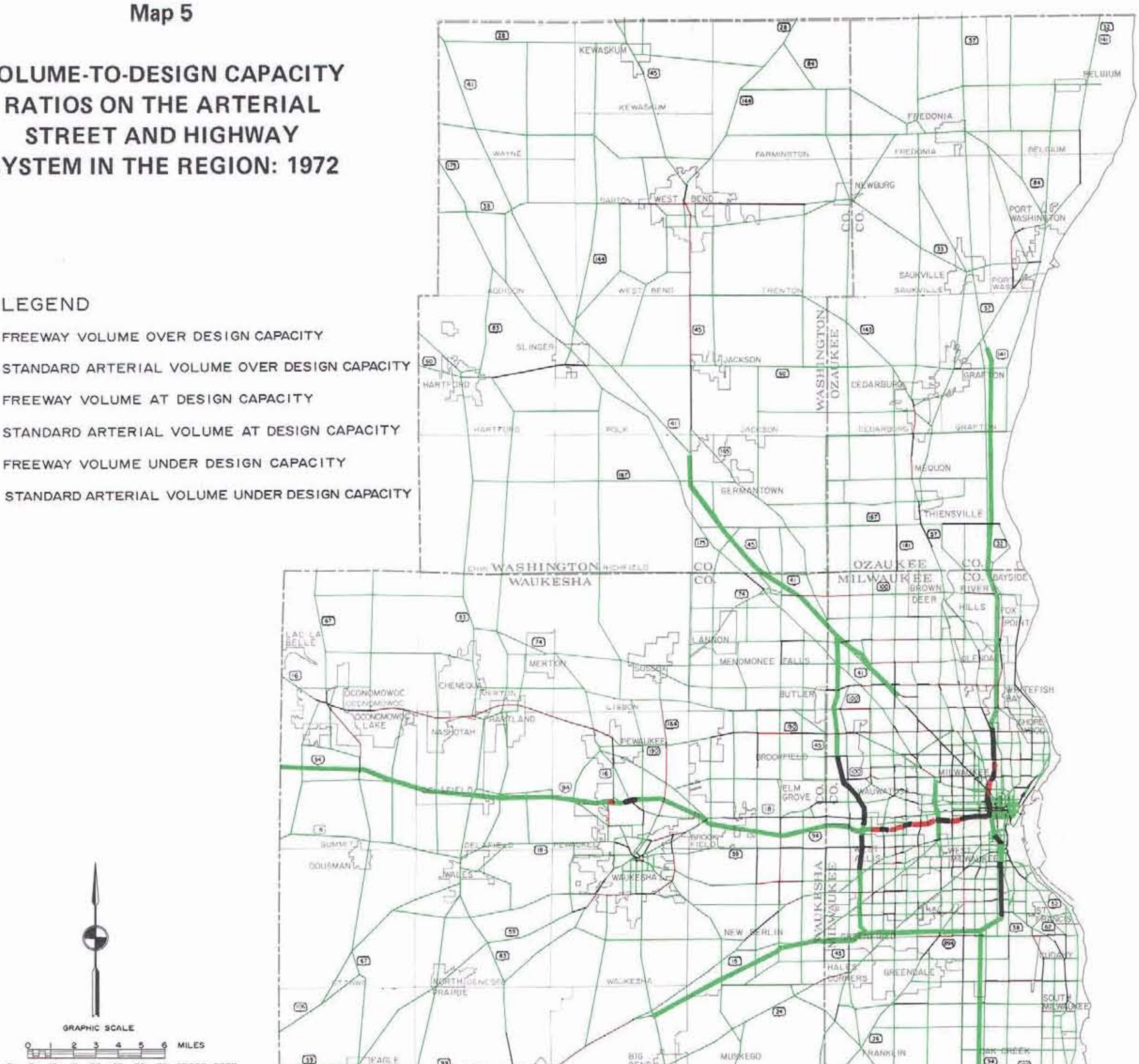
Source: SEWRPC.

Map 5

VOLUME-TO-DESIGN CAPACITY RATIOS ON THE ARTERIAL STREET AND HIGHWAY SYSTEM IN THE REGION: 1972

LEGEND

- FREEWAY VOLUME OVER DESIGN CAPACITY
- STANDARD ARTERIAL VOLUME OVER DESIGN CAPACITY
- FREEWAY VOLUME AT DESIGN CAPACITY
- STANDARD ARTERIAL VOLUME AT DESIGN CAPACITY
- FREEWAY VOLUME UNDER DESIGN CAPACITY
- STANDARD ARTERIAL VOLUME UNDER DESIGN CAPACITY



By 1972 the development of the regional freeway system had significantly altered traffic flow patterns and conditions within the Region. In the Milaukee area, congestion on many important surface arterials, such as W. National Avenue, S. 27th Street, Bluemound Road, STH 100, W. Fond du Lac Avenue, W. Appleton Avenue, and N. Port Washington Road, had been relieved by the construction of freeway facilities. The overwhelming majority of this congested arterial mileage—87 percent—is located in the Milwaukee, Racine, and Kenosha urbanized areas. In Milwaukee County about 17 percent of the arterial system was operating at or over design capacity, as compared to 25 percent of the arterial system in 1963. This significant reduction in traffic congestion in Milwaukee County is largely due to the opening of freeway facilities. The freeway facilities in Milwaukee County absorbed more than the 3.3 million vehicle miles by which travel demand in that county increased over the decade, thereby permitting a corresponding decrease in traffic congestion on the surface arterials. For the Region as a whole, arterial traffic congestion was held at about 1963 levels despite an 8 percent increase in population, a 40 percent increase in motor vehicle registrations, a 25 percent increase in trip generation, and a 54 percent increase in arterial vehicle miles of travel. Without the regional freeway system, such increases in travel demand could not have been absorbed without increasing traffic congestion to intolerable levels.

Source: SEWRPC.

Between 1963 and 1972, the number of miles of arterial streets and highways operating over design capacity in the Region was reduced from 192 to 166, or by about 14 percent. The reduction in the number of miles of arterial facilities operating over design capacity was even more pronounced in Milwaukee County, where the number of miles of facilities operating over design capacity was reduced by nearly one-half, from about 116 miles to about 61 miles. The number of miles of arterials operating at design capacity in the Region, however, increased from about 140 in 1963 to 152 in 1972, or by about 9 percent. In Milwaukee County, the number of miles of arterial streets operating at design capacity decreased over this period by nearly 16 percent, or from about 85 miles to about 72 miles. The net effect of these changes in arterial facility capacity and use was a reduction of about 14 miles, or 4 percent—from 332 to 318 miles—in arterial facilities operating at or over design capacity in the Region, and a reduction of about 69 miles or almost 35 percent—from 202 to 133 miles—in Milwaukee County.

Public Transit System

Public transit service in the Milwaukee area is primarily limited to motor bus service provided by the Milwaukee County Transit System in the developed portions of Milwaukee County. The total bus fleet of the Milwaukee County transit system in 1979 was 597 buses. Nearly 20 percent of these buses were more than 20 years old, while only 100 of the buses were less than 10 years old.

Total transit ridership in the Milwaukee area in 1978, adjusted to account for the effects of a two-month transit strike, approximated 52.6 million trips, or 179,000 trips per average weekday. This represents a significant increase over transit ridership in 1975, which was estimated to be 45.3 million trips. Transit ridership in the Milwaukee area has otherwise steadily declined since 1950—from over 216 million revenue passenger trips in that year, or 260 trips per capita per year, to the low of 45.3 million trips per year, or 36 trips per capita per year, in 1975.

In 1978 public transit service in the Milwaukee area was provided by motor bus in primary or modified rapid, secondary or express, and tertiary or local transit service. Modified rapid transit service, known as "Freeway Flyer" service, is the highest level of transit service provided in Milwaukee County. This service consists of 10 freeway bus routes connecting 13 outlying park-ride lots by nonstop service to the Milwaukee central business district, as shown on Map 6. On an average weekday in 1978, 203 vehicle trips were provided on these 10 Freeway Flyer routes. Total Freeway Flyer ridership has increased from about 81,000 annual revenue passengers in 1964, the year in which the service was initiated, to nearly 1 million annual revenue passengers in 1978, or 3,000 trips per average weekday.

Express public transit service in the Milwaukee area is provided over five routes, with 350 vehicle trips being provided on an average weekday in 1979. These routes all operate over surface arterial streets, making stops only at major street intersections and public transit transfer points.

Of the three types of transit service now provided in the Milwaukee area, local transit service provides the highest level of accessibility, with stops located every one to two blocks along its routes. It is also the most available form of transit service, with 44 local routes providing approximately 5,107 vehicle trips per average weekday in 1978.

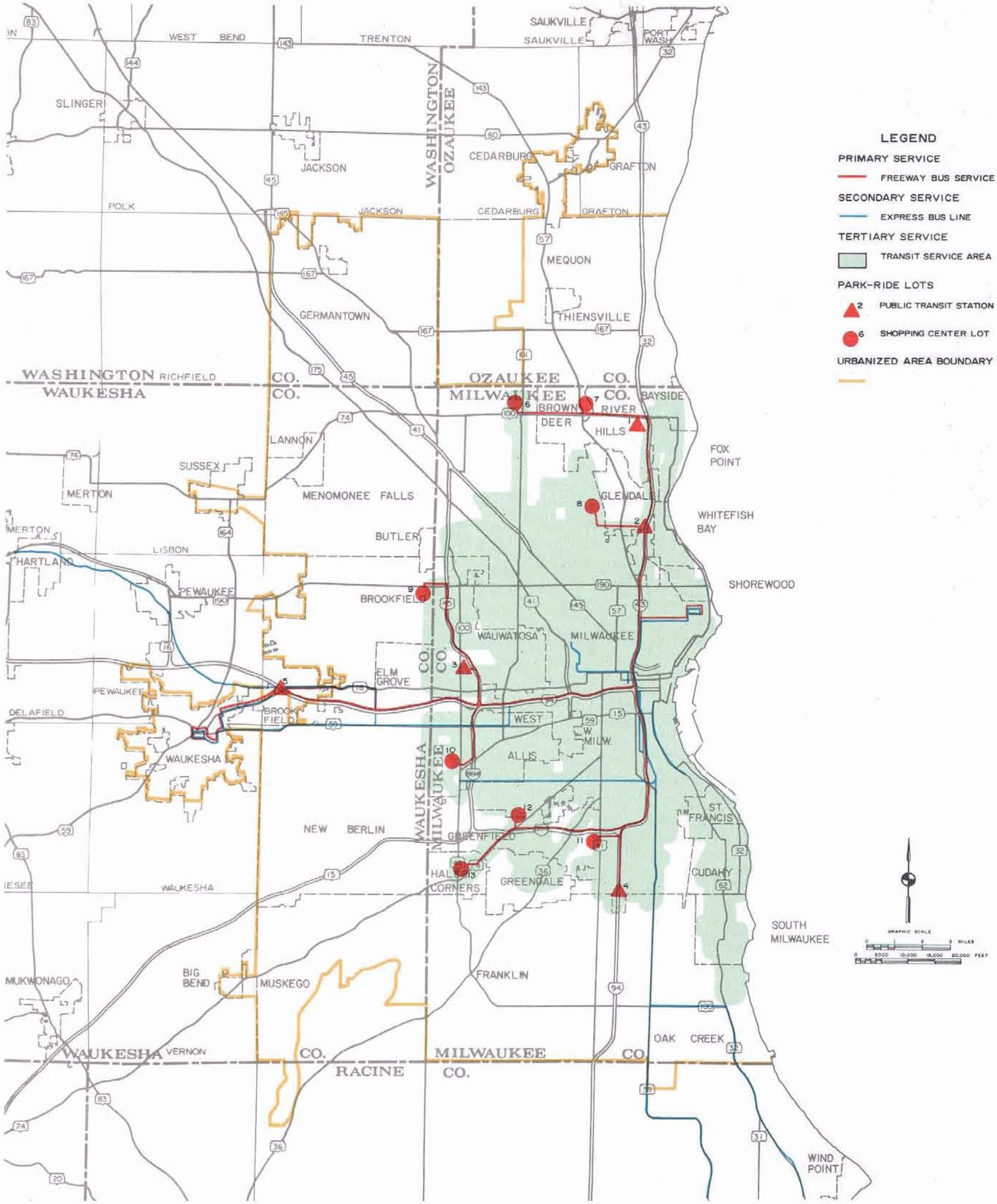
PLANNED TRANSPORTATION FACILITIES AND SERVICES

Also important to any primary transit system alternatives analysis is an understanding of the plans for the development of other elements of the regional transportation system. The Regional Planning Commission adopted its first regional transportation system plan in 1966. Extensive reevaluation of that plan began in 1972, and a new plan was adopted by the Commission in mid-1978. In the development of the revised regional transportation system plan, it was recognized that the future growth and change anticipated to occur within southeastern Wisconsin could be expected to generate demands for additional travel and for improved transportation facilities and services.

In order to deal with the sharply divided public opinion relating to further freeway development within the Region, as well as with the uncertainties related to population and employment growth and attendant changes in travel demand, energy cost and availability, and legislative and fiscal constraints, a two-tier approach to further freeway development was adopted by the Commission. Under this approach the freeway development recommendations contained in the plan were divided into an "upper tier" and a "lower tier." All other recommendations contained in the plan—those relating to standard arterial street and public transit development and, importantly, to

Map 6

PUBLIC TRANSIT SYSTEM IN THE MILWAUKEE URBANIZED AREA: 1979



As shown on the above map, fixed-route common carrier service was operated in the Milwaukee urbanized area at primary, secondary, and tertiary levels by motor bus in 1979. All tertiary levels of service and nearly all primary and secondary levels of service were limited to Milwaukee County. The existing modified rapid primary transit service utilizing motor buses was initiated in 1964 as a single route providing six vehicle trips during peak travel periods between the Milwaukee central business district and one privately owned outlying shopping center parking lot. This service has been expanded to include 10 freeway bus routes providing 203 weekday vehicle trips, primarily as peak-travel-period service, to 13 outlying park-ride lots.

Source: SEWRPC.

transportation systems management—were placed in the lower tier of the plan. The concept of the two-tier plan was that the facilities placed in the upper tier—about 37 miles of freeway in the Region and 13 miles in Milwaukee County—would remain on the long-range plan, but no further work would be undertaken toward the construction of these facilities for at least a decade. During that time, a coordinated set of transportation systems management measures intended to reduce peak-hour travel demand in Milwaukee County while obtaining the highest possible efficiency from existing transportation facilities and services was proposed to be implemented. The set of proposed transportation systems management actions included an extensive freeway traffic control system, increased promotion of carpooling and vanpooling, peak travel hour curb parking restrictions, and significantly improved public transit service. The two-tier plan envisioned that if at some future time it was determined that these actions to modify travel demand and achieve maximum facility and service efficiency had been effective and that surface arterials and transit services were adequately accommodating travel demand, then steps could be taken at that time to formally remove the upper-tier freeway proposals from the long-range plan. On the other hand, if the consensus at such future time was that travel demand modification and improved transportation efficiency efforts had not provided the needed transportation service, work could again proceed toward the construction of the upper-tier freeways. In the meantime, the plan recommended that all right-of-way cleared for the upper-tier freeway segments be held in a transportation land bank, with appropriate consideration given to the interim use of the land for park and open space purposes. The plan also recommended that any currently undeveloped lands needed to accommodate construction of the upper tier freeway segments be preserved in essentially open uses.

The adopted two-tier regional transportation system plan for the year 2000, as shown on Map 7, was composed of four elements: freeways, standard surface arterial streets and highways, public transit facilities and services, and transportation systems management actions. The regional freeway system proposed to serve the Region in the year 2000 consists of 336 miles of facility, of which 220 miles are existing freeways now open to traffic; 12 miles are existing freeways recommended for significant improvement in the lower tier of the plan; 7 miles are freeways committed for construction; 60 miles are freeways recommended for construction in the lower tier of the plan; and 37 miles are freeways recommended for construction in the upper tier of the plan.

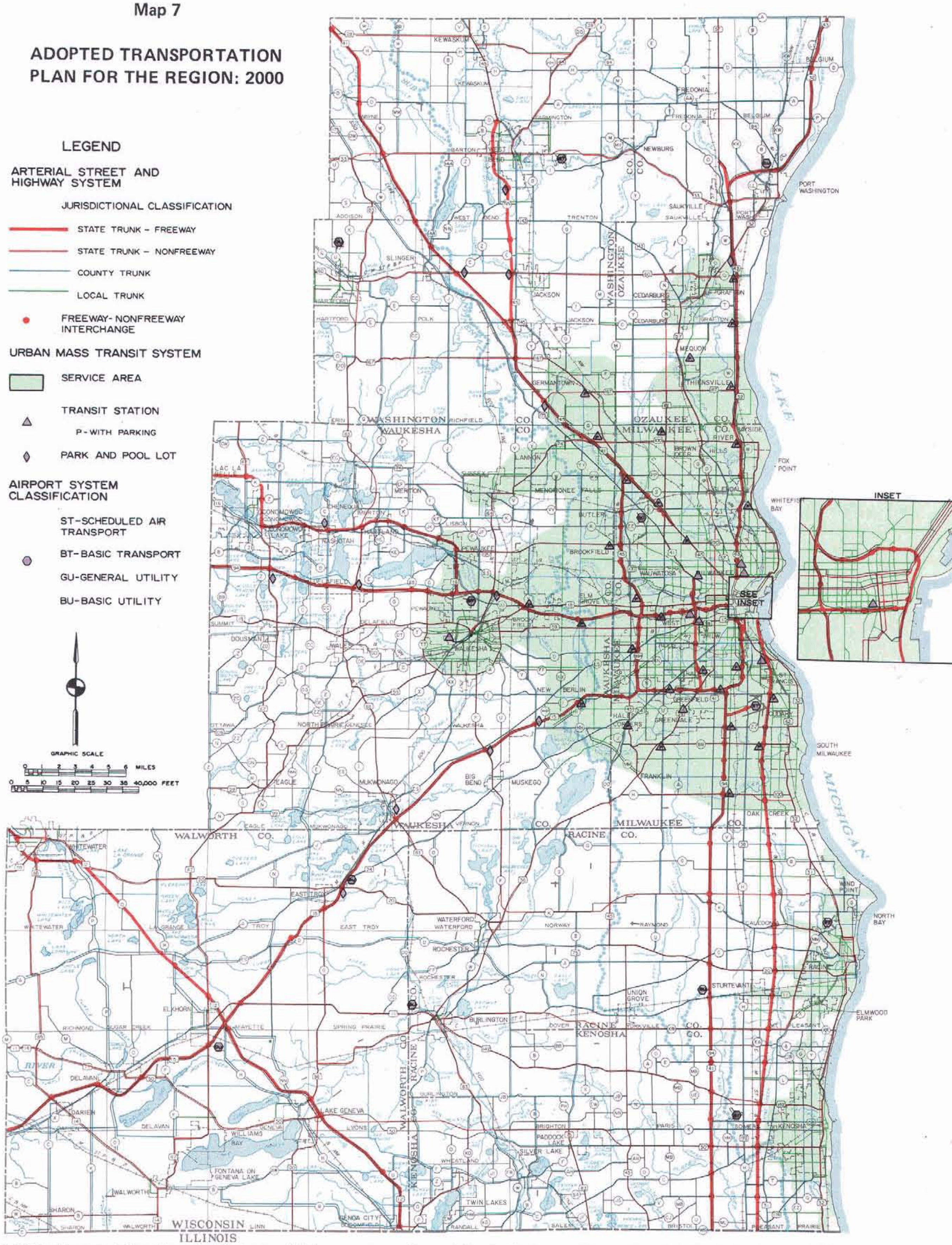
The standard arterial street and highway system would be increased from the 2,850 miles existing in 1972 to about 3,190 miles in the year 2000. The additional mileage primarily reflects the addition of existing nonarterial facilities to the surface arterial system. Approximately 106 miles of new standard surface arterial facilities would be developed under the plan. About 683 miles would be significantly improved, either through reconstruction for additional capacity or through construction of a replacement facility. The remaining 2,401 miles of surface arterials would require only preservation, with 103 miles requiring no work; 1,418 miles requiring resurfacing; and 880 miles requiring reconstruction at the same capacity for structural reasons.

The adopted transportation system plan recommends substantial expansion and improvement of the public transit systems serving the three urbanized areas of the Region: Milwaukee, Kenosha, and Racine. In the Milwaukee urbanized area, the plan envisions the provision of three levels of transit service: modified rapid or primary, express or secondary, and local or tertiary. Under the plan primary service would be of the modified rapid transit service type, provided by motor buses operating in mixed traffic over 80 miles of freeways and over 27 miles of surface arterial streets on extensions of the freeway routes. It is envisioned that these vehicles would provide for the collection and distribution of passengers at the ends of each route. The primary transit service would be supported by the implementation of a comprehensive freeway traffic management system, including freeway ramp meters to provide preferential access for transit vehicles.

The secondary level of transit service envisioned in the plan would provide express bus service over arterial streets, with stops generally located only at intersecting bus routes. Under the recommended plan, secondary service would be provided over 14 individual routes with exclusive transit lanes—that is, traffic lanes reserved for the exclusive use of buses during specified hours of the day—on six arterial streets. The exclusive transit lanes would total nearly 10 miles in length. Secondary transit service would be provided in mixed traffic over a total of about 146 miles of arterial facilities.

Map 7

ADOPTED TRANSPORTATION PLAN FOR THE REGION: 2000



Under the adopted transportation plan, arterial street and highway system mileage within the Region would total about 3,526 miles by the year 2000, an increase of about 516 miles, or about 17 percent, over 1972. Freeways would comprise 336 miles, or about 9 percent, of the total arterial system in the year 2000, an increase of 174 miles over 1972. Such freeways would, however, be expected to carry about 42 percent of the average daily traffic load. Of this increase, 97 miles represent seven planned new freeways. Of this total system about 2,650 miles, or about 75 percent, would fall into the system preservation category, including facilities for which no work, resurfacing, or reconstruction for same capacity is proposed; about 707 miles, or 20 percent, would fall into the system improvement category, for which reconstruction for additional capacity or new construction of replacement facilities is proposed; and about 176 miles, or 5 percent, would fall into the system expansion category, wherein the construction of new facilities is proposed.

Source: SEWRPC.

The tertiary level of transit service envisioned in the plan consists of local transit service provided by buses operated primarily over surface arterial and collector streets, with frequent stops for passenger boarding and alighting. Extension of the tertiary service to essentially all of the Milwaukee urbanized area, including the developed areas of southern Ozaukee County, southeastern Washington County, and eastern Waukesha County, is recommended.

In addition to the arterial street and highway and transit facility and service recommendations described above, the adopted regional transportation system plan for the year 2000 includes, among others, four major transportation system management recommendations. These management recommendations consist of the institution of an extensive freeway traffic management system in the Milwaukee area; increased promotion of carpooling and vanpooling; peak-travel-hour curb parking restrictions along major surface arterials; and the institution of a parking fee structure to encourage short-term and discourage long-term parking in the Milwaukee central business district. The management recommendations are designed to accomplish several objectives, including ensuring that maximum use is made of existing transportation facilities before commitments are made to new capital investment; encouraging the use of high-occupancy vehicles, including buses, vans, and carpools; effecting motor fuel savings; and reducing vehicle miles of travel and air pollutant emissions in congested areas.

The Commission has also prepared and adopted a transportation systems management plan which expands upon recommendations contained in the long-range system plan to maximize the efficiency of the transportation system within southeastern Wisconsin. This plan proposes a coordinated areawide program of 24 actions to ensure full and efficient use of existing arterial street and highway facilities, to reduce vehicle use in congested areas, to improve transit service, and to increase internal transit management efficiency. Among the actions proposed were integration of the "stub ends" of the incompleted freeway system into the existing surface arterial system; means of achieving greater efficiency in selected arterial corridors; a study of taxi fares and regulation; a study of the potential of work time rescheduling to reduce peak-period traffic demand; and continued implementation and improvement of transit service and carpool and vanpool promotion programs.

POTENTIAL EXCLUSIVE PRIMARY TRANSIT ALIGNMENTS

The ready availability of rights-of-way for exclusive primary transit guideways can significantly affect the cost and practicality of alternative primary transit system configurations and of alternative primary transit modes. Accordingly, as part of the Milwaukee area primary transit system alternatives analysis, an inventory was conducted of the extent, location, and physical characteristics of all rights-of-way suitable as a location for fixed guideways in the greater Milwaukee area. The inventory included an analysis of the physical suitability of abandoned electric interurban railway rights-of-way, electric power transmission line rights-of-way, freeway rights-of-way, and active and abandoned railway rights-of-way for busways, light rail transit, and heavy rail rapid transit, guideway development. In addition, existing railway lines were analyzed as potential locations for commuter rail routes.

Abandoned Electric Interurban and Street Railway Rights-of-way

An extensive network of electric interurban railway lines served the Milwaukee area from 1895 to 1963. The largest of the two systems which served the area was that of The Milwaukee Electric Railway & Light Company (the Milwaukee Electric Lines), consisting of 202 miles of electric interurban railway lines operated over combinations of public streets and private rights-of-way from downtown Milwaukee north to Port Washington and Sheboygan, west to Oconomowoc and Watertown, southwest to East Troy and to Burlington, and south to Racine and Kenosha. Of these 202 miles of line, 174 miles were located within southeastern Wisconsin and 90 miles were located within the study area. Approximately 180 miles, or 89 percent, of the total were operated over private rights-of-way, the remainder being operated over public streets. Within the Region 155 miles, or 89 percent, were operated over private rights-of-way, with the remaining mileage being operated over public streets. Within the Milwaukee area 78 miles, or 86 percent, were operated over private rights-of-way, with the remaining mileage being operated over public streets. Summarized in Table 10 and on Map 8 are the findings of the inventory with respect to the potential of the former Milwaukee Electric Lines private rights-of-way to be utilized for primary transit in the Milwaukee area. For inventory purposes, the rights-of-way were divided into seven segments, according to the original railway line or operating division for which they were used. Also indicated in Table 10 and on Map 8

Table 10

POTENTIAL FOR PRIMARY TRANSIT USE OF FORMER ELECTRIC INTERURBAN AND STREET RAILWAY PRIVATE RIGHTS-OF-WAY IN THE MILWAUKEE URBANIZED AREA

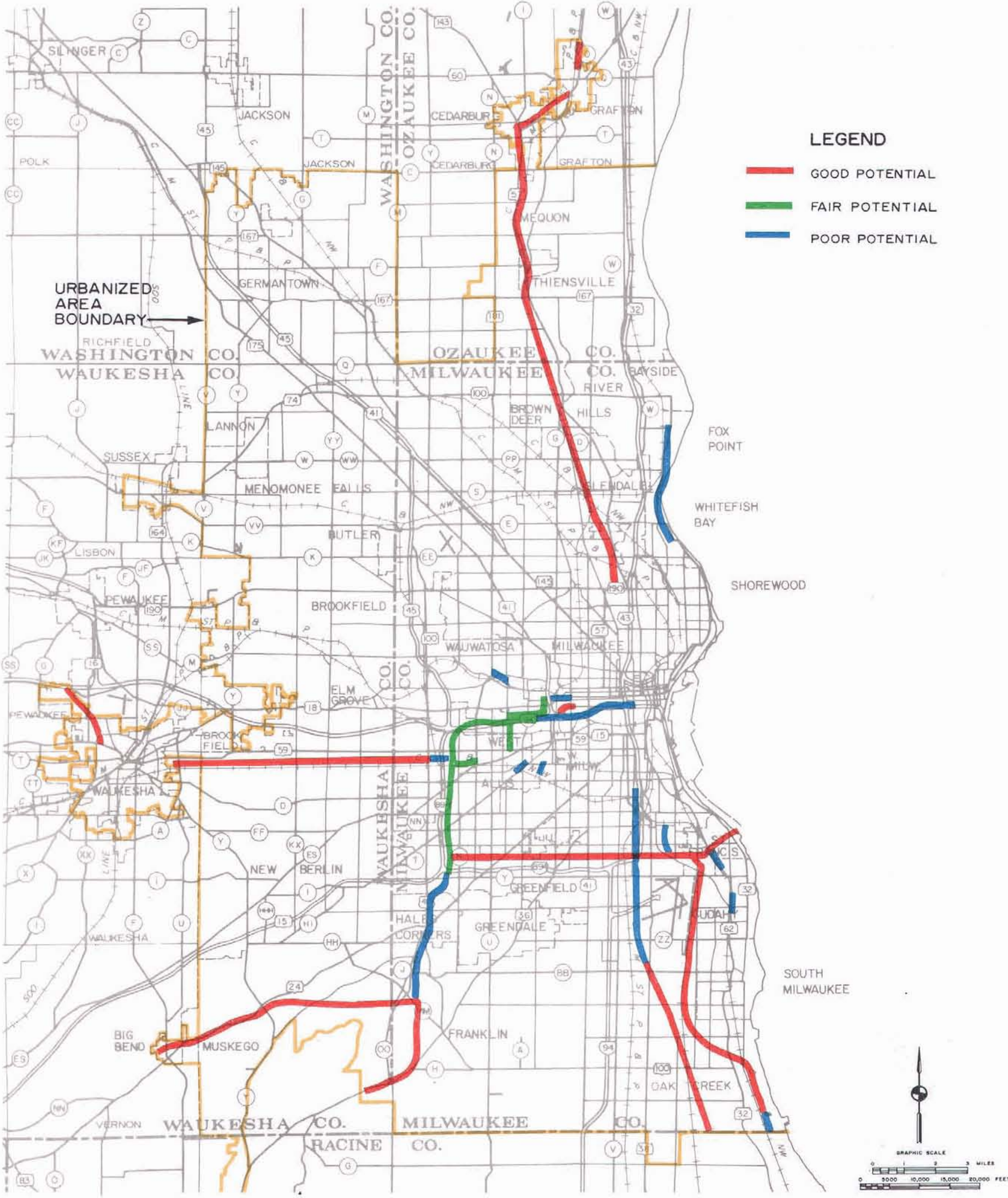
Right-of-Way					
Name and Owner	Limits	Width (feet)	Past Use	Present Use	Potential for Primary Transit Use
Milwaukee Electric Lines—Milwaukee Northern Division	N. 19th Street and W. Fiebrantz Avenue in the City of Milwaukee to northern limits of the Village of Grafton—17.5 miles, of which 0.6 mile in Village of Grafton is over public streets	66	Double-track interurban railway from W. Fiebrantz Avenue to W. Silver Spring Drive and single track for remainder (part of route from Public Service Building to City of Sheboygan)	Owned by the Wisconsin Electric Power Company and used for electric power transmission	Good—Right-of-way is largely intact to Village of Grafton. Three electric power substations constructed in right-of-way. Some relocation of wooden power line poles and steel latticed transmission towers may be necessary. Crosses 39 public streets, five railway main lines, and two railway spur tracks
Milwaukee Electric Lines—Local Rapid Transit Line	N. 8th Street and W. Clybourn in the City of Milwaukee to West Junction in the City of West Allis (Zoo Freeway and C&NW Belton Junction)—6.6 miles	100	Double-track interurban railway fully grade-separated (part of route from Public Service Building to West Junction, connecting with routes to City of Watertown, Village of East Troy, and City of Burlington)	East-West Freeway from N. 8th Street to Mitchell Boulevard. Owned by the Wisconsin Electric Power Company and used for electric power transmission from Mitchell Boulevard to West Junction, except for three freeway interchanges located over that distance (2.8 miles in freeway use)	Fair—Right-of-way is not intact. Between N. 8th Street and N. 29th Street does not exist; between N. 29th Street and N. 60th Street only short broken segments exist; between N. 60th Street and West Junction, crosses two freeway interchanges and one electric power substation. Crosses 23 public streets and two railway main lines
Milwaukee Electric Lines—*Watertown Division*	West Junction in the City of West Allis to the Silvernale station at western limits of the City of Waukesha—western limits of the Milwaukee urbanized area (East-West Freeway and CTH TJ)—13.4 miles, of which 2.9 miles in City of Waukesha are over public streets	66	Double-track interurban railway (part of route from West Junction to City of Watertown)	Between West Junction and S. 108th Street used for Zoo Freeway, mainline railway, and urban development. Between S. 108th Street and Silvernale station owned by the Wisconsin Electric Power Company and used for electric power transmission except through City of Waukesha, where right-of-way is public street	Good in Part—From 108th Street to the City of Waukesha eastern limits, the right-of-way is generally intact. One electric power distribution facility is constructed in the right-of-way of this segment. Crosses eight public streets and one railway spur track
Milwaukee Electric Lines—Muskego Lakes Division	West Junction in the City of West Allis to St. Martin's Junction—7.6 miles—and branches to Village of Big Bend—8.3 miles—and Durham Hill station at North Cape Road—3.0 miles—located at the western and southern limits of the Milwaukee urbanized area, respectively	66, except 100 to 120 between West Junction and W. Layton Avenue	Single-track interurban railway with passing sidings (part of routes from West Junction to the Village of East Troy and City of Burlington)	Between Layton Avenue four freeway interchanges are constructed along the right-of-way. Between Layton Avenue and St. Martin's Junction, is used for streets and commercial and residential development. Owned by the Wisconsin Electric Power Company between West Junction and W. Layton Avenue and between St. Martin's Junction and Village of Big Bend and the Durham Hill station	Fair to Good in Part—Right-of-way is only fair between West Junction and W. Layton Avenue because of construction of freeway interchanges, but good south and west of St. Martin's Junction. Relocation of wooden power line poles may be necessary. Crosses one freeway, 36 public streets, and one railway main line
Milwaukee Electric Lines—Lakeside Belt Line	Lakeside Power Plant in City of St. Francis to Greenwood Junction in City of Greenfield (IH 894 and W. Howard Avenue)—9.5 miles	150 to 180	Single-track freight railway, fully grade-separated with passing sidings (connected with Muskego Lakes Division of the Milwaukee Electric Lines)	Owned by the Wisconsin Electric Power Company and used for electric power transmission	Good—Right-of-way is intact. Some relocation of wooden power lines may be necessary. Crosses one freeway, 28 public streets, and three railway main lines
Milwaukee Electric Lines—Milwaukee-Racine-Kenosha Division	S. Howell Avenue and E. Burdick Avenue in the City of Milwaukee to the Racine County line at southern limit of the Milwaukee urbanized area—13.6 miles	100	Double-track interurban railway north of Lakeside Belt Line, and remainder is single track with sidings (part of route from Public Service Building to the City of Kenosha)	Owned by the Wisconsin Electric Power Company and used for electric power transmission	Good in Part—Right-of-way is largely intact between E. Layton Avenue and E. Elm Road in the City of Oak Creek. Northern portion of right-of-way now in residential development and southern portion used for Oak Creek Power Plant. Crosses 26 public streets, three railway main lines, and one railway spur track
North Shore Line	S. 5th Street and W. Harrison Avenue to Racine County line at southern limit of the Milwaukee urbanized area	100 to 140	Double-track interurban railway (route from City of Milwaukee to City of Chicago)	Owned by Milwaukee County except for parcels of the North-South and Airport Spur Freeways, and of the MATC South Campus. Other portions leased for parking lots and truck terminals	Good in Part—Right-of-way is intact south of E. College Avenue to Racine County line. Crosses 11 public streets and one railway main line
Milwaukee Electric Lines—Street Railway System (private right-of-way segments of 10.1 miles)	E. Waterford and S. Kinnickinnic Avenues to E. Plankinton and S. Kinnickinnic Avenues E. Grange and S. Packard Avenues to E. Dale and S. Packard Avenues N. 38th and W. Wells Streets to N. 44th and W. Wells Streets N. 52nd and W. Wells Streets to S. 70th Street and W. Greenfield Avenue S. 87th and W. Lapham Streets to West Junction N. 69th Street and W. Motor Avenue to W. Harwood Avenue N. 35th Street and W. St. Paul Avenue to connection with Local Rapid Transit Line at N. 41st Street E. Henry Clay Street and N. Marlborough Drive to E. Bradley Road S. 63rd and W. Burnham Streets to S. 67th Place and Becher Street McGeoch Avenue Spur	- -	Single- and double-track street railway of 15 to 20 lines and about 130 miles of trackage, mostly located on public streets (10.1 miles of private rights-of-way) in the City of Milwaukee	Mostly public streets and urban development	Fair to Poor—Right-of-way is generally fair to poor as a result of conversion to urban use except one 0.4-mile portion between N. 35th Street and W. St. Paul Avenue to connection with Local Rapid Transit Line at N. 41st Street, and other shorter discontinuous segments between N. 52nd Street and W. Wells Street and S. 70th Street and Greenfield Avenue, and between S. 87th and W. Lapham Streets and West Junction

Source: SEWRPC.

is the potential of the 10 private rights-of-way—ranging in length from 0.2 mile to 3.6 miles and totaling 10.1 miles in length—that were once part of the 130 miles of line of the Milwaukee area street railway system, also operated by the Milwaukee Electric Lines.

Map 8

POTENTIAL FOR PRIMARY TRANSIT FIXED GUIDEWAY LOCATION ON FORMER ELECTRIC INTERURBAN AND STREET RAILWAY RIGHTS-OF-WAY IN THE MILWAUKEE AREA



Nearly all of the former electric interurban railway rights-of-way within the Milwaukee urbanized area have segments which are intact and have good potential for at-grade primary transit fixed guideway development. Such segments have been determined to possess horizontal and vertical clearances adequate for the construction of primary transit fixed guideways and are largely clear of any obstructions such as buildings, substations, and steel power transmission towers. In addition, much of the original railway grade of such segments is intact, although almost all bridge structures and abutments have been removed. These intact portions are owned by the Wisconsin Electric Power Company and used primarily for the location of electric power transmission line towers, with the exception of the former right-of-way of the Chicago, North Shore & Milwaukee Railway Company line, which is for the most part owned by Milwaukee County. The former private rights-of-way segments utilized by the street railway system in and around the City of Milwaukee have for the most part been converted to other urban land uses, and therefore have poor potential for the location of primary transit fixed guideways.

Source: SEWRPC.

Nearly all of the former Milwaukee Electric Lines interurban rights-of-way have portions with good potential for primary transit development. The right-of-way of such portions is largely intact and is owned by the Wisconsin Electric Power Company and used for electric power transmission line location. However, the railway grade on such segments is only partially intact. Most fills have been leveled or severely altered and many cuts have been filled in. Nearly all bridges at former grade separations with highways or other railways have been removed. Of the 78.0 miles of former electric interurban railway rights-of-way operated by the Milwaukee Electric Lines on private rights-of-way in the Milwaukee urbanized area, 59.5 miles or 76.3 percent, were determined to have good potential for the location of fixed guideway facilities. Nevertheless, most of the former street railway private rights-of-way were found to have poor potential for use in the development of primary transit fixed guideways. Only one segment of private right-of-way, 0.4 mile in length, is still entirely clear, and two segments, 2.5 and 1.0 miles in length, have discontinuous portions that are still clear.

The other electric interurban railway system formerly serving the Milwaukee area was that of Chicago, North Shore & Milwaukee Railway Company (North Shore Line). Within the State of Wisconsin, this system consisted of a single route from downtown Milwaukee to Chicago by way of the Cities of Racine and Kenosha, and within the Southeastern Wisconsin Region consisted of about 36 route miles of line, of which 92 percent were operated over private rights-of-way, the remainder being operated over public streets. About 14 miles of line were located within the study area, of which 11 miles, or 80 percent, were operated over private rights-of-way. Abandoned in 1963, the 11.1-mile portion of the railway right-of-way that did not use public streets is largely, although not entirely, intact within the Milwaukee area, being owned largely by Milwaukee County (see Table 10). The railway grade is only partially intact on the right-of-way, as many fills have been leveled or severely altered and many cuts have been filled in, and bridges at former grade separations have been removed.

Electric Power Transmission Line Rights-of-Way

Electric power transmission trunkline rights-of-way were also inventoried with respect to their potential for use in the development of a fixed guideway primary transit system. There were a total of 1,987 miles of such trunk lines located in the Milwaukee area in 1978. Because more than one trunk line is typically located on an easement or right-of-way, these trunk lines were located on only 57 miles of rights-of-way owned in fee simple by the Wisconsin Electric Power Company, and 174 miles of easements obtained by the Wisconsin Electric Power Company. The owned rights-of-way in the Milwaukee area are specifically those private rights-of-way that were formerly utilized for electric interurban railway alignments by The Milwaukee Electric Railway & Light Company. All electric power transmission trunk lines in the Milwaukee area that are not located on former electric interurban railway rights-of-way were found to be located on easements, which have no potential for the development of primary transit fixed guideways. The easements generally consist only of small areas of land for the location of electric power transmission line supports connected by corridors over which only aerial rights are held by the power company. The land between the power line support structures is usually utilized in conjunction with surrounding land uses.

Freeway Rights-of-Way

The Milwaukee area freeway system was also inventoried with respect to its potential for use in the provision of primary transit guideway alignments. One way to provide primary transit service over the existing freeway system is through the reservation of existing freeway lanes for the exclusive use of motor buses, operating either in a normal flow direction or in a contraflow direction. Alternatively, parts of the freeway right-of-way other than the traffic-carrying lanes could be used for the location of primary transit fixed guideway alignments, including busways, light rail guideways, and heavy rail guideways. The parts of the freeway right-of-way that could be used include the inside shoulder and median of the freeway, the outside shoulders of the freeway, and the nonroadway portions of the freeway right-of-way adjacent to the outside shoulders.

There are two major obstacles to the provision of a system of reserved bus lanes on the Milwaukee area freeway system. One is the configuration of the system and the design of its interchanges, which results in freeway entrance and exit ramps connecting to both the right- and left-hand lanes of the freeway where reserved lanes for buses would be provided. Because of the frequency of such ramps connecting to the right-hand side of the freeway, it was concluded that, in general, only median lanes should be considered for use as either normal flow or contraflow reserved bus lanes in the Milwaukee area. Unfortunately, because of the number of left-hand ramps, major portions of the median lanes of the East-West Freeway in Milwaukee County (IH 94 and IH 794) and the inner portions of the North-South Freeway (IH 94 and IH 43) approaching the central business district of Milwaukee do not lend themselves to development for reserved bus lanes, particularly in a contraflow direction.

The other major obstacle to the provision of reserved lanes for the exclusive operation of buses on the Milwaukee area freeway system is the traffic congestion that may be expected to result, based upon existing freeway traffic capacities and volumes. As shown on Map 9, if a freeway lane were reserved for bus use in the normal flow direction, the central portions of the Milwaukee area freeway system—totaling about 41 miles in the morning peak hour and 44 miles in the evening peak hour, or about 40 and 43 percent, respectively, of the total freeway system—could be expected to carry the maximum possible traffic volumes, and, in addition, require some diversion of traffic. These freeways would experience severe congestion with continuous stop-and-go driving and operating speeds of 30 to 35 miles per hour or less. In addition, the necessary diversion of existing freeway traffic to surface arterial streets, to transit, or to other times of the day would have to approach 1,000 to 1,900 vehicles during the morning and evening peak hours on parts of the East-West Freeway (IH 94), North-South Freeway (IH 43 and IH 94), Zoo Freeway (USH 45), and Airport Freeway (IH 894). Additional portions of the Milwaukee area freeway system—totaling about 28 miles in the morning peak hour and 19 miles in the evening peak hour, or about 27 and 18 percent, respectively, of the total freeway system—would have to carry volumes exceeding their design capacity and approaching maximum possible volumes if a freeway lane were reserved for bus operation in the normal flow direction. Operating conditions on these freeways would approach unstable flow, with intermittent stop-and-go traffic conditions and operating speeds at or below 40 miles per hour.

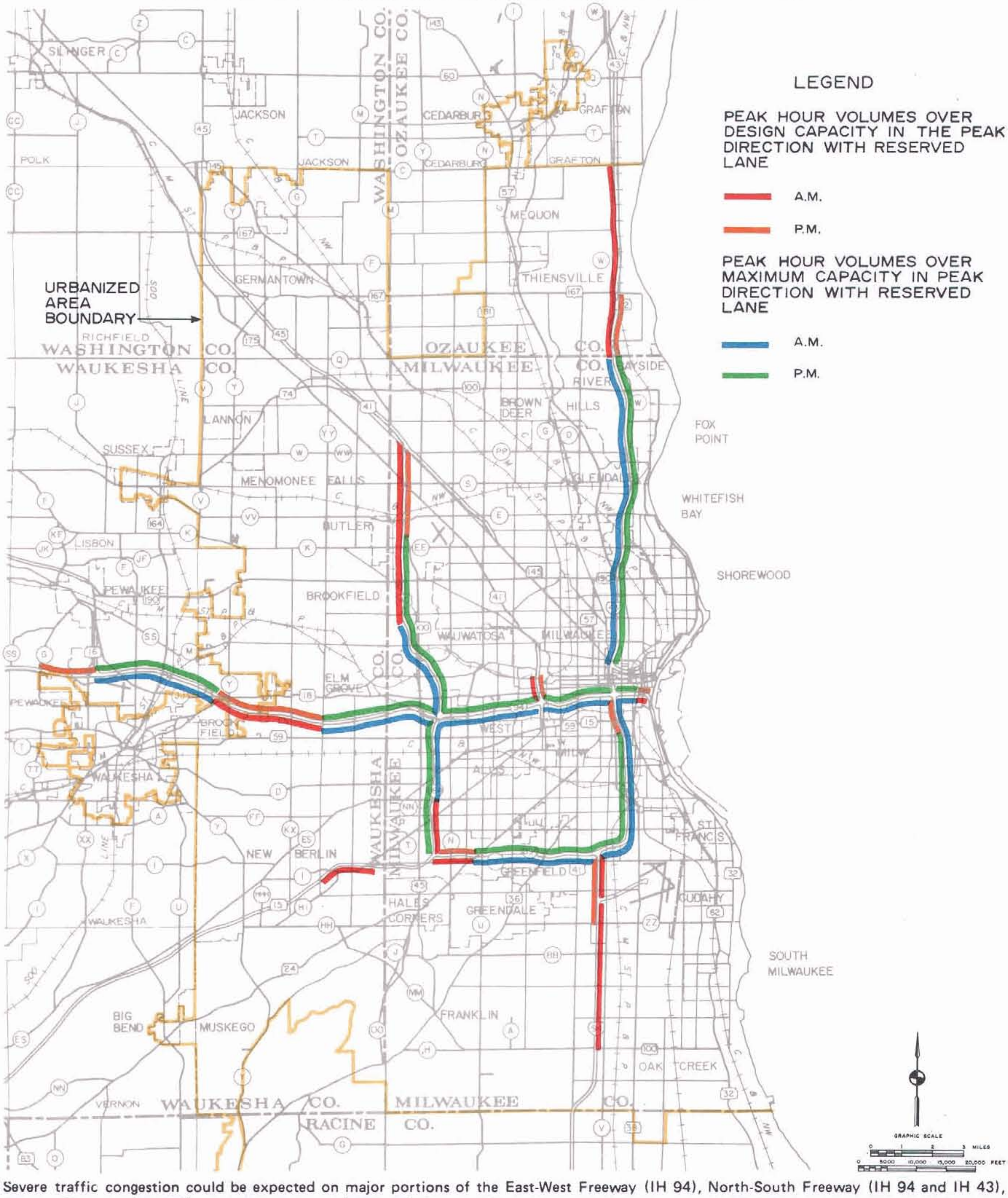
The traffic congestion problem caused by reserving an existing freeway lane for buses would be less severe for contraflow reserved bus lanes, as shown on Map 10. Only about five miles in the morning peak hour and eight miles in the evening peak hour of the East-West Freeway (IH 94) and Zoo Freeway (USH 45)—totaling about 5 and 8 percent of the total Milwaukee area freeway system—would have insufficient capacity with reduced lanes in the nonpeak direction to accommodate existing peak-hour traffic volumes. An additional 14 miles in the morning peak hour and nine miles in the evening peak hour—or 14 percent and 9 percent of the Milwaukee area freeway system, respectively—including additional segments of the East-West Freeway and Zoo Freeway and small segments of the North-South Freeway (IH 43) and Airport Freeway (IH 894), could be expected to operate over design capacity with existing traffic volumes if a traffic lane were reserved for a contraflow bus lane. However, it is important to recognize that the automobile travel which would be impacted by the traffic congestion which a contraflow lane may cause, would not have the opportunity to divert to the improved bus service in the newly reserved lane because it would be traveling in the direction opposite of the improved bus service.

Thus, based upon the configuration and design of the Milwaukee area freeway system and the existing traffic volumes carried on that system, reserved bus lanes could be developed in a contraflow directin only on median lanes over parts of the system, including all freeway segments outside Milwaukee County and, within Milwaukee County, on segments located between freeway-to-freeway interchanges of the North-South Freeway (IH 43 and IH 94), Airport Freeway (IH 894), Zoo Freeway (USH 45), and Fond du Lac Freeway (USH 41 and USH 45). Normal flow reserved bus lanes could be readily developed only on a much more limited set of segments of the freeway system, including the Lake Freeway (IH 794), Fond du Lac Freeway (USH 41 and USH 45), and Rock Freeway (USH 15).

As another alternative, the median, outside shoulders, and nonroadway portions adjacent to the outside shoulders could be considered for the location of new guideway facilities. However, the inventory data indicated that freeway medians, outside shoulders, and nonroadway portions of the Milwaukee area freeway system cannot readily be used as a location for fixed guideways for motor buses, light rail vehicles, or heavy rail vehicles. A major obstacle to such use is the width available for guideway development, particularly in the median, but also in the freeway shoulders and nonroadway portion of the rights-of-way, as shown in Table 11. This problem is most severe on those parts of the freeway system located in the central portions of Milwaukee County.

Map 9

PORTIONS OF MILWAUKEE AREA FREEWAY SYSTEM WHICH WOULD BE CONGESTED IF NORMAL FLOW RESERVED BUS LANES WERE IMPLEMENTED

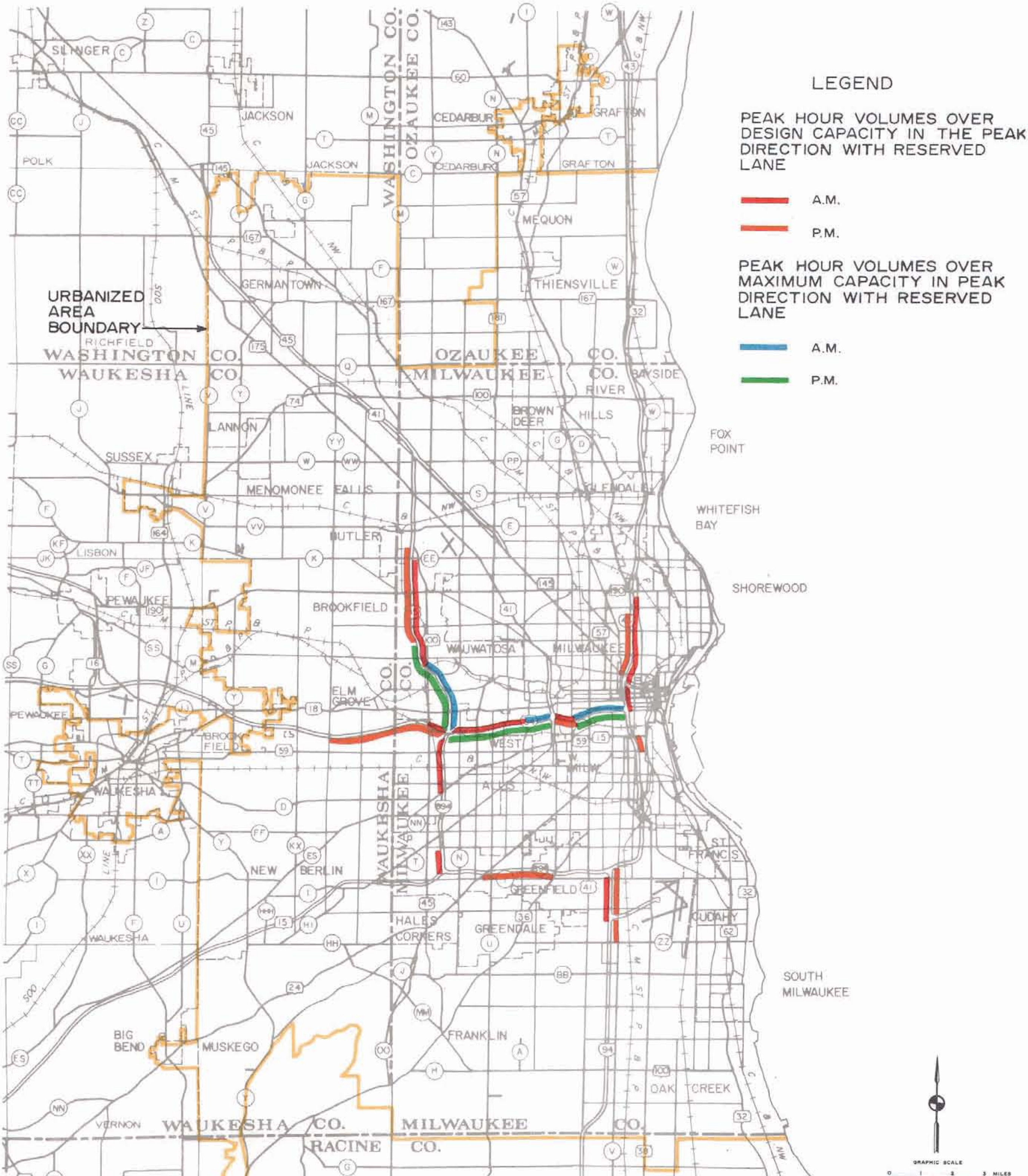


Severe traffic congestion could be expected on major portions of the East-West Freeway (IH 94), North-South Freeway (IH 94 and IH 43), Airport Freeway (IH 894), and Zoo Freeway (USH 45) if normal flow reserved bus lanes were provided during morning and evening peak hours. These freeways would be required to carry the maximum traffic volumes possible, and, in addition, divert some existing freeway traffic to surface streets, transit, or other times of the day. The traffic flow on these freeways—totaling 41 miles in the morning peak hour and 44 miles in the evening peak hour—would be unstable, with stop-and-go driving and operating speeds at or below 30 to 35 miles per hour. The necessary diversion of existing freeway traffic would range from 1,000 to 1,900 vehicles on some freeway segments, such as the East-West and Zoo Freeways. Another 28 miles of freeway in the morning peak hour and 19 miles of freeway in the evening peak hour would be required to carry traffic volumes approaching the maximum possible if normal flow reserved bus lanes were provided. Traffic conditions on these segments of freeway would approach unstable flow, with operating speeds at or below 40 miles per hour.

Source: SEWRPC.

Map 10

PORTIONS OF MILWAUKEE AREA FREEWAY SYSTEM WHICH WOULD BE CONGESTED IF CONTRAFLOW RESERVED BUS LANES WERE IMPLEMENTED



Only about five miles of freeway in the morning peak hour and eight miles of freeway in the evening peak hour would have insufficient capacity to accommodate existing traffic volumes in the nonpeak direction if contraflow reserved bus lanes were implemented. These freeways would be required to carry their maximum volumes under severe congestion and, in addition, divert some existing freeway traffic to surface streets, transit, or other times of the day. The remainder of the Milwaukee area freeway system would have sufficient capacity to accommodate existing freeway traffic volumes if contraflow reserved bus lanes were implemented. However, 14 miles of these freeways in the morning peak hour and nine miles in the evening peak hour would be required to carry near maximum volumes, and would thus experience traffic conditions approaching unstable flow with operating speeds at or below 40 miles per hour.

Source: SEWRPC.

Table 11

CLASSIFICATION OF MILWAUKEE AREA FREEWAY SYSTEM POTENTIAL TO PROVIDE SUFFICIENT HORIZONTAL CLEARANCE FOR AT-GRADE GUIDEWAYS

Type of Primary Transit System	Sufficient Width for Desirable Guideway (miles)	Sufficient Width for Absolute Minimum Guideway (miles)	Sufficient Width with Minor Reconstruction or Construction (miles)	Insufficient Width at Freeway Structure Only (miles)	Insufficient Width (miles)
Bus					
Median-Dual	27	20	- -	- -	56
Median-Single	46	3	- -	35	19
Outside Shoulder	26	- -	11	60	6
Nonroadway Right-of-Way	46	- -	46	- -	11
Light Rail					
Median	27	18	- -	30	28
Outside Shoulder	40	- -	42	15	6
Nonroadway Right-of-Way	46	- -	46	- -	11
Heavy Rail					
Median	25	22	- -	- -	56
Outside Shoulder	20	- -	58	19	6
Nonroadway Right-of-Way	46	- -	46	- -	11

Source: SEWRPC.

Another major obstacle to the use of existing freeway rights-of-way as a location for fixed guideway facilities is the frequency with which freeway-to-freeway ramps and freeway entrance and exit ramps would have to cross the primary transit guideway alignments in the freeway right-of-way. This problem would be particularly severe for use of the freeway shoulders and nonroadway portions of the right-of-way, as there would be a need to grade-separate the guideways from the many right-hand freeway ramps which would cross the potential guideway alignments, as shown on Maps 11 and 12. The construction of elevated guideways in the freeway right-of-way to provide such grade separation, however, may be expected to be particularly difficult and costly since the elevated guideway would need to be constructed through, over, or around freeway-to-freeway interchanges, and over other overpasses to the freeway. Consequently, only the outer reaches of the Milwaukee area freeway system—generally outside Milwaukee County—where freeway ramps, particularly those on the right-hand side, are relatively infrequent and where freeway medians, shoulders, and nonroadway portions are of sufficient width to support an at-grade dual guideway, may be considered practical for further consideration as primary transit corridors.

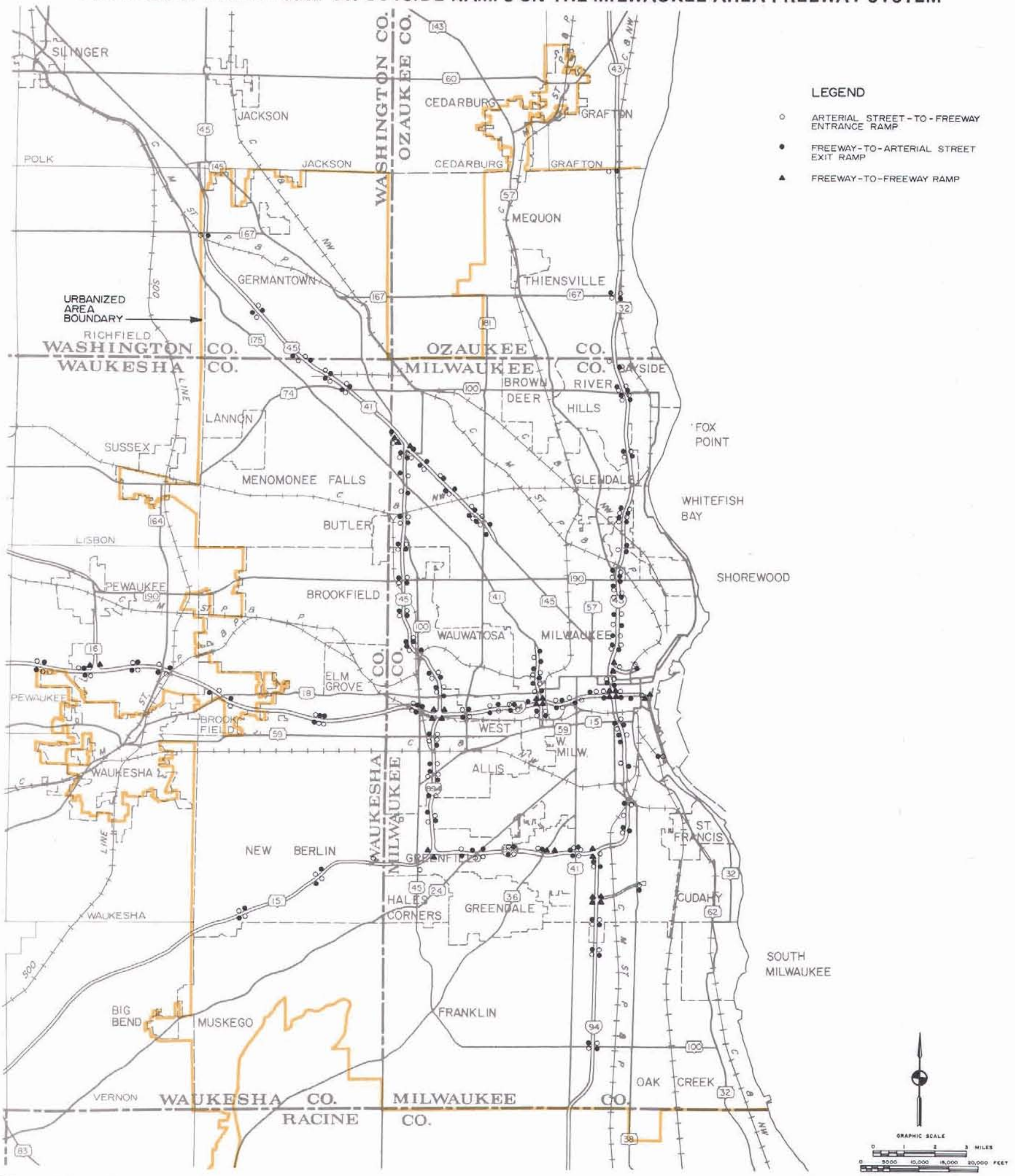
There are, however, two freeway corridors in the Milwaukee urbanized area with excellent potential for fixed guideway primary transit development. Both of these corridors have been cleared in anticipation of freeway construction, but such construction is not recommended in the adopted regional transportation system plan for a period of at least a decade. These two freeways are the Park Freeway-East and the Stadium Freeway-South, both of which have cleared rights-of-way for distances of about 1.2 miles and 0.5 mile, respectively. There is one other cleared freeway corridor in the Milwaukee area, that of the no longer recommended Park West Freeway. This corridor is approximately 2.2 miles in length, and 320 to 420 feet wide, and could readily accommodate fixed guideway development.

Active and Abandoned Railway Rights-of-way

The railway system rights-of-way within the Milwaukee area were also inventoried with respect to their potential to accommodate primary transit guideways. For the purposes of this inventory, the railway system was divided into 23 right-of-way segments, based upon the operating divisions and subdivisions currently or historically in effect on the Chicago, Milwaukee, St. Paul & Pacific Rail-

Map 11

LOCATION OF RIGHT-HAND OR OUTSIDE RAMPS ON THE MILWAUKEE AREA FREEWAY SYSTEM

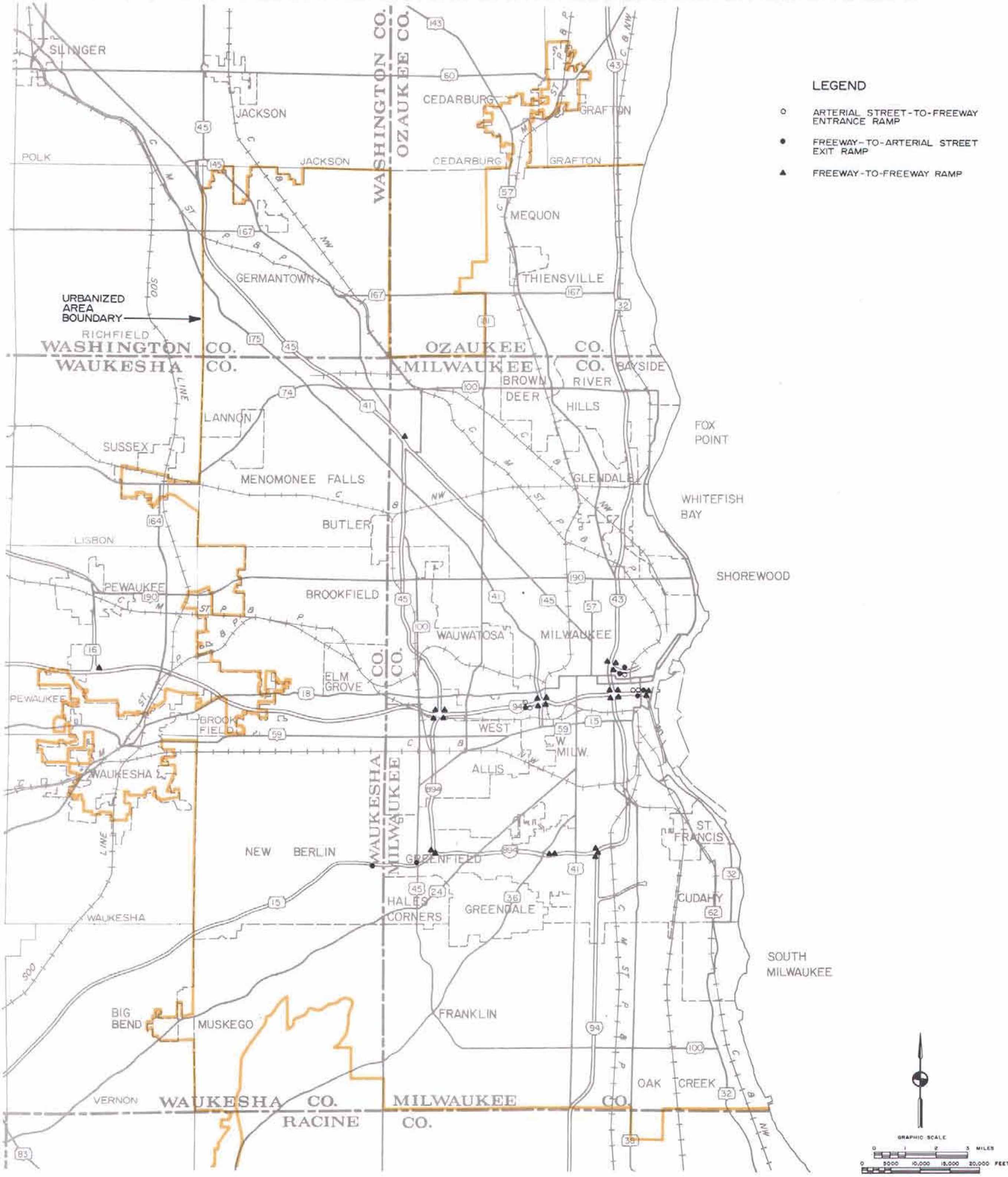


The problem of ramp crossings at freeway interchanges by potential primary transit alignments located on the freeway right-of-way hinders the use of the freeway outside shoulders, the nonroadway portion of the freeway right-of-way, and, for reserved busways, the lanes located adjacent to the outside shoulders. This is because most of the ramps on the Milwaukee freeway system are associated with arterial street interchanges, and the overwhelming number of these ramps enter or exit from the right-hand side of the freeway.

Source: SEWRPC.

Map 12

LOCATION OF LEFT-HAND OR MEDIAN RAMPS ON THE MILWAUKEE AREA FREEWAY SYSTEM



There are a limited number of arterial street interchanges served by left-hand ramps on the Milwaukee area freeway system. At freeway-to-freeway interchanges, ramps generally enter and exit on both the right-hand and left-hand sides of the freeway.

Source: SEWRPC.

road (Milwaukee Road), the Chicago & North Western Railway (C&NW), and the Soo Line Railroad. Tables 12 and 13 and Map 13 summarize the physical characteristics and potential for primary transit use of each active and abandoned railway right-of-way in the study area.

As indicated in Table 12, 14 of the 20 active railway lines that have been inventoried were determined to have, overall or in major segments, good or fair potential for the location of light rail transit, heavy rail rapid transit, or exclusive busway fixed guideway facilities, as sufficient right-of-way was available outside the existing railway trackage to accommodate a dual fixed guideway. In addition, of the three active railway lines which were assessed overall as having either poor or no potential for the development of fixed guideway facilities, all had limited portions suitable for the location of at-grade fixed guideway facilities. Those railway rights-of-way determined not to be suitable for the location of at-grade, fixed guideway, primary transit facility development generally had a large concentration of industrial sidings and lead tracks on both sides of the right-of-way; additional railway trackage for passing, storage, and station facilities within the right-of-way; and intensive industrial development located immediately adjacent to the right-of-way.

With respect to the three abandoned railway rights-of-way in the study area, there is potential to locate primary transit fixed guideway facilities only within the right-of-way of the former Chicago & North Western Railroad Company lakefront main line. The right-of-way of the former Milwaukee Road North Lake branch line is not direct in alignment. The right-of-way of the Chicago & North Western Railway Whitefish Bay main line has been converted to other uses, including public street rights-of-way and commercial and residential development.

Potential Commuter Rail Routes

A total of six railway routes within the seven-county Southeastern Wisconsin Region were identified in the inventory and assessment of readily available primary transit system rights-of-way as having the potential to be utilized for the operation of commuter rail service (see Map 14). In the identification of these commuter rail routes, the following characteristics of the routes were considered: construction to railway mainline engineering standards; access to the Milwaukee central business district and other major trip generators with concentrations of residential development; and the existence of double track. The six potential commuter rail routes radiate from downtown Milwaukee to Port Washington, Saukville, West Bend, Oconomowoc, Kenosha, and Waukesha.

Five of these six potential commuter rail routes appear to have good potential for such operation insofar as the engineering standards and physical condition of the trackage are concerned, as they would require between $251,000 and $484,000 per mile for the work necessary to permit commuter rail operation. This work would include a significant amount of track rehabilitation on each route, the construction of storage and servicing facilities for the trains at the outermost station on each route, the installation of automatic crossing gates at all public at-grade street and highway crossings, and—on three of the routes—the construction of a connecting track between the trackage of Milwaukee Road and the C&NW railway lines. The route between Milwaukee and Oconomowoc appears to have excellent potential for such operation since most of the trackage that would be utilized is presently in very good condition and would allow commuter train speeds of 60 miles per hour. The restoration of this route for commuter rail operation would require only $118,000 per mile in track rehabilitation costs. Table 14 and Map 14 summarize the work required and the cost thereof to operate commuter trains over each route.

In consideration of Table 14, it must be recognized that the Milwaukee Road is anticipating the completion of major track rehabilitation work during the 1980 and 1981 construction seasons on some of these six railway line segments. Should this occur, the initial investment for track rehabilitation required for some proposed commuter rail projects would be significantly reduced. These differences in total costs of track rehabilitation are summarized for each of the six commuter rail routes in Table 15. It must also be recognized that some segments of the six commuter rail routes considered utilize common trackage to gain access to the passenger station at Milwaukee. If a commuter rail system were implemented that used such a combination of routes, certain segments of rehabilitated railway track could be used by trains of more than one route. Accordingly, the total cost of track rehabilitation for such a commuter rail system would be $35,738,000.

PUBLIC FINANCIAL RESOURCES

Public Revenues

Total revenues of all local governments in the Region have increased steadily from about $0.56 billion in 1960 to about $1.14 billion in 1976—an

Table 12

POTENTIAL FOR PRIMARY TRANSIT FIXED GUIDEWAY LOCATION ON ACTIVE RAILWAY RIGHTS-OF-WAY IN THE MILWAUKEE URBANIZED AREA

Right-of-Way			
Name and Owner	Limits	Physical Characteristics	Potential for Primary Transit Use
Milwaukee Road—First Subdivision	Milwaukee passenger station and N. Springdale Road in the Town of Pewaukee—15.7 miles	Double-track railway line with passing and industrial sidings along both sides of the track. Right-of-way width ranges from 66 feet to 250 feet; outside clearances along the eastbound main line range from 10 feet to 45 feet and along the westbound main line from 10 feet to 35 feet. Most horizontal curves have curvature generally less than 2°00′. Vertical alignment is marked by flat gradients, generally less than 1.0 percent. There are 49 street, railroad, and watercourse crossings and industrial sidings concentrated east of the Stadium Freeway and between the Stadium Freeway Interchange and W. Harwood Avenue	Poor or No Potential—Insufficient horizontal clearance, industrial sidings and trackage requiring complete grade separation and the need to acquire additional right-of-way generally precludes ready development of primary transit fixed guideway on this right-of-way. Grade separations of at-grade crossings constitute a serious limitation and large capital cost consideration
Milwaukee Road—Fifth Subdivision	North Milwaukee Station located at N. 33rd Street and W. Cameron Avenue to Cedar Creek Road in the Village of Grafton—16.5 miles	Single-track railway line with passing and industrial sidings along both sides of the right-of-way. Right-of-way width ranges from 66 feet to 100 feet; outside clearances range from 15 feet to 47 feet on each side of the right-of-way. Horizontal alignment is marked by long stretches of tangent between large radius curves with curvatures less than 2°30′. Vertical alignment is marked by flat gradients, generally less than 1.0 percent. There are 51 street, railroad, and watercourse crossings and 25 industrial sidings concentrated between Good Hope Road and Cedar Creek Road in the Town of Grafton	Fair Potential—In general, the portion of this right-of-way west of Canco Station in the City of Milwaukee has good potential for the location of at-grade primary transit facilities. However, the section between North Milwaukee Station and Canco Station is not suitable for at-grade primary transit fixed guideway development because of the presence of industrial and railroad trackage, and of industrial development immediately adjacent to the right-of-way. Grade separation of at-grade crossings constitute a serious limitation and large capital cost consideration
Milwaukee Road—Twelfth Subdivision	North Milwaukee Station at N. 33rd and W. Cameron Avenue to USH 41/45 in the Village of Germantown—15.8 miles	Single-track railway line with passing and industrial sidings along both sides of the right-of-way. Right-of-way width is 99 feet along its entire length; outside clearances are 47 feet, except at North Milwaukee, Granville, and Germantown Stations, where they range between 10 feet and 20 feet. Horizontal alignment is marked by 12 curves, most of which have a curvature of less than 2°30′. Vertical alignment is marked by flat gradients, generally less than 1.0 percent. There are 39 street, railway, and watercourse crossings and 26 industrial sidings concentrated between W. Hampton Avenue and N. 43rd Street	Good Potential—The physical characteristics of the right-of-way, including horizontal and vertical alignment and right-of-way width, all allow for at-grade primary transit development. The portion of the right-of-way between N. 43rd Street and W. Hampton Avenue is not well suited because of the presence of additional railroad and industrial trackage within the right-of-way, requiring grade separation along this section of right-of-way
Milwaukee Road—Seventeenth Subdivision	Granville Station located at the intersection of N. 107th Street and N. Granville Road to the Menomonee Falls station located at E. Water Street in the Village of Menomonee Falls—3.8 miles	Single-track railway line with passing and industrial sidings. Right-of-way width is 100 feet between Granville Station and Milepost 101.0, where it narrows to 60 feet in width and remains this width to the Village of Menomonee Falls; outside clearances along both sides of the track are generally 27 feet. Horizontal alignment is marked by curves, most of which have a curvature of less than 2°30′. Vertical alignment is characterized by flat gradients, less than 2.0 percent. There are eight street, railway, and watercourse crossings along this line, and five industrial sidings which are concentrated between CTH YY and E. Water Street in the Village of Menomonee Falls	Good Potential—The physical characteristics of the right-of-way do not place severe constraints on the location of at-grade primary transit facilities. Crossings with public streets and industrial trackage pose a serious limitation to the use of the right-of-way for the location of fixed guideway facilities, placing a particularly serious constraint on heavy rail rapid transit development
Milwaukee Road—Twenty-Sixth Subdivision	Brookfield Station in the City of Brookfield to the Chicago & North Western railway crossing in the City of Waukesha—7.4 miles	Single-track railway line with passing and industrial sidings. The right-of-way is 66 feet wide except between W. Broadway Street and Mary Street in the City of Waukesha, where it is 80 feet wide, and between the junction with the First Subdivision and N. Brookfield Road, where it is 250 feet wide; outside clearances range between 10 feet and 31 feet. Most horizontal curves have a curvature of less than 2°00′. Vertical alignment is marked by flat gradient, generally less than 0.2 percent. There are 27 street, railway, and watercourse crossings along this line, and there are 12 industrial sidings concentrated between the C&NW railway crossing and the Soo Line crossing in the City of Waukesha	Fair Potential—The physical characteristics of the right-of-way would allow for at-grade primary transit development except between the C&NW Railway crossing and the Soo Line Railroad crossing, which is not well suited for primary transit fixed guideway development because of the presence of additional railroad trackage in the right-of-way and because of the industrial development located immediately adjacent to the right-of-way. Grade separations constitute a serious limitation and large capital cost consideration

Table 12 (continued)

Right-of-Way			
Name and Owner	Limits	Physical Characteristics	Potential for Primary Transit Use
Milwaukee Road—Thirtieth Subdivision	Milwaukee passenger station and the Milwaukee-Racine County line located in the City of Oak Creek—14.8 miles	Double-track railway line with passing and industrial sidings. Right-of-way is generally 100 feet wide except at Lake and Oakwood Stations, where it is 200 feet and 150 feet wide, respectively; outside clearances are generally 38 feet along each side of the track, but at some locations are reduced to 15 feet. There are 10 horizontal curves, most of which have a curvature of 2°00'. Vertical alignment is marked by flat gradients, generally less than 0.5 percent. There are 41 street, railway, and watercourse crossings along this line, and there are 31 industrial sidings concentrated between the Milwaukee passenger station and W. Drexel Avenue	Fair Potential—The right-of-way south of W. Drexel Avenue has good potential for the location of at-grade fixed guideway facilities; the portion north of W. Drexel Avenue has little or no potential because of the concentration of industrial sidings and the railway trackage for passing, storage, and station facilities within the right-of-way
Milwaukee Road—Trackage Between Grand Avenue Junction and North Milwaukee Station	Between the intersection of W. Wisconsin Avenue and N. 44th Street and North Milwaukee Station located at the intersection of W. Cameron Avenue and N. 33rd Street—5.2 miles	Double-track railway line located in a cut section between Grand Avenue Junction and W. Meinecke Avenue, and in a fill section from W. Meinecke to North Milwaukee Station. The right-of-way is generally 100 feet wide; outside clearances range between 10 feet and 38 feet. There are six horizontal curves, all of which have a curvature of less than 4°00'. Vertical alignment is marked by flat gradients, generally less than 1.0 percent. There are 22 street, railway, and railroad crossings along this line, and there are 52 industrial sidings concentrated between W. Meinecke Avenue and North Milwaukee Station	Poor Potential—The portion of the right-of-way north of W. Meinecke Avenue has poor potential because of the large number of industrial sidings, the presence of other railroad trackage in the right-of-way, and the intensive industrial development located immediately adjacent to the right-of-way Good Potential—The portion of the right-of-way south of W. Meinecke Avenue has good potential for the location of fixed guideway facilities. However, crossings with industrial lead tracks pose a serious limitation to the use of this portion of right-of-way, placing a particularly serious constraint on heavy rail rapid transit development
Milwaukee Road—Chestnut Street Line	North Milwaukee Station at W. Cameron Avenue and N. 33rd Street to S. Juneau Avenue in the City of Milwaukee—6.3 miles	Single-track railway line with passing and industrial sidings. Right-of-way width is generally 50 feet except between E. North Avenue and W. Juneau Avenue, where it is 400 feet; outside clearances are generally less than 20 feet on each side of the right-of-way. There are 10 horizontal curves most of which have a curvature of less than 4°00'. Vertical alignment is marked by flat gradients, generally less than 1.0 percent. There are 33 street, railway, and watercourse crossings along this line, and there are 65 industrial sidings distributed uniformly along the segment	Poor Potential—Because of the large number of industrial sidings, the presence of other railroad trackage for yards or stations in the right-of-way, and the intensive industrial development located immediately adjacent to the right-of-way, this railway line is not suitable for at-grade primary transit fixed guideway development. In addition, grade separations at crossings constitute a serious constraint and large capital cost consideration
Milwaukee Road—Elm Grove Line	Elm Grove Station in the City of Elm Grove to the west end of Air Line Yard in the Menomonee River Valley—6.0 miles	Single-track railway line with passing and industrial sidings. The right-of-way width is generally 100 feet; outside clearances are generally 47 feet on each side of the track. There are eight horizontal curves, most of which have a curvature of less than 2°00'. Vertical alignment is marked by flat gradients, generally less than 1.0 percent. There are 21 street, highway, and railroad crossings along this line, and there are 25 industrial sidings, most of which are concentrated along the south side of the right-of-way between Elm Grove Station and S. Hawley Road	Good Potential—The physical characteristics of this railway right-of-way would allow for primary transit development along the entire length of this segment. The north side of the right-of-way lends itself more readily to fixed guideway development

Table 12 (continued)

Right-of-Way			
Name and Owner	Limits	Physical Characteristics	Potential for Primary Transit Use
Milwaukee Road—Menomonee Valley Railway Trackage	Extends three miles westerly from the Milwaukee River to S. 44th Street and the Stadium Freeway (USH 41). Bounded along the north by the East-West Freeway (IH 94) and the south by a bluff located immediately north of Mitchell Park and W. Pierce Street	The Canal Street switching spur is a double-track railway line. Between N. 30th Street and S. 20th Street the right-of-way is 65 feet wide; between S. 20th Street and the South Menomonee Canal right-of-way is located within a 35-foot easement in the center of Canal Street. Outside clearances range between 10 feet and 20 feet except east of S. 20th Street, where there is no right-of-way available. There are 29 industrial sidings uniformly distributed along the entire length of the segment. The Plankinton spur track is a double-track railway. The right-of-way width west of the 16th Street viaduct is 50 feet; the portion of the railway segment east of the viaduct was sold to a private concern. The outside clearance along each side of the right-of-way is generally 16 feet	Poor Potential—The concentration of sidings along the outside of the right-of-way and inadequate outside clearances make the location of fixed guideway transit facilities on Menomonee Valley railway trackage impractical
Chicago & North Western—Shoreline Subdivision	Wiscona Junction and Pioneer Road in the City of Mequon—12.9 miles	Single-track railway line with passing sidings. The right-of-way width ranges between 99 feet and 200 feet, outside clearances range between 29 feet and 96 feet on each side of the track. There are five horizontal curves, all of which have a curvature of less than $2^{o}00'$. Vertical alignment is marked by flat gradients, less than 0.5 percent. There are 23 street, railway, and watercourse crossings along this line, and there are no industrial sidings or lead tracks along this segment	Good Potential—The physical characteristics would allow for at-grade primary transit development along this railway segment except west of N. Port Washington Road, where substantial earthwork would be required to obtain an adequate cross-sectional area for the location of at-grade primary transit fixed guideway facilities. Crossings with public streets pose a serious limitation to the use of the right-of-way, placing a particularly serious constraint on heavy rail rapid transit development
Chicago & North Western—Air Line Subdivision	Butler Junction in the City of Milwaukee to Cedar Lane in the unincorporated village of Rockfield—19.5 miles	Single-track railway line except between Butler Junction and the west switch of Wiscona Junction, where the line is a double-track railway. The right-of-way width is generally 100 feet; outside clearances range between 10 feet and 47 feet on each side of the track. There are 10 horizontal curves, most of which have a curvature of less than $3^{o}00'$. Vertical alignment is marked by flat gradients, generally less than 0.5 percent. There are 53 street, railroad, and watercourse crossings along this line, and there are 24 industrial sidings concentrated on the portion of the right-of-way between the junctions at Butler and Wiscona	Good Potential—The physical characteristics of the right-of-way would allow for at-grade primary transit development except between USH 45 and Wiscona Junction, where the presence of additional railroad and industrial trackage in the right-of-way precludes the location of at-grade primary transit development
Chicago & North Western—Adams Subdivision	Butler Yard and CTH J located northwest of the Village of Sussex—9.3 miles	Double-track railway line between Butler Yard and Milepost 18.0 and single-track line between Milepost 18.0 and CTH J. The right-of-way ranges in width between 100 feet and 725 feet; the outside clearances range from 10 feet to 97 feet along the north or east side of the right-of-way, and 33 feet to 170 feet along the south or west side of the right-of-way. There are three horizontal curves, all of which have curvatures of $3^{o}00'$ or less. Vertical alignment is marked by flat gradients, generally less than 0.6 percent. There are 22 street, highway, railroad, and watercourse crossings along this line, and there are nine industrial crossings concentrated at Butler Yard and between Butler Junction and Lily Road	Good Potential—The physical characteristics of the right-of-way would allow for at-grade primary transit development along this railway section. Crossings with public streets and watercourses pose the most serious limitation to the use of the right-of-way, placing a particularly serious constraint on heavy rail rapid transit development
Chicago & North Western—New Line Subdivision	Butler Yard and the Milwaukee-Racine County line—25.1 miles	Double-track railway line with passing and industrial sidings. The right-of-way width is generally 100 feet, but increases to 400 feet at Mitchell Yard; outside clearances range between 10 feet and 95 feet. There are 14 horizontal curves, most of which have a curvature of less than $3^{o}00'$. Vertical alignment is marked by flat gradients, generally less than 1.0 percent. There are 85 street, railway, and watercourse crossings along this line, and there are 49 industrial lead tracks or sidings, most of which are concentrated between Belton Junction and Chase Junction	Poor Potential—In general, the portions of the right-of-way between Butler Yard and Chase are not suitable for at-grade primary transit fixed guideway development because of the concentration of industrial sidings and lead tracks, the presence of other railroad trackage, and industrial development located immediately adjacent to the right-of-way Good Potential—The portion of the right-of-way between Chase and the Milwaukee-Racine County line has good potential. Crossings with public streets and industrial trackage pose a serious limitation on the use of the right-of-way, presenting a more serious constraint on heavy rail rapid transit development

Table 12 (continued)

Right-of-Way			
Name and Owner	Limits	Physical Characteristics	Potential for Primary Transit Use
Chicago & North Western—Waukesha Subdivision	Belton Junction and STH 59 in the City of Waukesha—11.0 miles	Single-track railway line with passing and industrial sidings. The right-of-way width is generally 100 feet except between E. Broadway Street and West Avenue in the City of Waukesha, where it ranges between 50 and 200 feet; outside clearances are generally 47 feet but are reduced to between 10 feet and 20 feet where passing track is located. There are eight horizontal curves, most of which have a curvature of less than 3°00'. Vertical alignment is marked by flat gradients, generally less than 1.0 percent. There are 30 street, railroad, and watercourse crossings along this line, and there are 14 industrial crossings concentrated between Hall's Siding and the Milwaukee Road railway crossing in the City of Waukesha	Fair Potential—While the physical characteristics of the right-of-way allow for at-grade primary transit development along this segment, the presence of industrial lead tracks and other railraod trackage in the right-of-way precludes the at-grade location of primary transit fixed guideway facilities between S. East Avenue and the Milwaukee Road railway crossing in the City of Waukesha
Chicago & North Western—Kenosha Subdivision	St. Francis Station and the Milwaukee-Racine County line in the City of Oak Creek—10.0 miles	Double-track railway line with passing and industrial sidings. The right-of-way width ranges between 100 feet and 200 feet; outside clearances range between 10 feet and 40 feet on both sides of the track. There are 10 horizontal curves, most of which have a curvature of less than 1°00'. Vertical alignment is marked by flat gradients, generally less than 0.75 percent. There are 23 street and watercourse crossings along this line, and there are 25 industrial crossings concentrated on that portion at Cudahy Station, South Milwaukee Station, and Oak Creek Station	Good Potential—The physical characteristics of the right-of-way generally allow the location of primary transit fixed guideway facilities along this railway segment. Crossings with public streets and industrial trackage pose the most serious limitation on the use of the right-of-way, presenting a more serious constraint on heavy rail rapid transit development
Chicago & North Western—Capitol Drive Spur Track	Wiscona Junction and E. Bradford Avenue in the City of Milwaukee—5.7 miles	Single-track railway line. Right-of-way width is generally 100 feet except between Wiscona Junction and N. Green Bay Avenue, where it is 160 feet; outside clearance between Wiscona Junction and N. Green Bay Avenue is 77 feet on each side of the track, and between N. Green Bay Avenue and E. Hampton Road is generally 47 feet. There are five horizontal curves, most of which have a curvature of less than 3°00'. Vertical alignment is marked by flat gradients, generally less than 1.0 percent. There are 22 street, railway, and watercourse crossings along this line, and there are seven industrial sidings along the west side of the railway right-of-way	Good Potential—Between Wiscona Junction and E. Hampton Avenue the location of at-grade primary transit fixed guideway facilities would not require changes to existing track configuration, nor would it necessitate the purchase of additional right-of-way or facility grade separation to provide adequate outside clearances. The remaining portion of this right-of-way—that between E. North Avenue and E. Hampton Avenue—has fair to good potential for the location of at-grade primary transit facilities. The outside clearances along both sides of the right-of-way would be adequate to permit at-grade transit fixed guideway development if the existing bicycle trail in the right-of-way were removed. The industrial sidings in the railroad right-of-way in the vicinity of E. Bradford Avenue will also present a problem to at-grade guideway development
Chicago & North Western—Chase Spur Track	Chase Junction to E. Washington Street in the City of Milwaukee—2.1 miles	Single-track railway line with passing and industrial trackage. The right-of-way width ranges between 30 feet and 100 feet; outside clearances range between 15 feet and 60 feet on both sides of the track. There are four horizontal curves, all of which have a curvature of less than 4°00'. Vertical alignment is marked by level gradients. There are eight street and watercourse crossings along this line, and there are nine industrial sidings concentrated between E. Lincoln Avenue and E. Washington Street	Poor Potential—Although the physical characteristics of the right-of-way would allow for primary transit development along the section of right-of-way north of E. Lincoln Avenue, the concentration of sidings and the presence of other railraod trackage for passing and storage in the right-of-way, along with a major watercourse crossing, make the location of fixed guideway facilities impractical Good Potential—The portion of the right-of-way south of E. Lincoln Avenue has good potential for an at-grade primary transit facility

Table 12 (continued)

Right-of-Way			
Name and Owner	Limits	Physical Characteristics	Potential for Primary Transit Use
Chicago & North Western—National Avenue Spur Track	St. Francis Tower to E. Erie Street in the City of Milwaukee—3.5 miles	Four-track railway line between St. Francis tower and E. Linus Street, and double-track line between E. Linus Street and E. Erie Street. The right-of-way width ranges between 100 feet and 475 feet; outside clearances range between 10 feet and 60 feet along both sides of the right-of-way. There are four horizontal curves, all of which have a curvature of less than 3°31'. Vertical alignment is marked by flat gradients, generally less than 0.75 percent. There are 13 street and watercourse crossings along this line, and there are 12 industrial sidings concentrated between E. Lincoln Avenue and E. Erie Street	Good Potential—The portion of the right-of-way south of E. Linus Street has good potential for the location of an at-grade primary transit facility. The concentrations of industrial sidings and other railroad trackage north of E. Linus Street, however, make the location of fixed guideway facilities impractical
Soo Line—First Subdivision	City limits of Waukesha—4.2 miles; village limits of Sussex—1.1 miles	Single-track railway line along both sections of the right-of-way. The right-of-way within the city limits of Waukesha between CTH A and W. College Avenue is generally 100 feet wide, and between W. College Avenue and the Waukesha city limits is 66 feet wide. The right-of-way width within the Village of Sussex is generally 66 feet; outside clearance within the City of Waukesha is generally 47 feet on each side of the right-of-way between CTH A and W. College Avenue. From W. College Avenue to the Waukesha city limits, the outside clearances are generally 30 feet on each side of the right-of-way except between E. Broadway and E. Arcadian Avenue and between E. Main Street and Whiterock Avenue, where no outside clearances are provided. The outside clearance along the portion of right-of-way located in the Village of Sussex is about 30 feet on each side of the right-of-way. There are five horizontal curves, all of which have a curvature of less than 4°00'. Vertical alignment is characterized by flat gradients. There are 23 street and railway crossings along this line, most of which are located in the City of Waukesha, and there are six industrial crossings concentrated in the City of Waukesha between E. Broadway and Whiterock Avenue	Fair Potential—The right-of-way in the City of Waukesha could accommodate at-grade primary transit facilities except between E. Broadway and Whiterock Avenue, where the presence of industrial crossings and other railroad trackage within the right-of-way precludes the development of at-grade primary transit facilities Good Potential—The physical characteristics of the right-of-way would allow for at-grade primary transit development along the portion of the right-of-way located in the Village of Sussex

Source: SEWRPC.

increase of about 104 percent, measured in constant 1967 dollars. Since 1960, the property tax levy has consistently been the major source of revenue for local governments in the Region. It should be noted, however, that measured in constant 1967 dollars, the per capita property tax has declined since 1972, when the per capita rate peaked at about \$265, falling to \$249 per capita in 1976. The full or equalized value of all taxable real and personal property has increased from \$9.68 billion in 1960 to \$15.42 billion in 1976, an overall increase of about 59 percent, measured in constant 1967 dollars.

Total revenues of all municipal units of governments within Milwaukee County increased by about 60 percent between 1960 and 1976—from \$289 million to \$463 million, measured in constant 1967 dollars. During this same period, property tax revenues collected by municipal units of government in Milwaukee County declined in relative importance—from providing over 49 percent of total revenues in 1960 to providing just over 40 percent of total revenues in 1976. Receipts from borrowing also declined within Milwaukee County, measured in constant 1967 dollars, from a 1960 level of over \$40 million to just under \$36 million in 1976, a decrease of about 11 percent.

Public Expenditures

Since 1960, the combined expenditures of all local governments within the Region have increased by about 103 percent—from the \$0.55 billion level in 1960 to \$1.13 billion in 1976, measured in con-

Table 13

POTENTIAL FOR PRIMARY TRANSIT FIXED GUIDEWAY LOCATION ON ABANDONED RAILWAY RIGHTS-OF-WAY IN THE MILWAUKEE URBANIZED AREA

Right-of-Way				
Name and Owner	Limits	Past Use	Present Use	Potential for Primary Transit Use
Former Chicago & North Western Railway Company—Lakefront Main Line	E. Bradford Avenue to E. Erie Street—2.7 miles	Used primarily for intercity passenger service and local freight and switching movements. Double-track railway with additional yard and terminal trackage to serve as an intercity passenger depot, passenger coach yard, industrial trackage, and locomotive servicing facilities. Right-of-way width is generally 100 feet north of E. Kane Place and 66 feet between E. Kane Place and E. Mequon Street	Right-of-way is intact north of E. Mason Street. North of E. Kane Place the grade is depressed below street level and the right-of-way width is about 60 feet. This section is owned by Milwaukee County and is used as a bicycle trail. South of E. Mason Street the right-of-way is not intact, is owned by the City and County of Milwaukee, and is either vacant or used for automobile parking lots. This section of the right-of-way is in the process of being developed for parkland and warehousing. There are 12 public street, highway, and pedestrian crossings on this line	Very Good Potential—North of E. Mason Street there is very good potential for the development of a primary transit system fixed guideway Poor Potential—The right-of-way south of E. Mason Street has poor potential for the ready location of primary transit since the land is being converted to other use
Former Milwaukee Road—North Lake Branch Line	E. Water Street in the Village of Menomonee Falls to the western limits of the Village of Sussex—8.7 miles	Operated as a single-track railway line. The right-of-way is generally 60 feet wide	The right-of-way is generally intact. The right-of-way between E. Water Street and W. Appleton Avenue has been purchased by Bend Industries, Inc. The right-of-way between W. Appleton Avenue and the easterly limits of the Village of Sussex has been purchased by Waukesha County, part of which is being used as an alignment for a sanitary trunk sewer, and part of which is to be used as a recreational trail	Poor Potential—Purchase of the right-of-way for a recreational trail by Waukesha County and the purchase of a portion of the right-of-way in the Village of Menomonee Falls suggests its long-term use for freight shipments by railway, creating a break in the continuity of the right-of-way
Former Chicago & North Western Railway—Whitefish Bay Main Line	Capitol Drive spur track near E. Capitol Drive to a connection with the Shoreline Subdivision, approximately 0.2 mile south of E. Green Tree Road—4.3 miles	Operated as a single-track railway line. The right-of-way is generally 66 feet wide. This route segment was utilized by passenger and freight trains between Milwaukee and Green Bay	The railway grade has been converted to other uses, including public street rights-of-way and commercial and residential development	Poor Potential—Since the right-of-way no longer exists, there is no potential for its use in the development of primary transit fixed guideway facilities

Source: SEWRPC.

stant 1967 dollars. The three largest categories of expenditure by governments in the Region in 1976 were education; health, sanitation, and welfare; and the protection of persons and property. In 1976, these three categories accounted for 70 percent of all governmental expenditures. Expenditures by all general-purpose units of government in the Region for the construction, operation, and maintenance of highways, streets, and bridges totaled about $96 million in 1960, or about 17 percent of total local expenditures, and $114 million in 1970, or about 10 percent of total local expenditures, measured in constant 1967 dollars.

The public financial expenditure pattern for the municipal units of government in Milwaukee County shows an overall increase in total expenditures—from about $281 million in 1960 to $471 million in 1976, an increase of about 68 percent, measured in constant 1967 dollars. Expenditures for highway construction, operation, and maintenance by Milwaukee County municipal units of government also increased by about 68 percent—from over $47 million in 1960 to over $80 million in 1976, in constant 1967 dollars—thus keeping pace with the increase in total expenditures. Expenditures for capital construction of highways, streets, and bridges by the municipal units of government within Milwaukee County, however, showed a much smaller increase—from over $31 million in 1960 to about $40 million in 1976 in constant 1967 dollars, an increase of about 29 percent. Thus, most of the increase in highway-related expenditures within Milwaukee County was for operation

Map 13

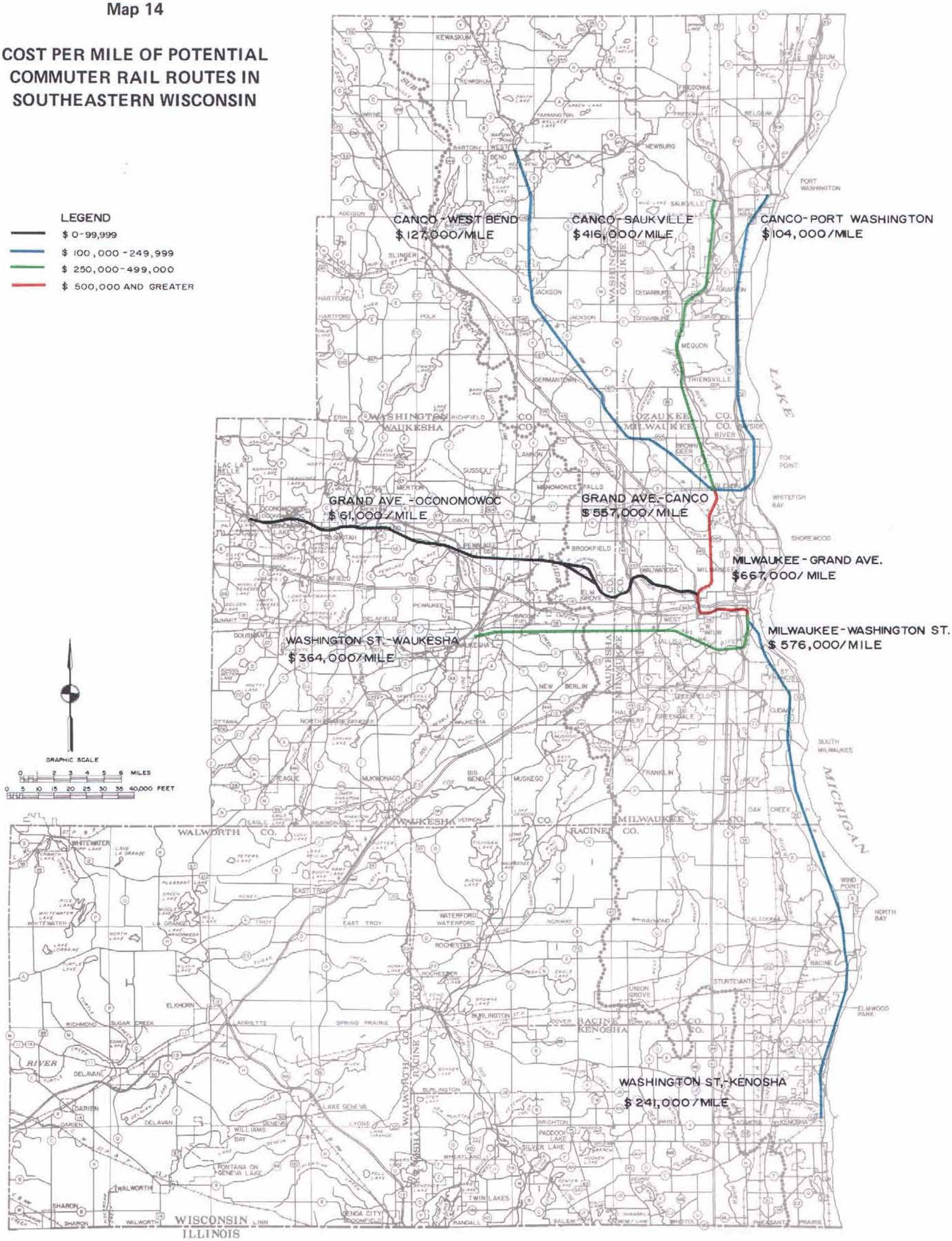
POTENTIAL FOR PRIMARY TRANSIT FIXED GUIDEWAY LOCATION ON ACTIVE AND ABANDONED RAILWAY RIGHTS-OF-WAY IN THE MILWAUKEE AREA

Thirteen of the 20 active railway lines in the Milwaukee area have been determined to have good potential for the location of at-grade primary transit fixed guideway facilities along either the entire length of the right-of-way or along a major segment of the right-of-way. This assessment is based upon the existence of adequate horizontal and vertical clearance for such fixed guideways on the right-of-way along either side of the existing railway trackage, the absence of lengthy portions of the right-of-way located on fill or in cut, the absence of other major obstructions on the right-of-way, and the absence of extensive industrial siding or lead tracks or additional railway trackage or station facilities on the right-of-way. Of the three abandoned railway rights-of-way in the Milwaukee area, only one has good potential for the location of primary transit fixed guideway facilities, that being the former Chicago & North Western Railway lakefront main line.

Source: SEWRPC.

Map 14

COST PER MILE OF POTENTIAL COMMUTER RAIL ROUTES IN SOUTHEASTERN WISCONSIN



A total of six railway routes within southeastern Wisconsin have been identified as having potential for the operation of commuter rail service. This identification is based on the fact that, for the most part, these routes are constructed to mainline engineering standards, have direct access to the Milwaukee central business district and other major trip generators, including major concentrations of residential development, and have double rather than single track. The six potential commuter rail routes radiate from downtown Milwaukee to Port Washington, Saukville, West Bend, Oconomowoc, Kenosha, and Waukesha. Unlike the potential rights-of-way for other primary transit modes, the rights-of-way and guideways for commuter rail service are already in place. An assessment of the potential of each of these rights-of-way, therefore, was based upon the extent to which each of the routes must be upgraded to satisfactorily handle commuter train operation at reasonable speeds. The route between Milwaukee and Oconomowoc appears to have excellent potential for commuter rail operation since the trackage is in very good condition and would entail track rehabilitation costs totaling less than $100,000 per mile west of Grand Avenue Junction. The remaining five routes appear to have good potential for such operation insofar as the engineering standards and physical condition of the trackage are concerned. In all five cases, however, track rehabilitation costs would substantially exceed $100,000 per mile. Noteworthy is the trackage in the Milwaukee terminal area, which would require substantial rehabilitation because of its presently poor condition.

Source: SEWRPC.

Table 14

COMPARISON OF COST PER ITEM FOR COMMUTER TRAIN OPERATION ON EXISTING RAILWAY LINES IN SOUTHEASTERN WISCONSIN

Item	Route					
	Milwaukee-Port Washington	Milwaukee-Saukville	Milwaukee-West Bend	Milwaukee-Oconomowoc	Milwaukee-Kenosha	Milwaukee-Waukesha
Cross Tie Replacement	$ 844,822	$ 1,423,202	$1,135,962	$ 310,552	$1,652,807	$ 855,264
Ballast Work	608,050	1,043,050	815,450	227,480	1,268,918	668,542
Continuous Welded Rail Installation	2,439,117	5,755,617	2,439,117	789,117	1,544,210	2,942,160
Rail Joints Renewal	2,250	- -	3,000	- -	52,500	5,500
Grade Crossing Renewal	38,180	87,160	53,360	2,160	84,040	21,375
Grade Crossing Protection	1,480,000	2,320,000	2,020,000	1,68,000	1,260,000	920,000
Turnout Rehabilitation	1,084,920	1,533,380	1,084,920	188,000	985,544	803,977
Roadbed Widening and Construction	15,000	- -	15,000	- -	8,000	77,030
New Track Installation	258,000	- -	117,600	- -	424,000	125,700
Railway Crossings	- -	- -	35,000	- -	35,000	- -
Signalization and Traffic Control	97,600	37,600	172,600	37,600	100,000	375,000
Property Acquisition	40,000	- -	- -	- -	- -	35,000
Supervision	343,395	609,995	394,595	161,745	370,751	335,227
Contingencies	725,135	1,280,205	828,665	332,665	778,577	716,477
Less Salvage[a]	396,000	934,000	396,000	128,000	250,626	469,819
Storage and Servicing Facilities	200,000	200,000	200,000	200,000	200,000	200,000
Total	$7,780,469	$13,356,209	$8,919,269	$3,801,319	$8,513,721	$7,611,433
Total per Mile	$ 263,745	$ 483,521	$ 257,039	$ 118,053	$ 257,212	$ 386,367

[a] *Salvage represents the value of steel rails sold for scrap as a result of replacement with continuous welded rail.*

Source: SEWRPC.

and maintenance and not for capital construction. The highway construction expenditure patterns for future years indicate that even for construction, the trend is toward funding only the preservation of the existing system. For example, in the annual element of the 1979-1983 transportation improvement program for the Milwaukee urbanized area, highway system preservation expenditures account for 53 percent of total proposed highway construction expenditures. Highway system improvement expenditures, those used to provide existing facilities with additional capacity, account for an additional 41 percent of total highway construction expenditures, leaving 6 percent for highway system expansion or the construction of new facilities.

Public Financial Resources: Public Transit

Public transit was not publicly funded in the Milwaukee urbanized area until 1975, when Milwaukee County obtained a federal grant from the U. S. Department of Transportation, Urban Mass Transportation Administration (UMTA), for over $17 million to fund 80 percent of the cost of acquiring the physical assets of the then privately owned local transit system and purchasing 100 new buses. The UMTA is a major source of transit financing to the Region and provides, through specific authorizations, funding for both the capital and the operational needs of public transit services in the Region. The operational needs of transit services are also funded through specific authorization by the Wisconsin Department of Transportation. These federal and state monies combined provide the bulk of the public transit capital and operating funds in the Milwaukee area. These funding sources, however, do not provide all of the monies needed for transit projects, as local "matching" funds are generally required to obtain both the federal and state financial assistance.

The Urban Mass Transportation Act of 1964, as amended, provides in Section 3, Section 5, and Section 16 funds to urban areas for property acquisition, capital improvements, and the day-to-day operation of public transportation services. Section 3 of the Act provides for the discretionary funding of capital-intensive transit projects by the UMTA. Section 5 provides a population and population density-based formula grant allocation to urbanized areas for the day-to-day operations of, and/or capital improvements to, urban transit systems. Section 16 provides for the capital funding of specialized transit vehicles to meet the special transportation needs of elderly and handicapped people.

Table 15

TOTAL COST OF TRACK REHABILITATION FOR POTENTIAL COMMUTER RAIL ROUTES IN SOUTHEASTERN WISCONSIN WITH AND WITHOUT COMPLETION OF ANTICIPATED MILWAUKEE ROAD TRACK REHABILITATION

Item	Route					
	Milwaukee-Port Washington	Milwaukee-Saukville	Milwaukee-West Bend	Milwaukee-Oconomowoc	Milwaukee-Kenosha	Milwaukee-Waukesha
Total Cost of Rehabilitation.	$7,780,000	$13,356,000	$8,919,000	$3,801,000	$8,514,000	$7,611,000
Cost of Milwaukee Road Portion	$5,205,000	$10,617,000	$5,205,000	$1,668,000	$ 921,000	$1,786,000
Total Cost With Milwaukee Road Participation.	$2,575,000	$2,739,000	$3,714,000	$2,133,000	$7,593,000	$5,825,000
Percent of Total Cost Attributable to Potential Commuter Rail Project With Milwaukee Road Participation	33.1	21.5	41.6	56.1	89.2	76.5

Source: SEWRPC.

Direct state financial assistance, in the form of an operating assistance financial aid program, was established under Chapter 85.05 of the Wisconsin Statutes in 1973 and was greatly increased in 1977. State funds are generally applied as part of the required nonfederal share for federal Section 5 operating assistance .

Within the Milwaukee area, total public operating assistance has substantially increased each year since 1975—from $7.0 million in 1976 to $9.6 million in 1977 and to $13.5 million in 1978. Total public subsidies have increased from $0.15 per ride in 1976 to $0.20 in 1977 and to $0.30 in 1978. Of the total subsidy amounts, $1.5 million, $1.9 million, and $2.0 million were provided by local tax levies in 1976, 1977, and 1978, respectively.

Since 1975 Milwaukee County has used over $59 million in UMTA capital assistance funds. In 1978, $19 million in UMTA capital assistance funds was used principally for the purchase of 150 buses.

CONCLUSION

This chapter has summarized those characteristics of the socioeconomic base of the Southeastern Wisconsin Region most relevant to primary transit system planning. The chapter provides only a summary of the most important of the inventory findings set forth in SEWRPC Technical Report No. 23, Transit-Related Socioeconomic, Land Use, and Transportation Conditions and Trends in the Milwaukee Area. The following summary of major inventory findings suggest several conclusions with respect to the development of the regional transportation system, particularly the primary transit element of that system.

- The scale of regional growth and urbanization within the Region is changing. The very high post-World War II rates of population increase and rural to urban migration appear to have diminished. These very high rates appear to have been replaced with more modest growth rates which are similar to those experienced by the Region in the 1930's and early 1940's.

- The pattern of urban growth within the Region is continuing to change from one of compact, concentric development centered on the oldest and largest central cities of the Region to one of highly diffused, multicentered, low-density development. This areawide diffusion of urban land uses and of population and economic activity has been accompanied by declines in the population levels of the older central cities and first-ring suburbs.

- Despite the fact that the resident population of the Region increased by only 1 percent between 1970 and 1978, from 1,756,100 people to 1,770,500 people, the number of persons in the labor force of the Region increased by nearly 20 percent over this same period, from 744,500 people to 891,700 people. This increase is the result of increased female labor force participation and the changing age structure of the resident population of the Region, wherein a larger proportion of the total population is of work force age. Employment within the Region increased by 15 percent from 1970 to 1978, from 741,600 jobs to 851,800 jobs.

- In the last 15 years, the freeway has emerged as the singularly most important element of the Region's transportation system. During this time, intercity railroad service has been significantly reduced and urban public transit service has suffered a substantial decline in utilization. Freeways comprise about 7 percent of the arterial street and highway system in the Region but carry about one-third of the total trips.

- There are a variety of rights-of-way within the Milwaukee area which can readily accommodate exclusive primary transit guideways at a minimum of cost and urban disruption. The rights-of-way suitable for light rail transit, heavy rail, rapid transit, or busway development include active and abandoned railroad rights-of-way in the Milwaukee area and portions of abandoned private rights-of-way of the extensive electric interurban railway system which once served the Milwaukee area. All of the remaining electric interurban railway rights-of-way are owned by the Wisconsin Electric Power Company and used for the location of electric power transmission trunk lines, except the right-of-way of the former Chicago, North Shore & Milwaukee Railway Company line which is owned by Milwaukee County.

- Six existing railway lines, radiating from downtown Milwaukee north to Port Washington and Saukville; northwest to West Bend; west to Waukesha and Oconomowoc; and south to Racine and Kenosha, have been determined to have location and physical characteristics suitable for the operation of commuter rail primary transit service. Further analysis indicated that these six railway lines have good to excellent potential for commuter rail development, based upon the extent of track rehabilitation, service and storage facility construction, and grade-crossing protection installation that would be necessary on these lines prior to initiation of commuter rail service.

- The significant decline in public transit utilization, which extends back to the 1950's and which occurred long before the emergence of the freeway as the dominant element of the regional transportation system, holds important implications for regional transportation system planning and development. The overwhelming usage and increasing predominance of the automobile present a formidable obstacle to the reestablishment of high-quality, widely used urban public transit services. The continuing trends toward regional land use decentralization and declining urban densities work directly against the development of public transit services. If these trends change, as they have recently begun to, in response to energy price increases and supply shortages and to the provision of a more competitive and attractive public transit service, then the market for public transit services perhaps can be expanded significantly in the Milwaukee area.

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Chapter IV

STATE-OF-THE-ART OF PRIMARY TRANSIT TECHNOLOGY

INTRODUCTION

Primary, or "rapid," transit is defined as that component of the total urban public transit system which is designed to provide the highest speeds, the highest capacities, and the lowest operating and maintenance costs per passenger mile in an urban area. In order to accomplish all these design objectives, the application of primary transit is necessarily limited to operation between relatively widely spaced stops over exclusive guideways or over existing freeways and railway lines located in the most heavily traveled corridors of an urban area. Such corridors typically link the major activity centers of an urban region with areas of concentrated residential development. The high capital costs of fixed guideway construction and the established locations of existing freeways and railway lines, which are essential to high-speed operation, are important factors limiting the provision of primary transit service in urban areas. Another important factor is that only in heavily traveled corridors, where transit travel demands require and can utilize the high passenger-carrying capacity of primary transit at attractive service intervals, can primary transit be efficient in terms of operating and maintenance costs. In addition, a number of the benefits attendant to the provision of primary transit service, such as reduced automobile travel and motor fuel consumption, air pollutant emissions, and parking and highway facility needs, can be achieved only in corridors where potential transit use is substantial.

The purpose of this chapter is to identify and describe those transit technologies and their specific modes of application which are capable of providing a primary level of transit service within the Milwaukee area during the 20-year planning horizon of this alternatives analysis.[1] The design, performance, and cost characteristics of the primary transit modes presented in this chapter are intended to provide a basic understanding of the advantages and disadvantages of each alternative transit technology having potential applicability in the provision of primary transit service in the Milwaukee area, and to specify the characteristics of these primary transit modes to be used in the design, test, and evaluation of specific alternative system plans under this study.[2] These characteristics include the pertinent physical characteristics of the primary transit vehicles, guideways, stations, and support facilities, as well as pertinent performance, capacity, economic, and energy characteristics of the relevant modes.

Consideration of each primary transit mode is herein limited to the characteristics of its current "state-of-the-art" development—that is, to the characteristics of the mode as constructed or expanded in other urbanized areas within the recent past, because the modes considered must be fully implementable as an operating system within the 20-year time frame of the study. The primary transit modes presented herein, therefore, in addition to excluding the technology of systems constructed to obsolete or outmoded standards, exclude technology considered to require further development before application can be considered practical.

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[1] *Secondary transit—or express service—is defined as transit service which is provided over arterial streets, with stops generally located only at intersecting transit routes and major traffic generators. Secondary transit service provides a somewhat greater degree of accessibility at somewhat lower operating speeds than does primary transit service. Tertiary transit—or local service—is defined as transit service which is provided in mixed traffic over arterial and collector streets, with stops typically no more than two city blocks apart, providing a high degree of accessibility but relatively low operating speeds. Tertiary transit service is typically provided throughout a continguously developed urbanized area, while secondary transit service is provided in those corridors of substantial demand where primary transit service is not available.*

[2] *This chapter is based upon information and data presented within SEWRPC Technical Report No. 24, State-of-the-Art of Primary Transit System Technology.*

IDENTIFICATION AND DESCRIPTION OF POTENTIALLY APPLICABLE PRIMARY TRANSIT TECHNOLOGIES

The urban transit technologies which have potential for the provision of a system of primary transit service in the Milwaukee area within the time frame of this study include motor bus technology, electric trolley bus technology, and rail transit technology. The specific modes of motor bus transit technology which permit provision of primary transit service are: operation in mixed traffic on freeways; operation over reserved lanes on freeways; operation on busways; and operation in express service over arterial surface streets, with substantial preferential treatment, including reserved lanes and traffic signal preemption. The available rail transit modes include: light rail transit, heavy rail rapid transit, and commuter rail. These technologies and their specific modes are considered to have potential for application in the provision of a fully operational primary transit system in the Milwaukee area over the next 20 years. All these modes have been proven to be capable of meeting the day-to-day demands of urban transit service, and are "readily available" in terms of individual system components.

Motor Bus Primary Transit Technology

The motor bus is the technology most commonly used to provide primary transit service in the urbanized areas of North America, as well as the technology most commonly used to provide express and local transit service. To provide a primary level of transit service, motor bus technology must be applied in one of the following four modes: mixed traffic operation on freeways, reserved lane operation on freeways, operation on busways, and arterial express operation (see Figure 7).

Mixed Traffic Operation on Freeways: Motor bus operation in mixed traffic on freeways is defined as the operation of rubber-tired, diesel-powered transit buses over freeway lanes that are also open to other types of motor vehicle traffic. This type of primary transit service is exemplified by the "Freeway Flyer" service currently provided in the Milwaukee area. In 1980, the Milwaukee County Transit System operated 10 Freeway Flyer routes from 12 outlying park-ride lots to the Milwaukee central business district. In addition, four specialized bus routes—known as UBUS routes—were operated over freeways to the University of Wisconsin-Milwaukee campus from various areas of Milwaukee County. Of all of the motor bus modes suitable for primary transit service, operation in mixed traffic on freeways is the most widely used in North America, becoming popular during the 1960's with the expansion of major freeway, expressway, and parkway systems. In 1980, most major metropolitan areas within the United States were providing at least some motor bus primary transit service in this fashion.

Application of this mode is almost entirely limited to the provision of highly efficient and attractive, direct, nonstop peak-period service between park-ride lots located adjacent to a freeway in or near outlying residential areas and a central business district. Intermediate stations could, however, be provided on the freeways used if physically separated from the main traffic flow as, for example, at entrance or exit ramps. Typically, the same bus which provides the "line-haul" service over the freeway provides the necessary collection and distribution service in the outlying residential areas served and in the central business district, offering an attractive and efficient "one-seat, no-transfer" ride. The area effectively served is greatly increased by the provision of park-ride lots in outlying areas.

Motor bus operation in mixed traffic on freeways is potentially subject to delays because of traffic congestion. Such delays, however, can be minimized if the freeway is operationally controlled. Operational control of freeways involves the restriction of automobile access to the freeway system at entrance ramps during periods of peak traffic demand to prevent breakdowns in the freeway traffic flow and to thereby maintain high rates of traffic flow and high operating speeds. Motor buses are afforded preferential access to the freeway system at all times by use of exclusive entrance ramps or bypass lanes at existing entrance ramps.

Bypass lanes for motor buses are provided at freeway entrance ramps in a number of urban areas within the United States, including Dallas, Los Angeles, Minneapolis, San Diego, and San Francisco. Exclusive entrance ramps for motor buses are also provided in a number of urban areas, including Chicago, Miami, Pittsburgh, San Diego, and Seattle. In the Milwaukee area there are two locations at which special bypass lanes for buses are provided at metered freeway entrance ramps, and three locations at which exclusive bus ramps are provided to connect park-ride lots directly to the freeway system.

Figure 7

MOTOR BUS PRIMARY TRANSIT TECHNOLOGY

OPERATION IN MIXED TRAFFIC ON FREEWAYS

SEWRPC Photo.

RESERVED FREEWAY LANE OPERATION

Photo courtesy of Milwaukee County Department of Public Works.

OPERATION ON BUSWAYS

Photo courtesy of Southern California Rapid Transit District.

ARTERIAL EXPRESS OPERATION

Photo courtesy of Florida Department of Transportation.

Motor bus transit technology includes four modes that have been identified as having potential for the provision of primary transit service in the Milwaukee area. The first mode is the operation of motor buses in mixed traffic on freeways (upper left), which typically functions as a nonstop peak-period service between outlying park-ride terminals and downtown areas, and is exemplified by the Milwaukee area "Freeway Flyer" service. The second mode is reserved freeway lane operation (upper right), whereby a travel lane of a freeway can be dedicated during peak periods for the exclusive use of high-occupancy vehicles. The third mode is the operation of busways (lower left), which are special-purpose roadways designed for the exclusive use of buses. The fourth motor bus mode is arterial express operation (lower right), which, for application as primary transit service, incorporates bus operation over arterial streets with substantial preferential treatment, including reserved lanes and traffic signal preemption.

Reserved Lane Operation on Freeways: On reserved lane bus systems, motor buses are operated over normal flow or contraflow lanes reserved within freeway rights-of-way for the exclusive operation of motor buses and, in some cases, other high-occupancy vehicles. As with operation in mixed traffic on freeways, a one-seat ride can be offered by circulation of the bus through the service areas located at each end of the reserved lane. The motor bus operation on the reserved lane itself is generally nonstop, and is usually provided only during peak travel periods. Reserved lanes are typically installed on the inside or left-hand side of the roadway, adjacent to the median area, so that conflicts with traffic movements to and from ramps are avoided. To the extent that ramps are provided on the left-hand side of the roadway, conflicts with traffic movements cannot be avoided, and the reserved lane cannot be provided without interchange reconstruction. This situation exists on the East-West Freeway (IH 94) in the Milwaukee area at the Zoo, Stadium, and Marquette Interchanges. Reserved bus lanes on freeways are a relatively recent development, being first implemented during the 1970's. Therefore, such facilities exist in only a few of the largest urban areas of the United States, including Boston, Honolulu, Houston, Los Angeles, Miami, New York City, Portland, San Diego, and San Francisco.

On normal flow reserved lanes, the motor buses are operated in the same direction as traffic in the adjacent lanes. Designation of such a reserved lane on a freeway is usually accomplished by appropriate pavement markings or by the use of traffic cones, traffic posts, and traffic barriers positioned to separate one of the existing traffic lanes from the remaining freeway lanes which remain open to other forms of motor vehicle traffic.

Reserved contraflow freeway lanes—wherein the motor buses travel against the direction of adjacent traffic—are applicable only where a relatively large directional imbalance exists between opposing traffic movements during peak travel periods. Because of the safety factor involved in the operation of opposing flows of traffic within the same roadway, more positive means of lane separation than signs and pavement markings are deemed necessary, such as traffic cones, posts, and barricades.

The provision of a reserved lane for motor buses on an existing freeway can have significant negative impacts, since reserved lanes are logically implemented only on congested freeways, there being no operational advantage to reserving bus lanes on uncongested freeways. Reserving a freeway lane for exclusive bus use in the peak travel direction on a congested freeway—a normal flow reserved lane—can severely disrupt travel in the freeway corridor unless a significant proportion of the automobile traffic can be diverted to the improved bus service. Reserving a freeway lane for exclusive bus use in the nonpeak direction on a congested freeway—a contraflow reserved lane—may cause little disruption if peak-period traffic volumes are directionally imbalanced. However, this is not the case on any freeway in the Milwaukee area, and thus disruption of traffic may be expected. Any disruption caused by the provision of a contraflow lane is particularly critical because the affected automobile traffic is in the opposite direction of, and therefore is not served by, the improved bus service.

Operation on Busways: Busways are special-purpose roadways designed for the exclusive use of transit buses. The facility may be constructed at, above, or below grade and may be located on a separate right-of-way or within an existing freeway or railway right-of-way.

Existing busways in the United States are generally oriented toward providing high-quality, peak-period service to or from central business districts. As of 1980, such facilities were in service in Los Angeles, Philadelphia, Pittsburgh, Providence, and Washington, D. C. Although no busways currently exist in the Milwaukee area, the construction of a busway in the East-West freeway corridor was recommended in the initial regional transportation system plan adopted in 1966. This recommendation led to the conduct of a preliminary engineering study of the proposed busway by the Milwaukee County Expressway and Transportation Commission in 1971.[3] Known as the East-West Transitway, the proposed facility was to extend a distance of 8.0 miles from downtown Milwaukee to a connection with the East-West Freeway near the Waukesha County line, with connecting ramps to the Stadium and Zoo Freeways and to four intermediate stations. In 1973, the Milwaukee County Board of Supervisors adopted the Milwaukee Area Transit Plan, but without inclusion of the busway proposal.

Busways have been constructed with and without intermediate station facilities and access locations. The use of intermediate stations permits busways to operate in a manner similar to typical rail systems. Efficient, direct, nonstop motor bus service without stations could be routed over the exclusive

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[3] *See Milwaukee Area Transit Plan, prepared by the Milwaukee County Expressway and Transportation Commission in cooperation with the Southeastern Wisconsin Regional Planning Commission, and formally adopted by the Milwaukee County Expressway and Transportation Commission on November 9, 1971, and by the Regional Planning Commission on March 2, 1972.*

busway as well. The motor bus can operate off the busway at each end of the facility, if desired, allowing for the efficient collection and distribution of passengers, and providing a highly convenient one-seat ride.

Arterial Express Operation: On arterial express bus primary transit systems, buses are operated over arterial streets with extensive preferential treatment. Although a strict definition of the term "primary transit" might preclude consideration of arterial express bus systems as a form of primary service, a level of service and performance approaching that of primary transit can be provided by arterial express bus operation if a sufficient degree of preferential treatment is provided.

Preferential treatment for buses operating in the arterial express bus mode can be provided by operation over reserved lanes on existing surface arterial streets; by preferential treatment at signalized intersections; or, preferably, by both if a level of service approaching that of primary transit service is to be provided. Reserved lanes on arterial streets can be operated either normal flow or contraflow, and can be located over either curb or median lanes. Like reserved lanes on freeways, reserved lanes on arterial streets are typically in service only during weekday peak travel periods. An extension of the arterial reserved lane concept is the transit mall, or exclusive transit street. Transit malls are typically implemented only in major business and shopping areas, and include ancillary pedestrian amenities.

Preferential treatment for motor buses at selected intersections is intended to reduce overall vehicle travel time. Methods of accomplishing preferential treatment include the provision of special traffic signal phases for transit turning movements, the phasing of traffic signal cycles to facilitate bus movements through a series of signalized intersections, and the modification of the green phase time, actuated by the presence of a bus at the intersection approach.

Some priority measures for arterial express bus service have been in service within United States cities, as well as in foreign cities, for many years. A number of normal and contraflow lanes reserved specifically for the use of motor buses were implemented during the late 1960's and early 1970's. Reserved bus lanes on arterial streets are typically implemented in or near the central business district. Used for several motor bus routes, most reserved lanes are less than one mile in length and, therefore, are limited to directly serving a particular activity center. There are, however, several reserved lanes in operation within the United States that are several miles or more in length. Because extensive use is made of existing streets and highways, only minor capital outlays are required for the initiation of arterial express bus service. Reserved lanes on surface arterials are provided for buses in over two dozen major urbanized areas within the United States, including Chicago, Minneapolis, and St. Louis, as well as in a number of European cities. Transit malls are found in at least seven major American cities, including Chicago, Detroit, and Minneapolis. Signal priority systems for the granting of preferential treatment to motor buses at intersections is provided in at least 12 United States cities.

Electric Trolley Bus Technology

The electric trolley bus is a rubber-tired bus propelled by electric motors. The motors receive power through power collection poles which are attached to the vehicle roof and which slide along a pair of overhead contact wires, as shown in Figure 8. Because the electric trolley bus requires an overhead power distribution system, deviation from established transit routes cannot occur unless specially designed vehicles are used, although the mode does not require a special guideway as do the rail transit modes.

Most electric trolley bus systems in the United States and Canada were installed during the 1930's and 1940's as an economic replacement for aging electric street railway facilities. Although most of these systems were converted to diesel motor bus operation during the 1950's and early 1960's, this technology remains in operation in the Boston, Dayton, Philadelphia, San Francisco, and Seattle urbanized areas of the United States. In Canada, such systems are in service in Edmonton, Hamilton, Toronto, and Vancouver. Even though all these existing systems have recently undergone some degree of renovation, there are no known proposals at this time for the establishment of completely new electric trolley bus systems within the United States or Canada.

None of the existing systems in North America provide a primary level of service, which would require use of an exclusive guideway or reserved lanes and preferential intersection treatment. Moreover, the typical electric trolley bus system has significant performance limitations imposed by

Figure 8

EXAMPLE OF ELECTRIC TROLLEY BUS TECHNOLOGY

In the United States and Canada today, the electric trolley bus generally operates in mixed traffic over arterial streets, providing a tertiary—or local—level of service. Although this technology does not require a specialized guideway as do rail transit modes, deviations from established routes are not possible because of the required overhead power distribution system. To provide primary transit service, electric trolley buses would have to operate in an arterial express mode with substantial preferential treatment, or over a busway.

Photo by Otto P. Dobnick.

its overhead power system. Only with special design provisions for the vehicles and overhead power system can this mode provide the high-quality, line-haul service provided by light rail transit and motor bus systems.

Rail Primary Transit Technology

Three modes of rail transit technology may be used to provide primary, or rapid transit, service: light rail transit, heavy rail rapid transit, and commuter rail (see Figure 9). Each of the rail transit modes is an individual "self-contained" system that can only function as a line-haul carrier, and not as a passenger collector or distributor. This fact, combined with the need to limit the number of station stops along a line in order to provide an efficient line-haul service, normally requires that adequate park-ride and feeder bus access be provided for passenger collection and distribution.

Light Rail Transit: Light rail transit consists of electrically propelled dual-rail vehicles which receive power from an overhead wire power supply system. Consequently, light rail transit does not need to be provided with a fully grade-separated right-of-way but, like the motor bus modes, can operate over public street rights-of-way. If operated over surface streets, however, light rail transit requires substantial preferential treatment if it is to perform at a primary level of service. Light rail transit vehicles can be operated as single units or in trains of up to four vehicles.

Light rail transit was developed during the 1960's through the evolutionary improvement of electric street railway systems in Western Europe. The initial improvements involved the reduction of mixed traffic operation and the addition of preferential treatment over motor vehicle traffic. During the 1970's, active interest in the mode gained momentum as urban areas outside Europe—including in the United States—undertook programs to either upgrade remaining street railway systems or construct new light rail transit systems. In the United States and Canada, light rail transit systems serve the Boston, Cleveland, Edmonton, Newark, Philadelphia, Pittsburgh, and San Francisco metropolitan areas, as of 1980.[4] Of these, only Edmonton's system is completely new and designed specifically as a light rail transit facility, the remaining systems having been converted from electric street railway operations.

Heavy Rail Rapid Transit: Heavy rail rapid transit consists of dual-rail vehicles propelled by electricity supplied through a side-running third rail. Heavy rail vehicles can thus operate only over an exclusive, fully grade-separated right-of-way. Heavy rail vehicles are typically coupled into a minimum "married pair" of two vehicles, and can be operated in trains of up to 10 vehicles in length. Semi-automated train operation is commonplace in modern heavy rail systems. Heavy rail rapid transit is typically thought of in terms of subway or elevated systems.

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[4] *In addition, light rail transit facilities were under construction in Buffalo, Calgary, San Diego, and Toronto as of the beginning of 1981. All four of those projects are completely new, including that in Toronto, where an extensive street railway system is in operation.*

Figure 9

EXAMPLES OF RAIL TRANSIT TECHNOLOGY

LIGHT RAIL TRANSIT

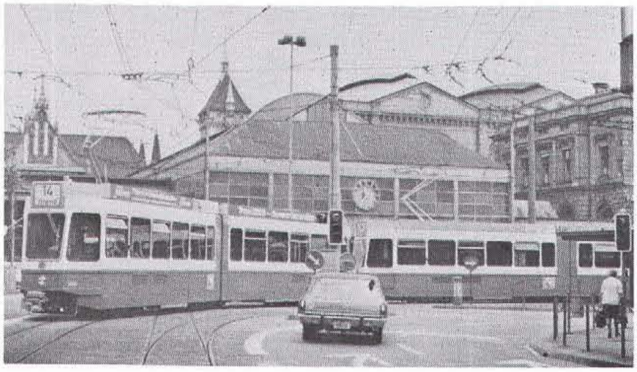

Photo courtesy of Brown Boveri Canada, Ltd.

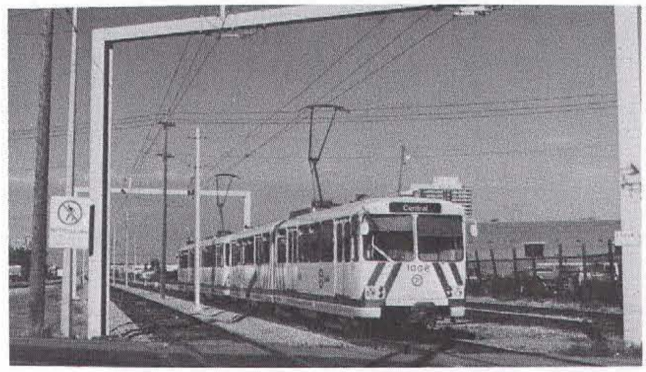

Photo by Russell E. Schultz.

HEAVY RAIL RAPID TRANSIT

Photo courtesy of Bay Area Rapid Transit District.

COMMUTER RAIL

SEWRPC Photo.

Rail transit technology includes three modes that have been identified as having potential for the provision of primary transit service in the Milwaukee area. The first mode is light rail transit, which utilizes electrically propelled vehicles which receive power from overhead wires and can operate in mixed traffic on surface streets, as well as over exclusive, partially or fully grade-separated rights-of-way. European light rail transit systems retain many street railway-like characteristics, especially operation over public street rights-of-way (upper left), while newer North American systems, also located principally on the surface, are generally constructed on exclusive rights-of-way (upper right). The second mode is heavy rail rapid transit (lower left), which requires a fully grade-separated, exclusive right-of-way because of high operating speeds, semi-automated operation, and use of a side-running third rail for power collection. The third rail transit mode is commuter rail (lower right), which is characterized in the United States and Canada by the use of bi-directional trains consisting of railway coaches propelled by diesel-electric locomotives operating over mainline trackage shared with intercity passenger and freight train traffic.

Conventional heavy rail transit systems were constructed in the United States from the 1890's through the 1920's. After a four-decade period of only limited construction, interest in such facilities increased sharply during the 1970's. Contemporary system start-ups exhibit an advanced level of automated train control, and follow standard mainline railway practices far less than do older, conventional systems. Heavy rail rapid transit is generally the most capital-intensive of the primary transit modes, requiring a major investment to produce a usable segment. The development of heavy rail rapid transit systems requires a lengthy implementation period. This is particularly true of systems which incorporate subway alignments. Normally related to heavy rail construction are severe community disruption and long periods of negative impacts.

Heavy rail rapid transit systems normally exist only in the largest urban areas and are generally radial in configuration. Within the United States and Canada, conventional heavy rail rapid transit systems exist in the Boston, Chicago, Cleveland, New York City, Philadelphia, and Toronto areas. Modern systems have been constructed in the Atlanta, Montreal, Philadelphia, San Francisco-Oakland, and Washington, D. C., metropolitan areas. In addition, modern systems are currently under construction in the Baltimore and Miami areas.

Commuter Rail: Commuter rail is a rail transit mode that utilizes diesel-electric or electrically propelled trains, operating over rights-of-way and trackage shared with intercity railway freight and passenger train traffic. This mode normally accommodates only the longest trips in metropolitan areas during weekday peak travel periods at high speeds with relatively few station stops. Common practice in the United States and Canada is to use trains of diesel-electric locomotives and coaches as opposed to electrified multiple-unit equipment. Rolling stock is manufactured to mainline railway standards with respect to suspension, size and strength, and seating arrangements. This, together with relatively long station spacings, characterizes the mode as providing a very high level of riding comfort.

This mode is the oldest of all the rail transit modes, but presently exists only where there are substantial concentrations of passenger trip origins in outlying suburban areas having destinations in the central business district. Because of this basic traffic requirement, commuter rail systems are found only in 10 metropolitan areas within the United States and Canada. Large-scale commuter rail operations which include frequent peak-period service and a base service during nonpeak periods and weekends are found in the Boston, Chicago, Montreal, New York City, Philadelphia, San Francisco, and Toronto areas. A limited amount of commuter rail service—generally oriented to peak-period and peak-direction travel on weekdays—is also operated in the Detroit, Pittsburgh, and Washington, D. C., areas. Only one commuter rail system has been implemented in recent years—Toronto's—and that was intended as a replacement for an existing commuter rail service.

Commuter rail utilizes standard railway rights-of-way and track. Because the railway track is shared with intercity freight and passenger traffic, the mode does not require the construction of a new guideway system. The implementation of new routes or extensions of existing routes is generally confined to existing railway roadbeds, structures, and rights-of-ways, although rehabilitation of such fixed-way facilities may be required prior to initiation of service.

Other Transit Technologies

There are a number of additional transit technologies which, while having certain potential advantages over the proven and readily available technologies, cannot realistically be expected to become practically available for the provision of primary transit service within the next two decades. These technologies, which must be termed "futuristic," are in various stages of development and require extensive research, experimentation, testing, and demonstration prior to practical application in regular service. Included in this group are personal rapid transit and group rapid transit, referred to collectively as light guideway or automated guideway transit systems (see Figure 10). Such systems would, in concept, provide for nonstop travel between trip origins and destinations for individuals or small groups of passengers over automatically controlled guideways at speeds and capacities required for primary transit service. Prior to practical application in primary transit service, significant advancement of this technology would be required in order to attain the requisite speeds and capacities. Automated guideway transit has been applied in the provision of special transit service in and around major activity centers; however, these applications have not proven the ability of such automated facilities to perform a primary transit function.

Another technology which still requires significant development is dual-mode transit. In a dual-mode transit system, vehicles operate under manual control in mixed traffic on conventional roadways and in a completely automated mode on specially constructed exclusive guideways. This highly sophisticated concept, although intensively studied for possible application on a demonstration and test basis in the Milwaukee area in 1970, has yet to be demonstrated and tested anywhere.[5] A more

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[5] *See Milwaukee County Dual-Mode Systems Study, Volume 1, Summary Report; Volume 2, Technical Evaluation; Volume 3, Socio-economic Evaluation; and Volume 4, Implementation Plan, prepared for the U. S. Department of Transportation, Urban Mass Transportation Administration, by Allis Chalmers Corporation, Milwaukee, December 1971; and Dual Mode Planning Case Study—Milwaukee, Volume 1, Executive Summary and Planning Analysis; Volume 2, Technical Appendices; and Volume 3, Transit Sketch Planning Manual, prepared for the U. S. Department of Transportation, Urban Mass Transportation Administration, by Cambridge Systematics, Inc., August 1977.*

Figure 10

EXAMPLE OF AUTOMATED GUIDEWAY TRANSIT SYSTEM

Automated guideway transit systems—also referred to as personal rapid transit, group rapid transit, and light guideway transit systems—are one of several technologies which are not considered to be capable of providing primary transit service in the Milwaukee area during the next 20 years. Although such systems have been constructed as specialized transit systems in and around major activity centers, significant advances must be made in both speeds and capacities before a primary level of service is attainable. Downtown people mover systems proposed in several United States cities would be similar to the demonstration system constructed in Morgantown, West Virginia, shown above.

Photo courtesy of University of West Virginia.

primitive variation of the dual-mode concept, and a technology which also must be considered as requiring further development, is the operation of standard motor buses with retractable steel wheels on existing railways. Performance and operational problems revealed in tests of this technology in the early 1960's have yet to be addressed.

Two other transit technologies—the intermediate-capacity transit system (ICTS) and the O-Bahn—which, while operational on test tracks, have yet to be demonstrated as practical in regular primary transit service or as having advantages over existing primary transit modes. The ICTS is a modified form of light rail transit technology which requires a fully grade-separated guideway because of its linear induction form of propulsion and automated operation. The vehicle's smaller size could purportedly reduce guideway development costs, since the elevated guideways would not be as large or structurally as substantial as those of heavy rail systems. Also, the vehicle's steerable wheel trucks and the relatively smaller profile of the elevated guideway would result in a less intrusive fixed facility in urban environments. The O-Bahn would provide automatic steering for standard buses on exclusive guideways through the provision of steel guide rails on both sides of the guideway, and rubber rollers on guidance arms running along the guide rails and attached to the steering gear of the bus.

Other exotic forms of transit technology cannot reasonably be considered to be potential contenders for the provision of primary transit service in the Milwaukee area because demonstrations and application of these technologies to date have not established their superiority in any way over proven primary transit technologies. Such technologies include monorail and rubber-tired duorail technologies. Monorail systems utilize a single rail for vehicle support and lateral guidance, while duorail technology is generally identical to heavy rail rapid transit except that propulsion and guidance is provided by rubber tires on a concrete guideway, although steel wheels and rails are still required for switching and as an emergency backup guidance system. The performance of monorails must be considered inferior to that of proven heavy and light rail transit, while the performance of rubber-tired duorail systems must be considered, at best, similar to that of the proven rail systems. Both technologies, moreover, entail higher costs than do proven rail transit technologies.

Moving way transit systems also cannot be considered to be a primary transit technology alternative for the Milwaukee area, because these systems provide neither the speed nor the capacity necessary for primary transit application. Moving way systems, which are "continuous carriers," or moving walkways, do not conceptually provide the necessary speed, while "discrete carrier" moving way systems, consisting of small cabs or compartments traveling on a beltway or cableway, do not provide the required capacity.

Other transit technologies which cannot be considered to be reasonable alternatives for application in the Milwaukee area are those which are obsolete, including the street railway, the electric interurban railway, and the older forms of conventional heavy rail rapid transit technology. Light rail transit technology represents an evolution of electric street and interurban railway technology, and is considered superior to both with respect to vehicle and guideway technology and in terms of the degree of preferential treatment provided in congested areas. Modern heavy rail rapid transit is similarly an evolutionary advancement of conventional heavy rail rapid transit in terms of vehicle and guideway technology, and is considered superior to the older form in every way.

PHYSICAL CHARACTERISTICS

The facilities and equipment necessary for a primary transit system can be classified into four major categories of components: vehicle technology, guideway technology, station characteristics, and support requirements. Definitive information on the physical characteristics of each of these major components is essential to an understanding of the developmental requirements and performance and costs attendant to each of the public transit modes suitable for primary transit service.

Vehicle characteristics pertinent to system planning include: configuration and size, multiple-unit training capability, propulsion, capacity, and performance capabilities, including maximum speed and acceleration and deceleration rates. Guideway characteristics pertinent to system planning include: right-of-way requirements, basic cross-sectional requirements, vertical and horizontal alignment requirements, and the extent of grade separation. Pertinent station characteristics include: location and spacing requirements, extent of passenger shelters and other physical facilities, method of fare collection, and interface with other modes. Finally, pertinent support requirements include: vehicle storage and maintenance, guideway and station maintenance, power supply, traffic control, and fare collection procedures.

Vehicle Technology

A wide variety of transit vehicles applicable to each of the primary transit modes are available from domestic and foreign manufacturers. Because of the varying characteristics of each of the rail transit modes and respective guideways, the rail vehicles are specifically designed and manufactured for use on either light rail transit, heavy rail rapid transit, or commuter rail systems (see Figure 11). On the other hand, any of the rubber-tired bus vehicles can be used with any of the bus modes or priority treatments, since the basic guideway for each mode is a paved roadway surface (see Figure 12).

Motor Bus Vehicles: Motor buses may be classified into three general categories: compact vehicles, conventional vehicles, and high-capacity vehicles. Only conventional and high-capacity vehicles are suitable for use in primary transit service. The need to minimize operating costs per passenger and to serve highly concentrated travel demands precludes the potential use of low-capacity, compact buses for primary transit service in large urban areas.

The conventional, urban transit motor bus is by far the most common vehicle configuration utilized for primary transit service within the United States and Canada. The conventional bus has a single-unit body with an overall length of 35 to 40 feet, and a seated capacity of between 47 and 53 passengers. Recently, however, interest in the use of high-capacity buses has increased in North America. Such buses have been widely used in Europe because of their potential for accommodating larger groups of passengers, especially on heavily used transit routes.

High-capacity motor buses are available in one of two configurations: articulated vehicles or double-deck vehicles. Articulated buses are extra-length vehicles—typically 55 to 60 feet in length—that "bend" in the middle in order to negotiate curves. This allows the articulated bus to have a minimum horizontal turning radius similar to that of a standard bus. Many of the characteristics of articulated buses are similar to those of conventional buses, although the range in seating capacity of the articulated bus of 67 to 72 passengers is about 40 percent greater than that of the conventional bus. The total capacity of articulated buses ranges from 107 to 180 passengers, or from 23 to 150 percent more passengers than can be handled by conventional buses.[6] The top speed of the

[6] *For purposes of this study, the term "capacity" is defined and used in three different ways. "Seated capacity" is the number of seat places available to passengers in the vehicle. "Design capacity" is the*

(footnote continued on next page)

articulated bus is about 55 miles per hour (mph), which is similar to that of conventional buses. Its acceleration rate is 2.0 miles per hour per second, only 20 percent less than that of a standard bus, and its deceleration rate of 2.5 miles per hour per second is the same as that of a standard bus. Both conventional and high-capacity motor buses incorporate low-level loading of passengers, generally at curbside. Also, both types of vehicles utilize propulsion systems which employ a diesel prime mover using petroleum-based motor fuel.

The other high-capacity bus configuration, the double-deck motor bus, has, since its inception, been popular in Great Britain and in countries with historic British links. This type of configuration has recently been demonstrated in New York City and Los Angeles on a limited basis. Double-deck motor buses have a smaller total capacity than do current production articulated vehicles. Other disadvantages of double-deck buses in comparison with articulated vehicles are that they have more limited interior clearances and require a stairway location near the doorway, which poses potential internal traffic flow problems.

During the late 1960's, the federal Urban Mass Transportation Administration (UMTA) began development of a new urban transit bus which was intended to serve as an eventual replacement for the buses then in production and service within the United States—buses which had underwent no major design changes since 1959. This new bus, called the "Transbus," was to incorporate features providing improved passenger comfort and quality of ride, reduced maintenance costs, and better accessibility for the elderly and handicapped. Manufacturers claimed difficulty in designing and building such a bus within the requirements set forth by the UMTA which, in turn, prevented bids for such vehicles from being procured. Subsequently, the U. S. Department of Transportation in August 1979 announced a temporary delay in the effective date of its requirements for procurement of the Transbus. In the interim, currently available buses may be purchased with the aid of federal grants provided they meet certain federal requirements, including the installation of wheelchair lifts. As of the beginning of 1981, the applicability of the Transbus specifications to contemporary and future motor bus design was uncertain. It therefore appears that the current conventional and articulated models offered by manufacturers may be acquired with federal support for use in primary transit service for at least the near-term future.

Electric Trolley Bus Vehicles: There are two basic types of electric trolley bus vehicles: conventional vehicles and articulated vehicles. Conventional vehicles are typically 40 feet in length and are the only configuration presently used within the United States. Articulated electric trolley buses offer the capacity and economic advantages of diesel-powered articulated motor buses. Vehicle propulsion is provided by 600- to 650-volt direct-current electric motors, the power being collected by two roof-mounted trolley poles from a dual-wire overhead power distribution system. The loading of the vehicles is low level, generally at curbside. While it is generally held that the acceleration characteristics of electric trolley bus vehicles are superior to those of diesel- or gasoline-powered motor buses, the improved diesel bus performance achieved during the 1970's makes the overall performance of the two types of vehicles quite similar. In fact, many transit operators who use both types of vehicles in local and express service contend that they have identical performance characteristics and can be used interchangeably in daily operation. Since most manufacturers utilize the same vehicle bodies for both diesel-powered and electric trolley buses, the seating and total capacity characteristics of the two types of buses are similar.

Light Rail Vehicles: Contemporary light rail vehicles are typically designed in either nonarticulated, single-articulated, or double-articulated con-

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(footnote 6 continued)

number of seat places available to passengers plus the number of standees which can comfortably be accommodated within the available open floor space in each vehicle. In this study, the design capacity of the typical state-of-the-art vehicles used in the design, test, and evaluation of each primary transit mode has been calculated to allow the same available floor space for each standee, regardless of the mode. The state-of-the-art vehicles generally all have two-plus-two across seating. "Maximum or total capacity" is the number of seat places available to passengers plus the maximum number of standees which can be accommodated within the available open floor space under "crush" loading conditions typical of some United States and Canadian transit operations.

Figure 11

TYPICAL RAIL VEHICLES FOR PRIMARY TRANSIT SERVICE

LIGHT RAIL VEHICLE

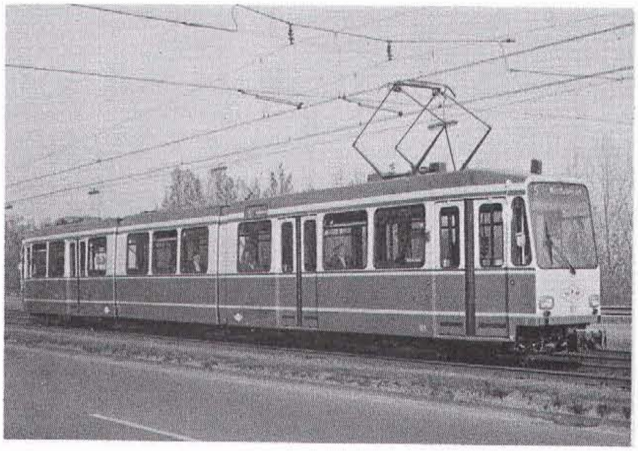
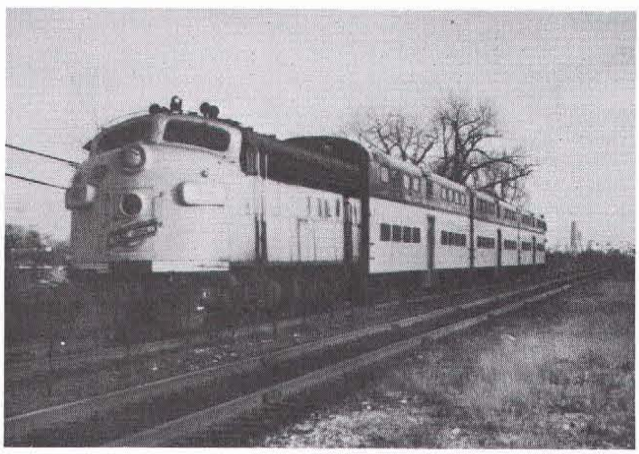


Photo courtesy of Brown Boveri Canada, Ltd.

HEAVY RAIL VEHICLE

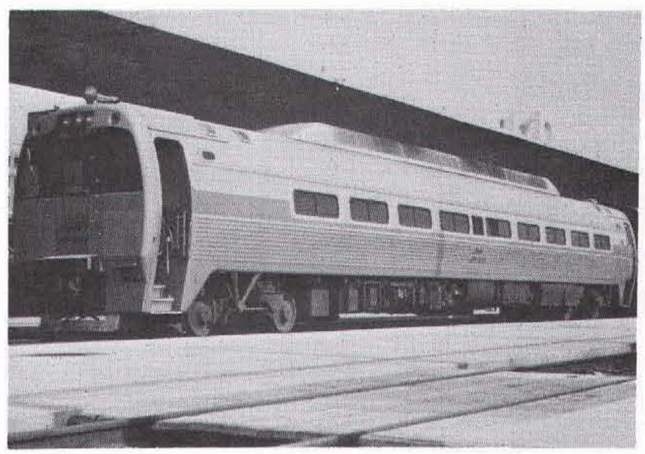
Photo courtesy of General Railway Signal Company.

BI-LEVEL COMMUTER TRAIN



SEWRPC Photo.

SELF-PROPELLED COMMUTER RAIL VEHICLE



SEWRPC Photo.

Each of the three rail transit modes requires a different type of vehicle. With respect to size and weight, light rail vehicles (upper left) are typically the shortest, narrowest, and lightest of the rail transit vehicles. Importantly, light rail vehicles are marked by the use of a single-wire overhead power supply system which permits operation on public streets in mixed traffic. These characteristics, along with vehicle articulation, are a function of light rail transit guideways, the horizontal and vertical alignments of which, in many cities, are subject to the limitations imposed by use of public street rights-of-way. Heavy rail vehicles (upper right) are typically longer, wider, and heavier than light rail vehicles since lateral clearances as well as horizontal and vertical curvatures are less restrictive. Heavy rail vehicles are marked by the use of high platforms for loading, and a third rail power supply system which makes the provision of an exclusive, fully grade-separated right-of-way necessary. Commuter rail vehicles are the largest and heaviest of all the rail transit vehicles since mainline railway trackage is used, requiring such equipment to safely and practically operate with intercity freight and passenger trains. Contemporary commuter trains are characterized by bi-directional trains propelled by diesel-electric locomotives (lower left). In situations where ridership does not warrant complete trains, self-propelled coaches represent an alternative vehicle configuration (lower right).

Figure 12

TYPICAL BUS VEHICLES FOR PRIMARY TRANSIT SERVICE

CONVENTIONAL MOTOR BUS

Photo courtesy of New Orleans Public Service, Inc.

ARTICULATED MOTOR BUS

Photo by Russell E. Schultz.

DOUBLE-DECK MOTOR BUS

Photo courtesy of Southern California Rapid Transit District.

ELECTRIC TROLLEY BUS

Photo by Otto P. Dobnick.

Rubber-tired buses are able to operate on any paved roadway surface, regardless of whether that roadway is a public street or highway, a reserved lane, or an exclusive busway. Because of this ability, diesel motor buses can perform a collection and distribution as well as line-haul function, therefore offering the possibility of a one-seat ride between many origins and destinations. Although conventional buses (upper left) are the most common configuration, articulated vehicles (upper right) and, to a lesser extent, double-deck vehicles (lower left) have recently drawn widespread attention in the United States because of their high passenger capacity. Electric trolley buses (lower right) can be considered a special alternative to the diesel motor bus because of their similar capacity and performance characteristics, although they do use a different propulsion system. The electric trolley bus requires an overhead, two-wire power supply system, limiting its operational flexibility.

figurations. Articulation allows extra-length vehicles to "bend" on joints supported by a two-axle truck when traversing curved trackage. Such design provides increased passenger capacity, yet retention of a narrow vehicle profile on curves. The seating capacity of articulated vehicles ranges between 46 and 84 passengers, or 10 to 100 percent more seats than can be accommodated by nonarticulated vehicles. The total capacity of articulated vehicles, which includes standees, ranges between 160 and 250 passengers, or 20 to 150 percent more capacity than that offered by nonarticulated vehicles. Vehicle propulsion for all types of light rail vehicles is typically provided by 600- to 650-volt direct-current electric motors, the power being collected by a panograph on the vehicle roof from an overhead, single-wire, power distribution system.

Light rail vehicles are generally the smallest as well as the lightest of all rail transit vehicles, varying from 50 to 53 feet in length for nonarticulated vehicles to 71 to 88 feet in length for single-articulated vehicles. In addition, light rail vehicles have high acceleration rates, ranging from 1.8 to 4.3 miles per hour per second, and high deceleration rates, also ranging from 1.8 to 4.3 miles per hour per second. There is little difference in the acceleration and deceleration rates of articulated and nonarticulated light rail vehicles, nor is there much difference in the top speeds of such vehicles, which range from 50 to 60 miles per hour. These high rates of acceleration and deceleration are important because, of all the rail modes, light rail transit has the shortest station spacings and, because operation in mixed traffic on surface streets is possible, short stopping distances are required for safety reasons. Advantages of light rail vehicles include a bi-directional and multiple-unit operational capability, which allows trains of up to four articulated vehicles to be assembled and controlled by one operator. The boarding of passengers may be either low level or high level at stations.

The most popular vehicle configuration for new light rail systems either recently opened or under construction in North America appears to be the single-articulated vehicle supported by three, two-axle trucks. This configuration allows greater passenger capacity, yet retains the ability to negotiate sharp curves while not significantly reducing acceleration and deceleration rates and maximum speed. Double-articulated light rail vehicles have less impressive performance characteristics than do single-articulated vehicles because of their additional body weight and unpowered trucks. These vehicles are typically used in Europe where light rail systems have been developed from existing street railways with narrow side clearances and narrow-gauge track. Thus, such systems require relatively narrow vehicles which, in turn, necessitate the additional length afforded by double articulation in order to accommodate about the same number of passengers as a standard-width, single-articulated vehicle.

Heavy Rail Vehicles: The typical heavy rail vehicle is a single, nonarticulated vehicle supported by two, two-axle trucks. The vehicle is usually capable only of single-direction operation with a control cab at one end. On most heavy rail systems, two vehicles are semi-permanently coupled into "married" pairs. Such married pairs have control cabs at each end and are capable of bi-directional operation. Trains of up to 10 cars, or five married pairs, can be operated, each car being 65 to 75 feet in length. Modern heavy rail vehicles are typically propelled by 600- to 1,000-volt direct-current electric motors. Heavy rail vehicles are capable of very high operating speeds—between 65 and 80 miles per hour—and possess acceleration and deceleration rates between 2.5 and 3.0 miles per hour per second. The current is transmitted to the electric traction motors in the vehicles via an energized, side-mounted third rail, which necessitates complete grade separation of heavy rail rapid transit systems. High-level platforms are employed for loading and unloading at stations. Seated capacities for heavy rail vehicles range from 58 to 80 passengers. The large size of the vehicles, however, permits a large number of standees to be accommodated, resulting in a total capacity per vehicle of from 170 to 300 passengers.

Commuter Rail Rolling Stock: Existing commuter rail rolling stock can be classified into two physical configurations based upon the form of propulsion: electrified multiple-unit equipment and unpowered passenger coaches generally pulled or pushed by diesel-electric-powered locomotives. The construction of a new electrified commuter rail operation entails a very high initial investment because of the third rail or overhead wire electric power transmission and distribution system required. As a consequence, corridors of very high travel demand are required to support electrified commuter rail service. Moreover, the characteristics of the power distribution system are such as to preclude a gradual, economical phasing in of the service, as would be possible with a diesel operation. For this reason, electrified commuter rail is not considered practicable in the Milwaukee area within the time frame of the study.

Contemporary, diesel-powered commuter train operations are characterized by the use of bi-directional trains of locomotive-hauled coaches. Where vertical clearances permit, coaches are designed with two levels to significantly increase vehicle capacity. Single-level coaches have a seated capacity of 108 passengers, while coaches with two levels have a seated capacity ranging from 157 to 162 passengers. Because of the relatively long trip distances associated with the commuter rail mode, it is desirable not to have standees, making the design capacity equal to the seated capacity. Since commuter rail operates on trackage shared with intercity freight and passenger train traffic, the rolling stock is manufactured to mainline railway standards, thus making commuter rail vehicles the largest and heaviest of all rail transit vehicles. Typical trains may be up to six coaches in length, and loading is from a low- or high-level platform. Since the coaches in a locomotive-hauled train are not powered, performance will depend upon the length of the train, although acceleration rates can be expected to be less than one mile per hour per second, and deceleration rates can be expected to range between one and three miles per hour per second.

In circumstances where the required capacity is low and necessary train lengths accordingly short, self-propelled coaches have proven to be popular. Self-propelled vehicles have a seated capacity similar to that of typical, single-level intercity railway passenger coaches—88 passengers—but also have control cabs at each end and diesel engine propulsion equipment mounted below the floor. Such equipment has an acceleration rate of about 0.5 mile per hour per second and a deceleration rate of up to three miles per hour per second. Commuter rail operators maintain that self-propelled coaches are best applied in relatively light traffic operations—operations in which only short trains are required. The training of more than two or three such units is generally not considered to be as cost-effective as the use of locomotive-hauled trains in situations where appreciable ridership is anticipated. All types of commuter rail rolling stock are capable of speeds in excess of 60 miles per hour (mph). However, because of this mode's low rates of acceleration, as well as the maximum speeds allowed by railway trackage to be utilized in southeastern Wisconsin, 60 mph is the maximum operating speed assumed in this study for system planning purposes.

Primary Transit Vehicle Comparison: The variety of primary transit vehicles that are available provides not only a wide range of size, performance, and capacity characteristics among the different modes, but also a range of such characteristics within each of the modes which have been identified as having potential for the provision of primary transit service in the Milwaukee area. Table 16 presents the ranges of those characteristics for the different vehicle configurations considered to be pertinent to this primary transit system alternatives analysis.

The largest vehicles in terms of length, width, height, and weight are those required by the rail transit modes. With the exception of coaches utilized in commuter rail service, seated capacities for vehicles of similar length are nearly the same, regardless of the mode. Conventional motor buses, conventional electric trolley buses, and nonarticulated light rail vehicles all seat about 45 to 50 passengers. Articulated motor buses, articulated electric trolley buses, single-articulated light rail vehicles, and heavy rail vehicles, on the other hand, all seat about 60 to 70 passengers. Because rail vehicles are generally larger than rubber-tired buses, they can accommodate a greater number of standees, even though rail vehicles and buses have similar seated capacities.[7] In terms of carrying seated passengers plus crush loads of standees, a nonarticulated light rail vehicle can handle up to 80 percent more passengers than a conventional bus, and a single-articulated light rail vehicle can handle up to 275 percent more passengers than a conventional bus and up to 250 percent more passengers than an articulated bus. A heavy rail vehicle can handle up to 315 percent more passengers than a conventional bus, up to 180 percent more passengers than an articulated bus, and up to 100 percent more passengers than a single-articulated light rail vehicle.

Commuter rail vehicles are the largest of all the primary transit vehicles, since they are manufactured to mainline railway standards. Hence, they possess the largest seated capacities, ranging from about 90 passengers to about 160 passengers, depending upon the coach configuration. Total crush capacities for certain coach designs may exceed those of all other primary transit vehicles, including heavy rail vehicles. It should be recognized, however, that the lengthy distances of typical commuter rail trips require that all passengers have seats available to them under normal operating conditions. Standees on commuter rail equipment, therefore, were not considered conducive to the provision of a high level of service under this study.

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[7] *Light rail vehicles are typically longer than motor buses: nonarticulated light rail vehicles are longer than conventional motor buses, and articulated light rail vehicles are longer than articulated motor buses. Furthermore, heavy rail vehicles and commuter rail rolling stock are both longer and wider than all motor buses, either conventional or articulated configurations.*

Table 16

CHARACTERISTICS OF PRIMARY TRANSIT VEHICLES

Characteristic	Conventional Motor Bus	Articulated Motor Bus	Nonarticulated Light Rail Vehicle	Single Articulated Light Rail Vehicle	Heavy Rail Rapid Transit Vehicle	Commuter Rail Coach	Self-Propelled Commuter Rail Coach	Conventional Electric Trolley Bus	Articulated Electric Trolley Bus
Length (feet)	36-40	55-60	50-53	71-88	65-75	85	85	36-40	54-59
Width (feet)	8.0-8.5	8.2-8.5	8.5	7-9	9.2-10.5	9.8-10.6	10.5	8.2-8.5	8.2
Height (feet)	9.8-10.2	9.9-10.3	10.8-11.0	9.75-11.5	10.5-12.3	12.7-15.9	14.3	9.6-11.3	9.6-11.3
Net Weight (tons)	10-12	13-18	26	22-43	26-40	37-54	64	11-13	13-17
Minimum Horizontal Turning Radius (feet)	44	40-44	36-60	42-100	120-400	N/A	N/A	34-42	34
Propulsion	6 or 8 cylinder diesel	6 or 8 cylinder diesel	600-650 volts D.C.	600-650 volts D.C.	600-1,000 volts D.C.	Diesel locomotive	Diesel locomotive	600 volts D.C.	600 volts D.C.
Acceleration Rate (miles per hour per second)	2.5	2.0	1.8-4.3	1.8-3.6	2.5-3.0	Less than 1.0	0.5	3.5-4.0	3.5-4.0
Deceleration Rate (miles per hour per second)	2.5	2.5	1.8-4.3	2.2-3.8	2.7-3.0	0.5-2.0	3.0	3.5	3.5
Maximum Speed (mph)	44-70	55	50	50-60	65-80	65[a]	80	37-51	37-44
Maximum Grade (percent)	N/A	N/A	8	4-9	3-4	N/A	N/A	N/A	N/A
Passenger Access (number of doors)	2-3 one side	2-4 one side	2 one side	3-4 each side	2-4 each side	1-2 each side	2 each side	2-3 one side	2-4 one side
Seated Capacity	47-53	67-72	42-50	58-84	58-80	104-162	88	29-53	31-67
Design Capacity	72-81	107-115	84-100	125-182	100-222	104-162	88	75-89	107-131
Total Capacity	94-108	125-180	100-130	147-270	200-300	--	--	94-105	139-184

NOTE: N/A indicates data not available.

[a] *Maximum speed of diesel-electric locomotive without optional gear ratios.*

Source: Manufacturers, Operators, and SEWRPC.

Another advantage of the rail transit modes in terms of vehicle capacity is their ability to couple the vehicles together, the entire train being under the control of a single operator. Diesel motor buses and electric trolley buses do not possess this "training" capability. Multiple-unit operation of up to four articulated light rail vehicles and up to 10 heavy rail vehicles is possible. A typical train length for a commuter rail train is six coaches of a multi-level design, although longer trains are possible.

With the exception of commuter rail equipment, rail transit vehicles are also able to offer the highest level of performance in primary transit service, as evidenced by higher acceleration and deceleration rates and higher operating speeds. This is largely due to the form of propulsion used, the performance qualities of the electric traction motor being superior in many respects to those of internal combustion engines. Diesel motor buses are capable of high operating speeds, but do not have acceleration and deceleration rates as high as those of light rail vehicles and heavy rail vehicles. Electric trolley buses, on the other hand, possess relatively high acceleration and deceleration rates, but are not normally capable of high-speed operation because of limitations imposed by the overhead wire power supply system as well as by the currently available traction motors used to propel such vehicles. Vehicles operated in commuter rail service, while capable of attaining high operating speeds, have the lowest acceleration and deceleration rates of all primary transit vehicles.

In order that alternative system plans for the primary transit modes with potential for application in the Milwaukee area could be designed, tested, evaluated, and compared, and a recommended primary transit plan for the Milwaukee area formulated, it was necessary to select specific vehicles which could be assumed to typify the state-of-the-art for each mode. The specific vehicle configurations that were selected for use in the system planning, along with the characteristics of those vehicle configurations, are shown in Table 17. The selection of specific vehicle types was based upon a considered judgment of how well each vehicle type represented the characteristics of the current state-of-the-art for each transit mode; the passenger-carrying capacity of the vehicles, from which the operating costs per passenger mile could be determined; and whether or not the vehicle configuration is presently manufactured within the United States.

Guideway Technology

Each of the primary transit modes identified within this study has different guideway requirements. Those primary transit modes which include motor bus or electric trolley bus technology employ the basic guidance principle of rubber-tired vehicles operating over paved roadway surfaces. Those primary transit modes which include rail transit technology employ the basic guidance principle of flanged steel wheels operating on steel railway tracks. This fundamental difference in guideway requirements is important because it largely determines the nature and extent of fixed facility construction and the magnitude of the capital costs necessary to implement each of the primary transit modes.

Diesel Motor Bus: Three of the four motor bus modes identified within this study, along with the electric trolley bus mode, are able to operate on existing public streets and highways, including freeways, thus precluding the need for a large capital investment in fixed guideway development. The busway mode, however, requires the construction of a fixed guideway for operation, although the vehicles typically collect and distribute passengers on public streets and highways at each end of the busway facility (see Figure 13). It is not the intent to here describe the geometric and structural design characteristics of arterial streets and highways that might be used in the provision of primary transit service, but rather to point out certain important considerations concerning the use of such facilities, as well as modifications to such facilities that may be necessary to implement the different bus primary transit modes. Engineering standards for surface segments of primary transit bus systems that do require new guideway construction are identical to those for ordinary streets and highways designed to carry heavy volumes of high-speed mixed traffic, conforming to the widely accepted standards prescribed by the American Association of State Highway and Transportation Officials (AASHTO).[8]

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[8] *American Association of State Highway and Transportation Officials, A Policy on Geometric Design of Rural Highways, 1965; and A Policy on Design of Urban Highways and Arterial Streets, 1973.*

Table 17

CHARACTERISTICS OF PRIMARY TRANSIT VEHICLES SELECTED FOR USE IN THE MILWAUKEE AREA ALTERNATIVES ANALYSIS

Characteristic	Conventional Motor Bus	High-Capacity Motor Bus	Light Rail Vehicle	Heavy Rail Rapid Transit Vehicle	Diesel Locomotive	Commuter Rail Coach	Electric Trolley Bus
Configuration	Single unit	Articulated	Articulated	Married pairs	Single locomotive	Bi-level gallery coach	Articulated
Length (feet)	40.0	59.8	71.0	75.0	56.2	85.0	55.0
Width (feet)	8.5	8.5	8.8	10.2	10.7	10.6	8.2
Height (feet)	10.0	9.9	11.5	11.8	15.4	15.9	10.4
Net Weight (tons)	12	18	33	36	130	52	14
Number of Axles	2	3	6	4	4	4	3
Acceleration Rate (miles per hour per second)	2.5	2.0	2.8	3.0	Less than 1.0	Not applicable	3.5
Deceleration Rate (miles per hour per second)	2.5	2.5	3.5	3.0	0.5-2.0	Not applicable	3.5
Maximum Speed (mph)	55	55	50	70	65	Not applicable	37
Passenger Access (number of doors)	2 one side	2 one side	3 each side	3 each side	Not applicable	1 each side	2 one side
Seated Capacity	48	67	68	74	Not applicable	157	67
Design Capacity	72	107	147	222	Not applicable	157	107
Total Capacity[a]	98	155	219	275	Not applicable	- -	155

[a] *Includes standees under crush loading conditions.*

Source: Manufacturers, Operators, and SEWRPC.

Figure 13

GUIDEWAY TECHNOLOGY FOR MOTOR BUS PRIMARY TRANSIT SYSTEMS

Photo courtesy of U. S. Department of Transportation.

Photo courtesy of Metropolitan Transit Authority of Harris County.

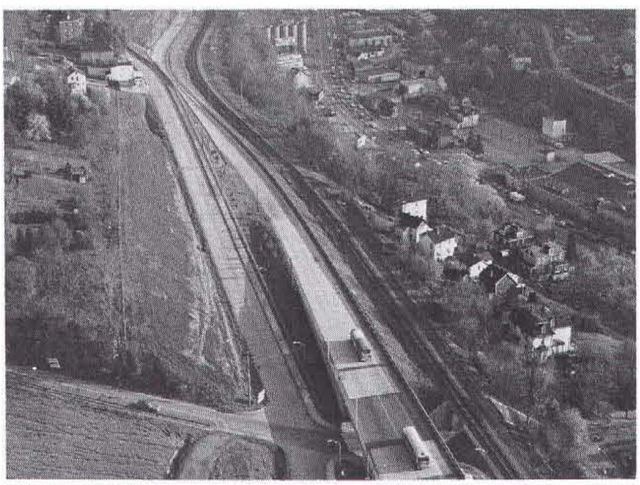


Photo courtesy of Port Authority of Allegheny County.

Photo by Russell E. Schultz.

Three of the four motor bus modes suitable for the provision of primary transit service in the Milwaukee area depend upon the efficient and effective use of traffic engineering measures, since extensive use is made of existing street, highway, and freeway facilities. For example, the operation of motor buses in mixed traffic on freeways may require the implementation of bypass lanes for motor buses at metered freeway ramps (upper left), and reserved freeway lanes—whether on freeways or arterial streets—may require the daily placement and removal of signs, signals, and lane separation devices (upper right). The fourth motor bus mode—the busway—is a fixed guideway specially designed and constructed for the high-speed operation of transit vehicles. Busways may be designed as exclusive, fully grade-separated facilities to safely provide high operating speeds, herein termed Class A busways (lower left), or as at-grade facilities, herein termed Class B busways (lower right), providing a lower level of service.

The operation of motor buses in mixed traffic over freeways usually requires few or no guideway-related additions or modifications to the existing freeway facilities. The two types of guideway components that may be necessary, however, are bypass lanes for transit vehicles at metered freeway entrance ramps and exclusive entrance ramps for transit vehicles. Such lanes and ramps should be a minimum of 12 feet wide with appropriate shoulders, and should comply with accepted freeway ramp design standards.

The implementation of reserved freeway lanes for motor bus operation also involves a minimum amount of physical construction or reconstruction. The separation of normal flow reserved lanes is usually accomplished by the temporary placement of traffic cones and barricades or flexible traffic posts between the reserved and mixed traffic lanes, or by delineation with pavement markings and striping. The separation of a contraflow lane from the mixed traffic lanes is usually accomplished in the same manner, except that some sort of physical separation such as posts or cones is considered essential because of the opposing directions of the adjacent traffic streams. While the daily installation and removal of cones, barricades, posts, and signs may represent a significant operating cost attendant to a particular reserved lane facility, these devices permit entrance through the lane at only one point and are thus considered to be largely self-enforcing. Contraflow lane operations require in addition a special transitional lane to allow the motor buses to cross the median area and enter the reserved lane.

The operation of buses on busways is the only bus transit mode which requires the construction of a fixed guideway prior to initiation of primary transit service. Busways may be classified as Class A or Class B alignments, depending upon the overall level of service provided. Class A busways provide for high-speed, high-capacity, rapid transit service. Being fully grade-separated, Class A busways are generally economically feasible only in major travel corridors of large urbanized areas where primary transit vehicles must operate nonstop over relatively long distances. Class B busways provide for a somewhat lower quality of service, serve somewhat shorter trips, and operate at lower overall speeds than do Class A busways. Station frequency is usually greater along Class B busways, and at-grade crossings with arterial streets may be incorporated to assist in minimizing capital costs. Class A and Class B busway alignments can be used alternately within the same facility as the constraints of a given corridor may dictate. Considerations in the design of busways include appropriate transitional lanes for any necessary connections to freeways and appropriate intersections for connection to surface arterial streets. In some instances, ridership forecasts may indicate the potential for future conversion of a busway into a rail transit guideway. In such cases, the right-of-way cross-section and alignment should be designed so that minimum changes are required for conversion to the selected rail transit mode.

Special consideration is required for busway segments that are to be located in tunnels or subways. Because of the need for adequate ventilation to control vehicle exhaust fumes, construction costs for underground busways may be expected to be 20 to 30 percent greater for diesel bus operation than for comparable electric vehicle operation. Underground stations along busways also require special design consideration in order to minimize air pollution in passenger waiting areas. For these reasons, and because the motor bus can operate in mixed traffic over surface streets in congested areas or can utilize a Class B busway design in such areas—therefore, not absolutely requiring an exclusive, fully grade-separated right-of-way—motor bus subways were not considered further within this study.

The fourth bus mode—arterial express bus systems—utilizes existing street facilities but with preferential treatment over other motor vehicle traffic. If a primary level of transit service is to be provided, necessary preferential treatment should take the form of reserved lanes, which can be implemented in a variety of ways. Normal flow lanes located adjacent to curbs should be at least 10 feet wide, while contraflow curb lanes should be at least 12 feet wide. Reserved lanes located adjacent to the centerline or in the center of the roadway should be at least 10 feet wide for one-way operation, and 20 to 22 feet wide for two-way operation. Reserved lanes on arterial streets may, in effect, constitute a Class B busway. Appropriate transition lanes to and from the reserved transit lanes are necessary and should include proper lane channelization, pavement markings, striping, and appropriate signing.

A Class B busway, or an arterial express bus operation on reserved surface street lanes, can provide a level of service similar to that of light rail transit operating over reserved lanes or in the median area of a surface arterial street. Because of these inherent similarities, arterial express bus systems may be expected to have route configurations and alignments that are similar to those of any Class B busways to be tested under a systems analysis. It seems reasonable, therefore, to combine these two modes for system planning purposes and to consider them together under the motor bus-on-busway alternative.

Electric Trolley Bus: With regard to guideways, the electric trolley bus mode uses the same types of roadway surfaces used by diesel motor buses. From a practical standpoint, the electric trolley bus is generally considered as being unable to operate over freeways because of the limitation imposed on the maximum operating speed by the overhead power supply system, with its potential for dewirement at high speeds and the restrictions on speed required for operation through overhead wire switches and crossings. Electric trolley buses, however, are able to operate over busways and in mixed traffic on reserved lanes on arterial streets.

Rail Transit: The three rail transit modes considered within this study—light rail transit, heavy rail rapid transit, and commuter rail—while possessing common track structure and roadbed requirements, utilize somewhat different types of guideway technology. Two of the three rail transit modes require extensive fixed guideway construction prior to system start-up. Commuter rail is the only rail transit mode capable of utilizing existing facilities, although some degree of railway track rehabilitation may be required. There are three basic types of railway track structure and roadbed: open track, fixed track, and paved track. Open track consists of steel T-rails attached to either creosoted hardwood or concrete cross ties anchored to the roadbed by crushed stone ballast. Fixed track consists of steel T-rails attached directly to the concrete floor of a subway or tunnel or to the superstructure of a bridge or trestle. Paved track consists of girder rail attached to cross ties or held by tiebars, with the area between and around the rails being paved. Such track is required wherever a rail transit mode shares the right-of-way with rubber-tired vehicles or pedestrians. The most common track gauge utilized for rail transit systems in the United States and Canada, regardless of which type of track structure and roadbed is used, is standard gauge of 4 feet 8 and one-half inches between the running rails.

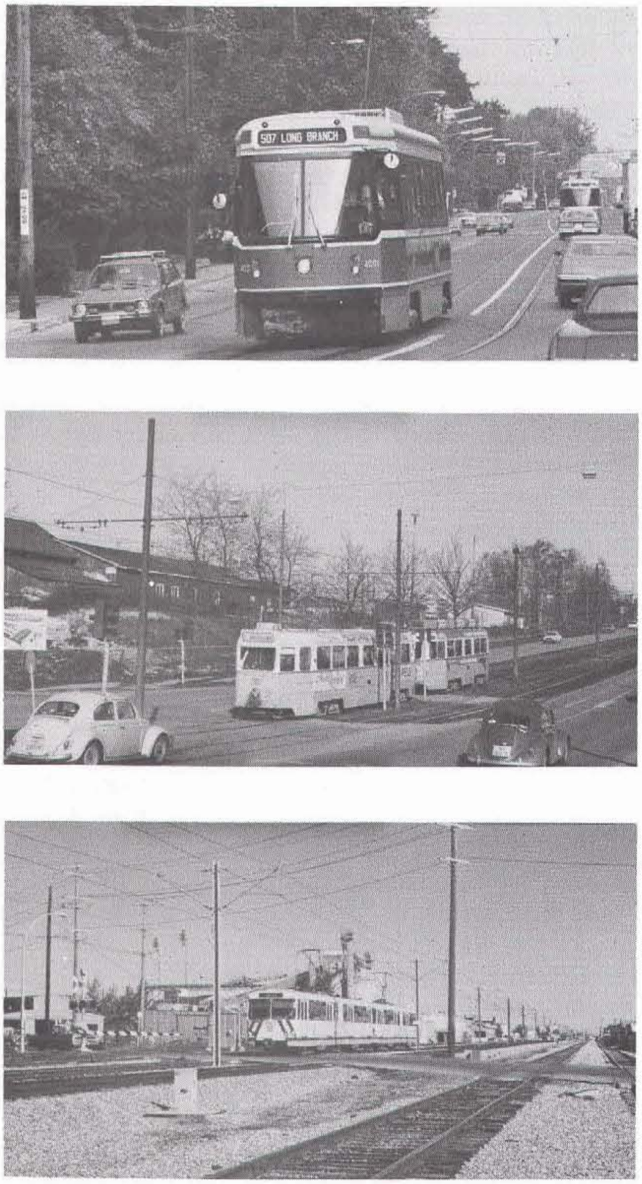
Light Rail Transit: Of the three rail transit modes considered to be applicable for primary transit service, light rail transit has the greatest variety of alignment options and track structure options available, and thus is considered to be the most versatile rail primary transit mode. Light rail transit alignments can be situated over reserved lanes and median areas of public streets; over pedestrian and transit malls; along the rights-of-way of freeways, active or abandoned railways, and utilities; in subways; on elevated structures; and through other open areas in urbanized areas (see Figure 14). Light rail transit can also be operated over public streets in mixed traffic; however, unless the streets are not congested, such operation may not be capable of meeting the primary transit requirements of high speed and capacity. On light rail transit systems constructed within the past several years open track is used extensively, with paved track being used only in transit and pedestrian malls. Fixed track would be required on elevated structures or in subways.

Like busways, light rail transit guideways may be classified into Class A and Class B alignments. Class A light rail transit alignments make extensive use of exclusive rights-of-way with relatively gentle horizontal curves and gradients and with grade separations at arterial street crossings. Class B light rail alignments provide little or no grade separation, involving extensive use of public street rights-of-way with the trackage situated in reserved lanes or in median strips. Class B light rail transit alignments may also utilize sharper, street railway-like horizontal curves and steeper gradients than Class A alignments. Class A alignments provide a level of service approaching that of heavy rail rapid transit, serving longer trips and having higher operating speeds and wider station spacings than Class B alignments. Class A and Class B light rail transit alignments can be used alternately within the same facility as the constraints of a given corridor may dictate.

Heavy Rail Rapid Transit: The alignment options for heavy rail rapid transit guideways are much less flexible than those for light rail transit guideways, since the guideway must be fully grade-separated. Modern heavy rail rapid transit alignments generally utilize subways through major activity centers such as a central business district, and either elevated or depressed alignments in other areas (see Figure 15). Because of the cost and disruption attendant to the location of heavy rail rights-of-way through developed areas, new systems and extensions of existing systems tend to utilize expressway or active railway rights-of-way for guideway location through such areas. Also, because of the extensive use of aerial and subway

Figure 14

GUIDEWAY TECHNOLOGY FOR
LIGHT RAIL TRANSIT SYSTEMS



Light rail transit is considered to be a very versatile primary transit fixed guideway mode because of the variety of vehicle designs, station configurations, fare collection procedures, and especially guideway alignments which are available for formulating alternative transportation system plans. Light rail fixed guideway alignments, like heavy rail rapid transit alignments, can be located on fully grade-separated rights-of-way such as elevated structures or subways. Light rail transit alignments, however, can also be placed on a wide variety of surface locations, including arterial street rights-of-way—either in mixed traffic (top), in reserved lanes, or in the median areas of divided highways or boulevards (center)—transit malls, exclusive rights-of-way with at-grade highway crossings (bottom), and abandoned railway rights-of-way.

Photo (top) courtesy of Urban Transportation Development Corporation, Ltd.
Photo (center) by Otto P. Dobnick.
Photo (bottom) by Russell E. Schultz.

alignments, heavy rail guideways make wide use of fixed track construction, with some open track on surface segments. Paved track is not used on heavy rail rapid transit systems.

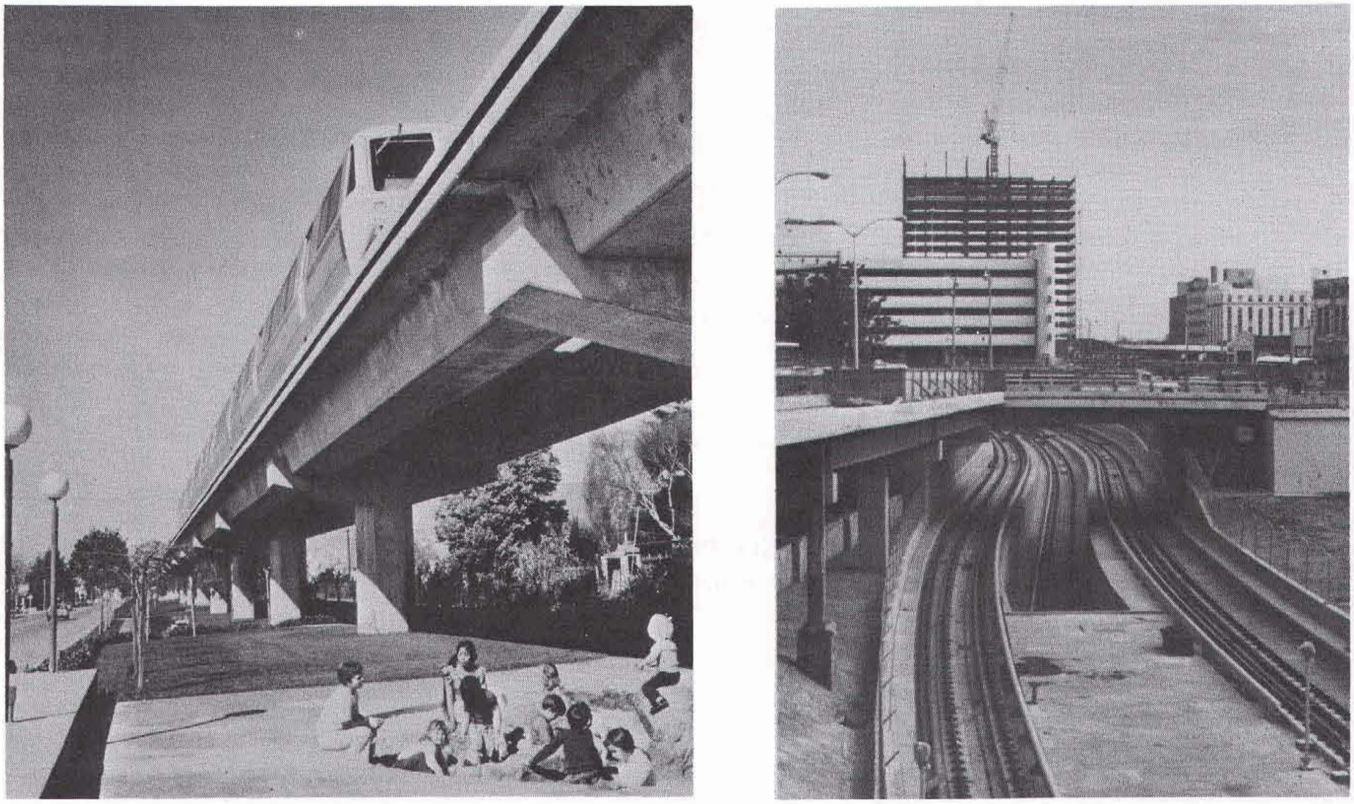
Commuter Rail: Commuter rail operations are normally limited to the existing mainline common carrier railway network radiating out of the central business district. Therefore, the guideway system is normally in place, although rehabilitation of the trackage may be necessary in order to permit desirable operating speeds. To adequately provide for commuter rail operation, trackage should—at a minimum—meet the Class 3 requirements of the Federal Railroad Administration track safety standards, which allow passenger train speeds of up to 60 mph. Under all but the most unusual conditions, the trackage need not meet better than Class 4 requirements, which allow passenger train speeds of up to 80 mph. Open trackage is usually used for commuter rail operations, with fixed track used only on lengthy bridges and trestles and paved track used only at at-grade crossings.

Primary Transit Guideway Comparison: Of the eight primary transit modes identified within this study, five involve the operation of rubber-tired buses over paved roadway surfaces. Because of this aspect of motor bus technology, motor buses can operate in mixed traffic on freeways, over reserved lanes on freeways, on arterial streets, and over busways within a single corridor. A motor bus service or route could be operated over any combination of these priority treatments, thus offering a flexible, high level of service for passengers without necessitating transfers between a large number of origins and destinations. Rail transit modes do not have this flexibility, since the inherent nature of light rail transit, heavy rail rapid transit, and commuter rail does not typically permit the use of an individual guideway by vehicles of another mode. The electric trolley bus mode—with special design provisions—can operate in a busway mode in addition to an arterial express mode, but its flexibility is limited by the placement of the overhead power distribution system.

Actual guideway locations and dimensions for the primary transit modes discussed herein are highly dependent upon site-specific conditions, although it should be apparent from the foregoing summary that there are important differences between the guideway requirements of each mode. Table 18 presents selected guideway characteristics pertinent to the design, test, and evaluation of alternative systems of fixed guideway facilities.

Figure 15

GUIDEWAY TECHNOLOGY FOR HEAVY RAIL RAPID TRANSIT SYSTEMS



Alignments for modern heavy rail rapid transit guideways must be fully grade-separated at crossings with all streets, highways, freeways, and other railway lines. This design feature is necessitated by the high operating speeds, semi-automated operation, and the electrified third rail for power distribution of heavy rail rapid transit. In urbanized areas, heavy rail rapid transit system construction will generally entail—in addition to subways—lengthy segments of guideway either on aerial structures (left) or in retained cuts (right).

Photo (left) courtesy of Bay Area Rapid Transit District.
Photo (right) by Otto P. Dobnick.

Five of the eight transit modes identified herein make predominant use of existing transportation facilities to meet guideway requirements. The basic characteristics of such guideways, such as vertical and horizontal curvatures, right-of-way width, guideway cross-sections, and the extent of grade separation, are therefore governed by the configuration and location of the existing facilities. These five modes are: motor bus operation in mixed traffic on freeways, motor bus operation on reserved freeway lanes, arterial express bus operation, commuter rail, and electric trolley bus operation.

The three remaining primary transit modes—busways, light rail transit, and heavy rail rapid transit—require a newly constructed fixed guideway prior to any service start-up. Fixed guideways for heavy rail rapid transit systems are the least flexible with regard to location, having a maximum gradient limitation of 3 percent and a minimum horizontal curvature limitation of 7 degrees, and requiring a fully grade-separated, exclusive right-of-way. Design criteria for busway and light rail transit fixed guideways are dependent upon whether the facility is a Class A or Class B alignment. Class A busways have a maximum gradient limitation of 5 percent and a minimum horizontal curvature limitation of 7 and one-half degrees, and Class B busways have a maximum gradient limitation of 6 percent and a minimum horizontal curvature of 23 degrees. Class A light rail transit guideways have a maximum gradient limitation of 4 percent and a minimum horizontal curvature limitation of 8 degrees, and Class B alignments have a maximum

Table 18

CHARACTERISTICS OF DUAL GUIDEWAYS FOR PRIMARY TRANSIT MODES SELECTED FOR USE IN THE MILWAUKEE AREA ALTERNATIVES ANALYSIS

Characteristic	Motor Bus on Freeways	Motor Bus on Reserved Freeway Lanes	Busways		Arterial Express Lanes	Light Rail Transit		Heavy Rail Rapid Transit	Commuter Rail	Electric Trolley Bus Technology
			Class A	Class B		Class A	Class B			
New Guideway Construction	Not required	Not required	Necessary	Necessary	Not required	Necessary	Necessary	Necessary	Not required	Not required
Right-of-Way Width	Existing	Existing	32-foot minimum	32-foot minimum	Existing	30-foot minimum	30-foot minimum	32-foot minimum	Existing	Existing
Minimum Desirable Guideway Width[a] (feet)										
Surface	12-	12-	32	32	10- to 12-	32	32	38	34	10- to 12-
Aerial	foot	foot	36	36	foot	30	30	32	34	foot
Subway	lanes	lanes	34	34	lanes	34	34	34	34	lanes
Maximum Mainline Gradient (percent)	--[d]	--[d]	5	6	--[d]	4	8	3	1	--[d]
Minimum Horizontal Mainline Curvature[b] (degrees)	--[d]	--[d]	7½	23	--[d]	8	50-foot radius	7	2	--[d]
Minimum Vertical Clearance[c]	14'-9"	14'-9"	14'-9"	14'-9"	12'-6"	17'-0"	17'-0"	17'-0"	22'-0"[e]	13'-6"
Grade Separation	Complete	Complete	Complete	Optional	Minimal	Partial	Optional	Complete	Existing	Minimal
Extent of New Construction	Ramps	Ramps and transition lanes	Entire guideway	Entire guideway	Lane separation	Entire guideway	Entire guideway	Entire guideway	Possible rehabilitation	Minimal

[a] *Applicable only for level, tangent guideway segments. Guideway segments that are curved either horizontally or vertically may require greater clearances, depending upon site-specific design. Such variations for cross-sectional requirements are set forth in Chapter II and Chapter III of SEWRPC Technical Report No. 24, State-of-the-Art of Primary Transit System Technology.*

[b] *Does not apply to station and storage areas, junctions, intersections, or crossovers. Curvature is measured from centerline of guideway.*

[c] *Measured from either top of roadway surface or top of rail.*

[d] *Determined by existing freeway or surface arterial facilities.*

[e] *For new bridge structures. Existing bridges may not meet the recommended minimum vertical clearances.*

Source: SEWRPC.

gradient limitation of 8 percent and a minimum horizontal curvature limitation of 50 feet (radius). Fixed guideways for the busway and light rail transit modes do not necessarily require a fully grade-separated right-of-way, being able to operate through at-grade crossings with other railways and with streets and highways. Class A alignments for both modes would incorporate complete or near-complete grade separation, while Class B alignments—which are intended to make liberal utilization of existing rights-of-way—would incorporate little or no grade separation.

These characteristics are to be regarded as minimum or maximum limits, as appropriate, for mainline application, and do not necessarily apply to station and storage areas, junctions, intersections, or crossovers. To the extent possible, actual facility design should incorporate less restrictive gradients and horizontal curvatures, if such alignments are feasible. A more restrictive guideway design can be expected to result in a greater capital cost for a new primary transit system, as well as a larger amount of community disruption in densely developed urbanized areas.

There is less variation in the cross-sectional requirements than in the curvature and gradient requirements for the three primary transit modes which require newly constructed fixed guideways. The minimum desirable guideway widths for busways, light rail transit systems, and heavy rail rapid transit dual guideway systems vary between 30 feet and 38 feet, regardless of whether the guideway is located on the surface, on an aerial structure, or in a subway. Similarly, the minimum vertical clearance is 14 feet 9 inches for busways and 17 feet for light rail transit and heavy rail rapid transit systems. Segments of the guideway that are curved either horizontally or vertically may require somewhat greater clearances, depending upon site-specific design constraints. Right-of-way widths cannot be narrower than the width of the guideway, although extra right-of-way to both sides is desirable for maintenance access. To the extent possible, and as space permits, right-of-way and fixed guideway cross-sections should be designed to be less restrictive than dictated by the aforementioned limits.

Station Characteristics

The operation and design of station facilities vary considerably among the various primary transit modes. Such differences in design and operation are a function of the locations of the stations, the type of vehicles and length of trains, the manner of passenger access, the anticipated level of utilization, and the method of fare collection. In addition, station design is highly dependent upon the type of guideway served. For example, the design and operation of heavy rail system stations are significantly influenced by the necessity of a completely grade-separated guideway. In general, primary transit stations can be classified into three categories, depending upon the purpose and size of the individual facility: minor stations, major stations, and downtown station areas for passenger collection and distribution.

Bus Transit: Stations for motor buses and electric trolley buses vary in complexity with the type of operation, but are typically minor facilities (see Figure 16). Stations can consist of facilities quite similar to typical curbside bus stops, and can range in complexity from a small paved waiting area marked by appropriate signing to specially constructed platforms with shelters, lighting, seats, public telephone service, and possibly rest rooms. The more elaborate stations are generally applicable at park-ride lots, on busways at stations with light to moderate patronage, and at mainline stations for the bus-on-freeway and arterial express modes.

Major station facilities have application primarily at transit centers and other locations of substantial transfer of passengers between routes or modes, and at mainline stations where large passenger volumes are anticipated. Such facilities may require buildings and turnout bays so that stopped vehicles can easily be passed by other buses. The capital and operating costs of major bus stations may approach those of some heavy rail rapid transit stations.

Downtown station areas for bus transit are not normally recognizable facilities. Such terminal buildings are practical only in the largest cities with very intensive central business district travel demand. Instead, passenger collection and distribution in these areas is accomplished by the operation of buses over arterial streets which may include reserved lanes. To facilitate the efficient movement of transit vehicles through such an area, transit malls are sometimes developed as in Chicago, Detroit, and Minneapolis, among other cities. Such malls are usually developed in conjunction with retail area redevelopment, and incorporate the placement of shelters, kiosks, special paving, and other pedestrian amenities.

Figure 16

TYPICAL MOTOR BUS PRIMARY TRANSIT STATIONS

Most stations for the various motor bus primary transit modes need consist only of an adequate boarding platform area with some shelter, along with basic accessory items such as lighting, signing, and proper access for both pedestrian and automobile traffic (top). At major stations such as outlying terminals or transfer points, a building may be required (center). In central business districts, buses are operated over arterial streets, either in mixed traffic or over reserved lanes, or over transit malls (bottom), which are generally major shopping streets specially reconstructed for the exclusive use of transit vehicles.

Photo (top) courtesy of Wisconsin Department of Transportation, District 2.
Photo (center) courtesy of Southern California Rapid Transit District.
Photo (bottom) by Otto P. Dobnick.

Station spacing varies widely for the bus transit modes. Buses operating over reserved lanes and in mixed traffic on freeways typically operate nonstop from outlying areas into the central business district, using local bus stops in the outlying and downtown areas. Existing busway facilities may have station spacings of up to four miles. For purposes of alternative plan design, test, and evaluation under this study, however, typical station spacings for bus primary transit facilities were assumed to approximate one to two miles in medium-density urban areas, one-half to one mile in high-density urban areas, and one-quarter mile within the central business district. The typical platform length assumed under this study was about 140 feet, enabling two articulated buses traveling in the same direction to load and unload simultaneously. All station platforms for both diesel motor buses and electric trolley buses are designed for low-level loading.

Rail Transit: Because of the varying design and operational requirements of each of the three rail transit modes, stations for each mode have quite different characteristics. Three general types of stations can be defined for light rail transit and motor bus primary transit systems: minor stations, major stations, and downtown station areas for passenger collection and distribution (see Figure 17). Because the light rail transit mode—like the bus transit modes—is typically designed for on-board or self-service fare collection procedures, minor stations are used for at-grade, low-passenger-volume locations and at locations where right-of-way widths are constrained, such as in arterial street median areas. Such stations are relatively simple, consisting of platforms, proper pedestrian access, and signing, but may also include shelters, lighting, seating, and other pedestrian amenities.

Major stations for light rail transit systems are applicable at major transfer stations and other locations where large passenger volumes are anticipated. Such stations require buildings, and may incorporate controlled access of passengers to facilitate fare collection in the station. The capital and operating costs of such major stations may approach those of some heavy rail rapid transit stations, especially when the station is located within a subway.[9]

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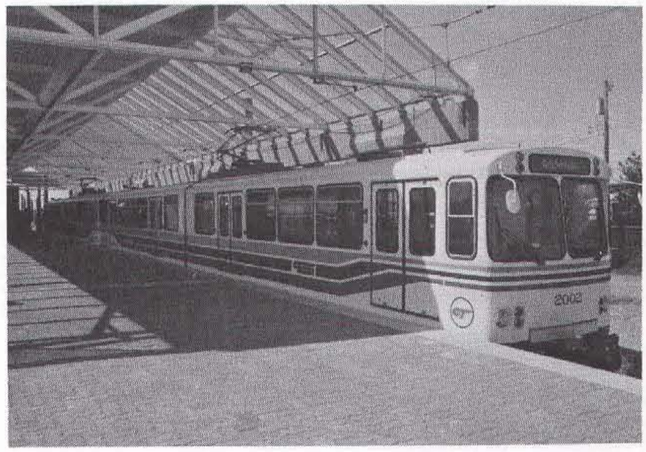
[9] *Of the newly constructed light rail transit systems within North America that serve central business districts, the Buffalo and Edmonton systems now have or will have subway stations.*

Figure 17

TYPICAL LIGHT RAIL TRANSIT STATIONS



An often-cited advantage to the development of a light rail transit system is the fact that such a system requires minimal station facilities, which may consist only of waiting platforms and proper signing (left). More elaborate station facilities may consist of buildings along with canopies or awnings over the platform area (right). In addition, a light rail transit system can be designed for either low-level boarding (left) or high-level boarding (right).

Photo (left) courtesy of San Francisco Public Utilities Commission.
Photo (right) courtesy of City of Calgary Transportation Department.

Downtown station areas for light rail transit typically involve the use of transit malls, whereby a major shopping street in the central business district is dedicated for the exclusive use of transit vehicles. Such malls usually include pedestrian amenities such as shelters and landscaping.

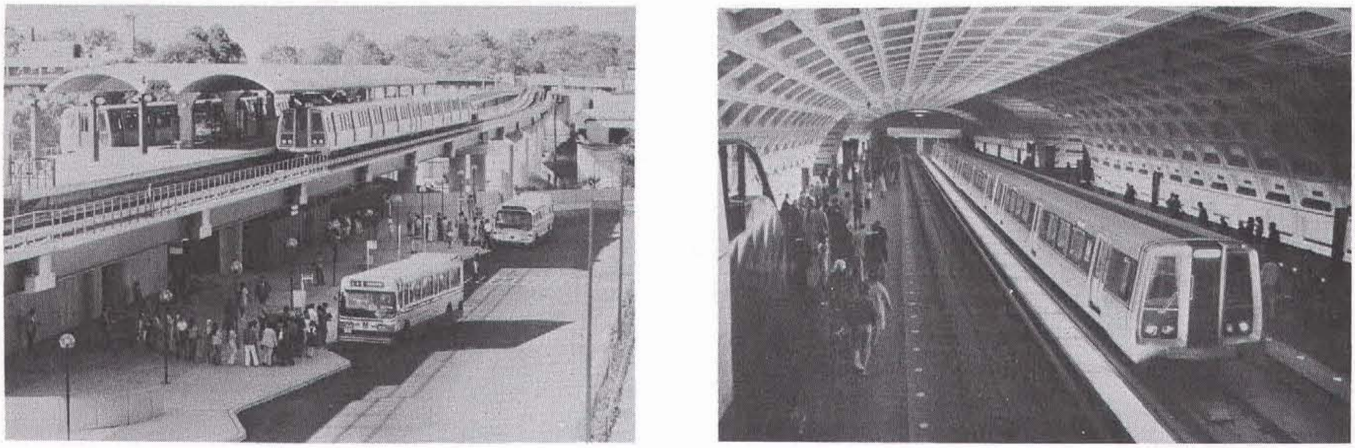
For purposes of system design, test, and evaluation under this study, typical station spacing for light rail transit was assumed to approximate one to two miles in medium-density areas, one-half to one mile in high-density areas, and one-quarter mile within central business districts. A typical platform length of about 200 feet was assumed, enabling a train of two single-articulated light rail vehicles to be accommodated in a single direction.

An important consideration in station design unique to light rail transit is the boarding platform height, which can provide for either high-level loading, low-level loading, or dual-level loading, the latter requiring movable steps on the vehicles. Boarding platform height does not significantly affect the spatial requirements of stations, but will influence vehicle design, system performance, and passenger accessibility. High-level loading and unloading offers the advantages of shorter station dwell times and ready access for the elderly and handicapped, while low-level loading—although requiring a smaller initial station investment—necessitates greater capital and operating costs because of a more complex vehicle design that requires stepwells or movable steps and, under current federal regulations, special access provisions for the elderly and handicapped.

Heavy rail rapid transit stations are the most elaborate and costly of not only the rail transit modes, but all the primary transit modes (see Figure 18). Such stations generally have at least two levels, a design feature necessitated by the need for complete grade separation of the guideway. Typically, one level is constructed with the platforms for boarding and deboarding trains, and the other level provides space for fare collection and interface with other modes. Where unconstrained by surrounding intensive urban development, heavy rail rapid transit stations usually include large park-ride lots, thus requiring a relatively large site to accommodate the entire station. When located in downtown areas, such stations can be very costly but are able to offer the opportunity for direct sheltered access to shopping areas and other major trip generators. The typical station spacing assumed for heavy rail rapid transit in the system design, test, and evaluation under this study

Figure 18

TYPICAL HEAVY RAIL RAPID TRANSIT STATIONS



Because heavy rail rapid transit systems require a fully grade-separated, exclusive guideway alignment, and because fare collection is performed at each station prior to boarding, such facilities are relatively elaborate and expensive. In urbanized areas, such stations are generally located either above ground on aerial structures (left) or underground in subways (right). Thus, not only are facilities for ready access to and from park-ride lots and feeder bus stops required, but facilities for pedestrian flow are required within the station limits, necessitating escalators or ramps and elavators for the elderly and handicapped, in addition to stairways between the various levels.

Photos courtesy of Washington Metropolitan Area Transit Authority.

approximated two miles in medium-density areas, one mile in high-density areas, and one-half mile in central business districts. Heavy rail station sizes are generally governed by the required platform lengths. Such lengths were assumed under this study to approximate 500 feet, adequate to accommodate a six-car train. All station platforms for this mode must be designed for high-level boarding and deboarding of passengers.

Commuter rail stations are, in many instances, simple adaptations of existing facilities. Outlying stations typically consist of either existing railway stations and platforms or newly constructed platforms with shelters and other passenger amenities (see Figure 19). The principal downtown station generally is the existing intercity passenger train terminal. The station spacing for commuter rail will typically vary between two and three miles in outlying areas, although this is highly dependent upon the location of existing concentrations of residential development. Station platforms must be able to accommodate the longest trains and, for the purposes of this study, were assumed to approximate 400 feet in length, sufficient for a four-car commuter train. In North American commuter rail practice, low-level loading is preferred, and thus only low-level platforms are required at stations.

Primary Transit Station Comparison: As already noted, stations for primary transit systems have a wide variety of size, configuration, and location characteristics which, in systems level planning, can only be specified in general terms. Table 19 summarizes the station characteristics assumed for use in system plan design, test, and evaluation under this study. As shown in this table, primary transit motor bus service, as well as light rail transit service, may be expected to require only minor stations in most instances. Only at important transfer locations would a major facility, such as a transit center, be necessary. In addition, these five modes are able to easily utilize transit malls in central business districts, thus providing an alternative to costly elevated or underground stations in such areas. Elaborate stations are almost always required for heavy rail rapid transit, regardless of the station location. A commuter rail system typically will use existing facilities in downtown areas and require only minor stations in outlying areas. A primary transit service employing electric trolley bus technology would require stations identical to those used for a similar guideway configuration under diesel motor bus operation.

An additional component critical to station design is automobile parking lot space, since primary transit stations—especially those utilizing fixed

Figure 19

TYPICAL OUTLYING COMMUTER RAIL STATION

Commuter rail systems normally use existing railway station facilities. As shown in this view, outlying stations can consist of relatively simple facilities, such as existing railway depot structures and platforms or newly constructed platforms with or without shelters. In downtown areas, commuter trains generally make use of the existing intercity railway passenger train terminal.

SEWRPC Photo.

guideways—depend, to a large degree, upon automobile access for cost-effective operation. Park-ride facilities are especially important in outlying suburban areas where residential densities cannot support feeder bus service. Parking lots are typically located adjacent to the primary transit stations in medium-density and suburban areas, but are rarely located in high-density and downtown areas.

Support Requirements

Support requirements for primary transit systems can be divided into five basic elements: vehicle storage and maintenance, guideway and station maintenance, power supply, traffic control, and fare collection procedures. These five support elements represent the major "hardware" items which are required for the operation of a primary transit system in addition to the vehicles, guideways, and station facilities. Not all of these support elements will be required to the same extent, if at all, by each of the alternative primary transit modes.

Vehicle storage facilities for the motor bus transit modes typically consist of garages and attendant paved parking lots, while storage facilities for light rail transit and heavy rail rapid transit consist of specially constructed railway yards. For a city where a large bus fleet already exists—such as in the Milwaukee area—the vehicle storage needs of the primary system may require only an expansion of existing facilities. Railway yards for light rail and heavy rail vehicle storage are normally located at or near the ends of routes so that vehicle deadheading can be minimized. The climate in the Milwaukee area requires that, for efficient operation of the system during the winter season, storage facilities for diesel motor buses include heated garages for easier starting during cold weather. Electrically propelled vehicles for the light rail transit, heavy rail rapid transit, and electric trolley bus modes may be stored outside. Storage tracks for commuter rail rolling stock are also located outdoors, and thus during the winter months the diesel-electric locomotives may be required to idle overnight, possibly causing noise and air pollution problems.

Like vehicle storage facilities, maintenance and repair facilities for diesel motor bus primary transit systems may require only the expansion of existing facilities. The addition of an electrified primary transit mode—such as the electric trolley bus mode, light rail transit mode, or heavy rail rapid transit mode—to an existing diesel motor bus mode will require the addition of specialized maintenance equipment, the retraining of staff, and increased parts inventories because of the addition of a different propulsion system. Unlike the electric trolley bus mode, the light rail transit and heavy rail rapid transit modes would require the construction of specially designed maintenance and repair facilities. Improvements to existing railway yard facilities or newly constructed facilities would be required to accommodate commuter rail rolling stock storage and servicing areas. Heavy maintenance and repair could be contracted out to the participating railway company.

The maintenance of guideways, structures, rights-of-way, stations, and other fixed facilities may be expected to have the least intensive requirements for the motor bus transit modes and the most intensive requirements for the rail transit modes because of the guideway requirements of the latter. Except in situations where extensive busway facilities are utilized, such maintenance activities can be expected to be minimal for diesel motor bus transit and electric trolley bus systems. For the small amount of guideway and grounds maintenance that may be required, agreements may be negotiated with local authorities or private contractors. Newly constructed light rail transit and heavy rail rapid transit systems would require specialized equipment, crews, and material inventories for regular roadbed and track structure maintenance and

Table 19

SELECTED STATION CHARACTERISTICS FOR PRIMARY TRANSIT MODES

	Motor Bus on Freeways	Motor Bus on Reserved Freeway Lanes	Motor or Electric Trolley Bus on Busways	Motor or Trolley Bus on Arterial Express Lanes	Light Rail Transit	Heavy Rail Rapid Transit	Commuter Rail
Station Type							
Medium-Density Areas	Minor[a]	None	Minor	Bus stops	Minor	Major	Platforms
High-Density Areas	Minor[a]	None	Minor[b]	Bus stops	Minor[b]	Major	Platforms
Downtown	Transit mall	Transit mall	Transit mall	Transit mall	Transit mall	Major	Intercity rail terminal
Typical Station Spacing							
Medium-Density Areas	1-2 miles	- -	1-2 miles	1 mile	1-2 miles	2 miles	3 miles
High-Density Areas	½-1 mile	- -	½-1 mile	½ mile	½-1 mile	1 mile	2½ miles
Downtown	¼ mile	¼ mile	¼ mile	¼ mile	¼ mile	½ mile	Intercity rail terminal
Platform Height	Low level	Low level	Low level	Low level	Low or high level	High level	Low or high level
Typical Platform Length (feet) . . .	140	140	140	140	200	500	400
Vehicle Capacity at Platform	2 vehicles	2 vehicles	2 vehicles	2 vehicles	2-car train	6-car train	4-car train
Typical Station or Stop Dwell Time (seconds)	30	30	30	30	30	20	30-60

[a] *Stations are assumed to be located off the freeway travel lanes.*

[b] *Stations at major interchange points between routes and/or modes may be expected to be more elaborate.*

Source: SEWRPC.

repairs. For commuter rail, these tasks are generally the responsibility of the operating railway, the costs being prorated according to predetermined agreements.

Power supply and distribution requirements are generally applicable only to the light rail transit, heavy rail rapid transit, and electric trolley bus modes. Power plants for diesel motor bus technologies as well as dieselized commuter rail service are contained on-board the vehicle or train, requiring no attendant guideway-related apparatus. Power for the electrified primary transit technologies typically is purchased commercially and transformed into an operating voltage through a system of primary and secondary substations. Primary substations are normally located at 10-mile intervals, and secondary substations at one- to two-mile intervals. The extent and complexity of the power supply and distribution system are dependent upon peak-period power requirements, the determination of which requires detailed preliminary engineering analyses.

The light rail transit mode requires an overhead wire power distribution system consisting of either a single contact wire or a catenary system. A simple contact wire is practical where high speeds—generally above 45 mph—are not required or in areas where aesthetic considerations are particularly important. Single contact wires require support columns at approximately 100-foot intervals. Catenary overhead is required for high-speed operation and requires support structures every 150 to 300 feet. Power distribution for heavy rail transit is normally effected by a side-mounted third rail. The larger cross-section of the third rail provides a greater current capacity which, in turn, permits longer trains than can be operated in a light rail transit system, while allowing for similar substation arrangements and intervals.

The electric trolley bus mode requires an overhead power distribution system consisting of a pair of wires suspended over the roadway surface. The overhead contact wire systems currently available fall into one of two categories: rigid systems which allow operating speeds of up to 35 or 40 mph, and elastic systems which permit speeds of up to 50 mph. The visual intrusion of the overhead power distribution system for both the electric trolley bus mode and the light rail transit mode is frequently cited as a major disadvantage to the construction of electrified transit systems. Proper design of the overhead wire system can mitigate these impacts, however.

Traffic control for the bus and rail transit modes differs substantially. For the bus modes, traffic control involves the use of signing, pavement markings, channelization, and traffic signal priority devices to improve vehicle movement through the existing traffic patterns. Such devices are especially important at transitional lanes and at other joint-use or mixed-traffic areas. These traffic control devices should follow the standards set forth in the latest revision of the Manual on Uniform Traffic Control Devices for Streets and Highways.[10] Priority at traffic signals may be provided for motor buses, electric trolley buses, and light rail vehicles operating over a Class B guideway, over reserved lanes, or in mixed traffic on arterial streets. Passive signal priority involves the retiming of signals for vehicle progression through a series of consecutive intersections or the reordering of signal phases to activate a special phase for transit vehicle movements. Active signal priority involves the detection of approaching transit vehicles in order to activate a special phase or to extend or advance the available green time at an intersection. A freeway operational control system—as envisioned in this study under the motor bus operation on freeway in mixed traffic mode—would be comprised of ramp-meter signals which regulate the flow of traffic onto the freeway system; a surveillance subsystem which monitors operating conditions on the freeway system through a system of vehicle detectors, speed detectors, and television cameras; changeable message signs to aid in the transmitting of information to drivers; and a control subsystem which utilizes the information gathered by the surveillance system as input into a preprogrammed computer, which controls the operation of the freeway through adjustment of the ramp-meter timing, the transmittal of driver information, and incident management.

The principal functions of traffic control apparatus on rail transit systems are to control the speed and spacing of traffic along the guideway; to protect against conflicting movements, including interface with other modes; and to control routings within the system. Modern heavy rail rapid transit systems in the United States employ automatic train control systems whereby most functions of train

[10] *U. S. Department of Transportation, Federal Highway Administration, Manual on Uniform Control Devices for Streets and Highways, (Washington, D. C., U. S. Government Printing Office, 1978).*

operation are automated. The majority of the existing light rail systems rely on visual sight rules for operation, with some automatic train protection on segments with restricted visibility. Commuter rail service is governed by whatever general railway signal system is already in place, this normally being automatic block signals or centralized traffic control.

There are four basic fare collection procedures that have application for primary transit system operation. The most common procedure is the pay-as-you-enter system, which is normally used on motor bus, electric trolley bus, and light rail transit systems within the United States. Recently, interest has been expressed in using self-service fare collection for these modes. Under a self-service ticketing system, passengers purchase tickets from vending machines and validate them at the time of use either at another machine mounted in the vehicle or at the station. Compliance with this system is maintained by a staff of checkers who, in European practice, are legally empowered to fine offenders "on the spot." Popular throughout Western Europe, self-service ticketing can reduce average travel time and operating expenses, although this system remains untried in the United States as of 1980. Controlled fare access collection is common on heavy rail rapid transit systems throughout the world. Under this system, fares are collected at stations before passengers are permitted access to the boarding platform. The fourth and last fare collection procedure is on-board ticket collection, which is typical of commuter rail service in North America. Tickets are purchased at stations or through the mail and are inspected on board the trains.

Overall Comparison of Primary Transit System Physical Characteristics

Urban transportation systems, by their very nature, consist of large fleets of vehicles and large physical plants. Whether already existing or newly constructed or acquired, the elements of such systems are: vehicles, guideways, stations, and various support facilities. The characteristics of these elements are summarized in Table 20 for each of the primary transit modes which have been identified as having potential for application in the Milwaukee area. Through careful examination of the information contained within this table, an approximate ranking can be made of the extent to which each of the eight modes requires the construction, procurement, or existence of each of these system elements.

Motor bus operation on freeways in mixed traffic, motor bus operation on freeways over reserved lanes, and arterial express service have the least intensive hardware and fixed plant requirements, since extensive utilization is made of existing facilities. Because the freeway and arterial street system is used as the guideway, little or no new construction is necessary except park-ride lots and exclusive freeway entrance ramps or bypass lanes at freeway entrance ramps. Station requirements are minimal, generally consisting of little more than waiting platforms with shelters and other minor passenger amenities. Vehicle storage and maintenance facility requirements would be met through an expansion of facilities already in place. Traffic control would encompass ramp meters and other monitoring and control apparatus if a freeway operational control system were implemented, bus priority measures at intersections for arterial express buses, and lane control measures for reserved lanes. The other primary transit modes require hardware and fixed plant in the following order of priority, from the mode with the least intensive requirements to that with the most intensive requirements: electric trolley bus technology, commuter rail, motor buses on busways, electric trolley buses on busways, light rail transit, and heavy rail rapid transit.

The electric trolley bus would typically be operated in arterial express service. This mode would differ from the express operation of diesel motor buses on arterial streets only in that the form of propulsion would require an overhead wire power distribution system, and the indoor storage of vehicles would not be required.

Like the bus transit modes, the commuter rail mode makes extensive use of existing facilities. Although right-of-way and the guideway are already in place, some degree of track rehabilitation may be necessary. Station and storage yard areas will entail either rehabilitation of existing facilities or new construction.

The motor bus on busway mode is one of three modes which have intensive fixed plant requirements, since a system of guideways with attendant stations would have to be newly constructed. The amount and sophistication of guideway and station construction will ultimately depend upon whether the system largely incorporates Class A or Class B alignments. Support facility requirements would be similar to those necessary for operation of the other diesel motor bus modes.

Table 20

SUMMARY OF PRIMARY TRANSIT SYSTEM PHYSICAL CHARACTERISTICS

Element	Motor Bus on Freeways	Motor Bus on Reserved Freeway Lanes	Busways	Arterial Express Lane Operation	Light Rail Transit	Heavy Rail Rapid Transit	Commuter Rail	Electric Trolley Bus
Guideways								
New or Existing	Existing	Existing	New	Existing	New	New	Existing	Existing or new
Right-of-Way	Shared	Reserved	Reserved or exclusive	Reserved	Reserved or exclusive (may even be shared in uncongested areas)	Exclusive	Exclusive (however, shared with freight and intercity passenger traffic)	Reserved or exclusive
Surface Alignment	Depends upon existing freeway facilities	Depends upon existing freeway facilities	Most common	Depends upon existing arterial street facilities	Most common	Common	Depends upon existing railway facilities	Common
Aerial Alignment			Possible		Possible	Common		Possible
Subway Alignment			Possible		Possible	Common		Possible
Grade Crossings	None	None	May be accommodated	Frequent	May be accommodated	None	Common	May be accommodated
Construction Disruption	Minor	Minor	Minor-Major	Minor	Minor-Major	Major	Minor	Minor
Vehicles								
Configuration	Conventional, articulated, or double deck				Single unit to double articulated	Permanently coupled pairs	Single- or double-level coaches	Conventional or articulated
Length (feet)	35-60				44-91	65-75	85	40-55
Train Length	Single unit				1 to 4 vehicles	1 to 10 vehicles	Locomotive plus 1 to 6 coaches (typical)	Single unit
Propulsion	Diesel				Electricity	Electricity	Diesel or electricity	Electricity
Weight (tons)	10-18				16-43	26-40	37-54	11-17
Seating Capacity	47-84				42-84	58-80	88-162	29-73
Total Capacity	72-107				100-251	170-273	172-438	75-184
Stations								
Extent of Facility	Minimal	Minimal	Simple or elaborate	Minimal	Simple or elaborate	Elaborate	Simple	Minimal
Platform Height	Low level	Low level	Low level	Low level	Low or high level	High level	Low or high level	Low level
Actual Spacing	0.5-3.7 miles, or nonstop			0.2-0.5 mile or nonstop	0.2-0.5 mile	0.3-1.2 miles	0.7-2.8 miles	0.2-0.5 mile
Attendants	Not required	Not required	Optional	Not required	Optional	Necessary	Optional	Not required
Support Facilities								
Vehicle Storage	Inside	Inside	Inside	Inside	Outside	Outside	Outside	Outside
Vehicle Maintenance	Addition necessary to existing bus facilities				Separate facilities required		Contract with railway	Separate facilities required
Guideway Maintenance	Minimal	Minimal	Significant	Minimal	Extensive	Extensive	Significant	Minimal
Traffic Control	Minimal	Simple	Minimal	Simple	Simple	Sophisticated	Standard	Minimal
Fare Collection	On board	On board	On board or at station	On board	On board or at station	At station	Through ticket sales	On board
Power Distribution	On board	On board	On board	On board	Overhead wire	Third rail	Locomotive hauled	Overhead dual wires

Source: SEWRPC.

The operation of busways using electric trolley buses would differ from the operation of busways using motor buses only in that the form of propulsion would require an overhead wire power distribution system, and the indoor storage of vehicles would not be required.

Like the busway modes, light rail transit would require the construction of a new system of guideways and stations. In addition, significant support facilities would be necessary, including a new overhead wire power distribution system, vehicle storage and maintenance facilities, and traffic control apparatus for the provision of preferential treatment over motor vehicle traffic at intersections.

Of all the primary transit modes, heavy rail rapid transit has the most intensive equipment and fixed plant requirements. The fixed guideway alignments for this mode must be completely grade-separated, thus resulting in complicated and disruptive construction, especially if subway segments are involved. Station facilities are elaborate and must accommodate high-level boarding as well as fare collection apparatus. Support facilities are also complicated in that storage and maintenance facilities would have to be constructed, sophisticated traffic control systems are required, and a power distribution system in the form of an outside running third rail is necessary.

In general, each of the eight primary transit modes identified herein requires a certain amount of equipment, fixed plant, and other hardware for system development. The first four of these eight modes—motor bus operation on freeways in mixed traffic, motor bus operation on freeways in reserved lanes, arterial express operation, and commuter rail—plus the special alternative of the electric trolley bus extensively use existing facilities and therefore have minimal to relatively simple requirements in the way of fixed plant, structures, and other equipment. The remaining three modes all require fixed guideways which, in turn, involve the construction of various civil engineering works, including railway trackage or paved roadways, bridges, cuts and fills, and possibly subways. Stations for the fixed guideway modes are generally more elaborate than those for the other modes, even though the facilities for busways and light rail transit systems can range from simple platforms with shelters to elaborate buildings with controlled access. Two of the three fixed guideway primary transit modes utilize rail transit technology, therefore necessitating the construction of separate vehicle storage and maintenance facilities, some degree of traffic control, and equipment for guideway maintenance, and a power distribution system for electrically propelled modes.

PERFORMANCE CHARACTERISTICS

System performance for all eight primary transit modes considered to be potentially applicable in the Milwaukee area may be defined in terms of three critical characteristics: speed, headway, and capacity. These factors are important determinants of the level of public acceptance and use of a new primary transit system. Speed, headway, and capacity all affect, and are affected by, the design of a primary transit system. Consequently, these performance characteristics are particularly important in the test and evaluation of alternative primary transit system plans.

Speed Characteristics

Transit speeds may be expressed as absolute maximum vehicle speeds, as typical operating speeds, and as average operating speeds. Maximum vehicle speeds are determined by the particular vehicle design, which, in turn, is governed by specifications related to the intended operation. The electric trolley bus typically has the lowest maximum vehicle speed, with such speeds for currently available models ranging from 37 to 44 miles per hour (mph). Light rail vehicles and diesel motor buses have maximum vehicle speeds ranging from 50 to 60 mph and 54 to 60 mph, respectively. Commuter rail rolling stock has maximum vehicle speeds ranging from 65 to 80 mph, depending upon whether the equipment is diesel-electric locomotive-propelled or self-propelled. The vehicles designed for modern heavy rail rapid transit systems have the highest maximum speeds, ranging from 70 to 80 mph.

Most of these maximum vehicle speeds can be further increased by the use of optional larger engines or different gear ratios. Such high maximum speeds, however, would not be necessary or practical for primary transit system operation in the Milwaukee area. For purposes of this study, vehicle characteristics have been selected which permit maximum vehicle speeds of 55 mph for diesel motor buses, 37 mph for electric trolley buses, 50 mph for light rail vehicles, 70 mph for heavy rail vehicles, and 65 mph for diesel-electric locomotives used in commuter rail service.

Typical operating speeds represent the actual speeds at which vehicles may be expected to travel along a particular segment of guideway. Typical operating speeds are a function not only of the maximum speeds attainable by the different vehicles, but also of the constraints imposed by the guideway type and alignment, by traffic and adjacent land use conditions, and by station spacing. Maximum operating speeds for motor bus operation on freeways in mixed traffic are currently limited to 55 mph, the posted maximum speed limit, although the maximum vehicle speeds assumed in the design of certain segments of the freeway system in the Milwaukee area are as high as 80 mph. Traffic conditions on freeways, however, may further limit actual operating speeds. The operation of transit vehicles—diesel motor buses, electric trolley buses, and light rail vehicles—over reserved lanes within public street rights-of-way will also be limited to the posted speed limits. Such speed limits are determined primarily by safety considerations for adjacent and crossing vehicular and pedestrian traffic. In transit malls and in congested areas, operating speeds for all surface modes will range from 20 to 25 mph. Over guideways located in the median areas of arterial streets and boulevards, operating speeds of up to 10 mph in excess of the posted speed limits for adjacent motor vehicle traffic may be reasonable. The operation of diesel motor buses, electric trolley buses, or light rail vehicles over fully grade-separated, exclusive rights-of-way will permit the attainment of the maximum vehicle speeds if stations are spaced far enough apart.

Heavy rail rapid transit systems require a fully grade-separated right-of-way, and thus have few constraints, other than station spacing, which would prohibit the achievement of maximum vehicle speeds of 70 mph. Speed reductions would be necessary only when traversing some horizontal curves and when passing through stations and junctions.

Operating speeds for commuter rail trains are determined by the condition of the railway track and roadbed structure,[11] the number of at-grade crossings with public streets and highways, station spacing, and adjacent land use conditions. Train operation through terminal areas and switching yard districts will generally limit the operating speeds from 25 to 40 mph because of the special trackwork and other train movements in the area. Otherwise, mainline operating speeds for commuter trains will typically range from 50 to 60 mph.

Average system speeds for primary transit modes reflect a variety of critical performance and operational criteria, including maximum vehicle speeds, actual, or typical, operating speeds, vehicle acceleration and deceleration characteristics, guideway-related constraints, station spacing, and station dwell times. An additional consideration for those modes which utilize guideways over reserved sections of arterial street rights-of-way is the extent to which preferential treatment is available over traffic flows on cross streets. If the transit vehicles are required to stop at intersections for cross traffic, the effect on average speed will be the same as that which would result from having station stops equal in number to those intersections without preferential treatment. Therefore, for the purpose of comparing the various primary transit modes operating under the most favorable conditions, it was assumed under this study that both Class B busways and Class B light rail transit guideways would be provided preferential treatment at all intersections where motor vehicle traffic conflicts are possible.

The average speeds for the various guideway types and station spacings selected for alternative primary transit system design, test, and evaluation are shown in Table 21. The average speeds shown in this table are based upon optimal operating conditions, the values themselves having been calculated from the maximum vehicle speeds, acceleration and deceleration rates, typical station dwell times, and typical station spacings. These speeds assume full vehicle acceleration immediately upon leaving a station, continuous operation at the maximum allowable vehicle speed, and full service deceleration prior to arriving at the next station, as well as level, tangent track with no intermediate speed restrictions between stations. It must be recognized that other factors—such as gradients, horizontal and vertical curvatures, and trackage arrangements at junctions—also affect average speeds. Therefore, when individual alternative alignments are examined, the assumed average speeds must undergo refinement based upon the site-specific design of the system components.

As shown in Table 21, the utilization of exclusive guideways provides the highest average speeds for each mode. Of all the fixed guideway modes, heavy rail rapid transit systems are typically capable of the highest average speeds, since a fully grade-separated right-of-way is necessary. The average speeds of light rail transit and busway systems are largely dependent upon the alignment, type, and configuration of the guideway and the degree of grade separation provided. The other motor bus primary transit modes—motor bus operation over freeways in mixed traffic, motor bus operation over freeways on reserved lanes, and arterial express service—have a wide range of average speeds, such speeds varying with the traffic as well as roadway conditions. For example, if a large pro-

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[11] *Because of the proposed level of mainline railway track rehabilitation assumed in this study, the maximum operating speeds for commuter trains within the Region would be limited to 60 mph. See Chapter VII of SEWRPC Technical Report No. 23, Transit-Related Socioeconomic, Land Use, and Transportation Conditions and Trends in the Milwaukee Area.*

Table 21

SPEED CHARACTERISTICS FOR PRIMARY TRANSIT MODES SELECTED FOR USE IN THE MILWAUKEE AREA ALTERNATIVES ANALYSIS

Characteristic	Miles per Hour									
	Motor Bus on Freeways	Motor Bus on Reserved Freeway Lanes	Busways		Arterial Express Lanes	Light Rail Transit		Heavy Rail Rapid Transit	Commuter Rail	Electric Trolley Bus Technology
			Class A	Class B		Class A	Class B			
Maximum Vehicle Speed	55.0	55.0	55.0	55.0	55.0	50.0	50.0	70.0	65.0	40.0[f]
Typical Operating Speeds										
Transit Mall	20.0	20.0	20.0	20.0	20.0	20.0	20.0	--	--	20.0
Surface Arterial Reserved Right-of-Way	--	--	--	40.0	30.0	--	40.0	--	--	30.0
At-Grade Exclusive Right-of-Way	--	--	--	45.0	--	--	45.0	--	50.0	40.0[f]
Grade-Separated Exclusive Right-of-Way	45.0-55.0[b]	40.0[c]; 55.0[d]	55.0	--	--	50.0	--	70.0	60.0	40.0[f]
Average Speeds on Transit Malls and in Central Business District										
One-Quarter-Mile Station Spacing	10.7	10.7	10.7	10.7	10.7	11.3	11.3	--	--	11.1
Average Speeds on Surface Arterial Rights-of-Way[a]										
One-Half-Mile Station Spacing	--	--	--	19.4	17.4	--	21.5	--	--	18.2
One-Mile Station Spacing	--	--	--	26.1	22.0	--	28.0	--	--	22.7
Two-Mile Station Spacing	--	--	--	31.6	25.4	--	32.9	--	--	--
Average Speeds on At-Grade Exclusive Rights-of-Way										
One-Half-Mile Station Spacing	--	--	--	19.9	--	--	22.5	--	26.0 to 32.8[e]	20.8
One-Mile Station Spacing	--	--	--	27.6	--	--	30.0	--	26.0 to 32.8[e]	27.4
Two-Mile Station Spacing	--	--	--	34.2	--	--	36.0	--	26.0 to 32.8[e]	32.5
Average Speeds on Grade-Separated Exclusive Rights-of-Way										
One-Half-Mile Station Spacing	19.9-20.9[b]	19.4[c]; 20.9[d]	20.9	--	--	23.4	--	26.1	26.0 to 32.8[e]	20.8
One-Mile Station Spacing	27.6-30.0[b]	26.1[c]; 30.0[d]	30.0	--	--	31.9	--	38.0	26.0 to 32.8[e]	27.4
Two-Mile Station Spacing	34.2-38.8[b]	30.2[c]; 38.8[d]	38.8	--	--	38.9	--	49.3	26.0 to 32.8[e]	32.5

[a] *Assumes preferential treatment at all arterial cross streets.*

[b] *On operationally controlled freeway under mixed traffic conditions.*

[c] *On contraflow lane.*

[d] *On normal flow lane.*

[e] *Average speed is within this range, based upon route-specific station spacing.*

[f] *Assumes use of available technology.*

Source: SEWRPC.

portion of a transit route is located over reserved freeway lanes, or over operationally controlled freeways, then the average speed may be expected to be high. However, if much of the route is operated in mixed traffic, then the average speed may be expected to be low. Since the overall performance of electric trolley buses is very similar to that of diesel motor buses, average speeds may be expected to be about the same under similar conditions.

Given identical maximum operating speeds and similar guideway characteristics and station spacing, electrically propelled vehicles will exhibit higher average speeds than diesel motor buses because they have somewhat better acceleration rates than vehicles with diesel engines. Station spacing and dwell times are particularly important determinants of average speeds. Station spacing is critical since each station stop represents additional time for vehicle deceleration, loading and unloading of passengers, and vehicle acceleration. Increasing the station spacing will significantly increase the average speed for all primary transit modes.[12] Station dwell time is a function of how fast vehicles can be loaded and unloaded at each stop.

Vehicle performance is particularly critical to the overall level of service provided by a primary transit system, since high acceleration and deceleration rates will permit high vehicle operating speeds to be sustained for relatively long periods of time between stations, thus enabling a high average speed to be achieved. Vehicles for each of the primary transit modes require a specific minimum distance if the maximum operating speed is to be attained, as shown in Figure 20. If station spacings or other stops are required which are shorter than this minimum distance, then the particular mode will be incapable of performing to its full potential. Furthermore, the minimum distances shown in Figure 20 represent ideal operating conditions. With any combination of factors including, but not limited to, surrounding traffic, inclement weather, underlying topography, and unusually heavy passenger loadings, the minimum distance required for a vehicle to accelerate to its maximum operating speed and then decelerate to a stop can be expected to be even longer.

[12] *Within the context of this planning report, motor bus primary transit modes are generally considered to have station spacings similar to those of rail transit modes. It is, however, common practice to operate nonstop buses in a "freeway flyer" type of service in which the vehicle makes no or very few stops along the line-haul portion of each trip. Consequently, the average speed may be very high and, possibly, equal to that of heavy rail rapid transit operation with its attendant station spacing.*

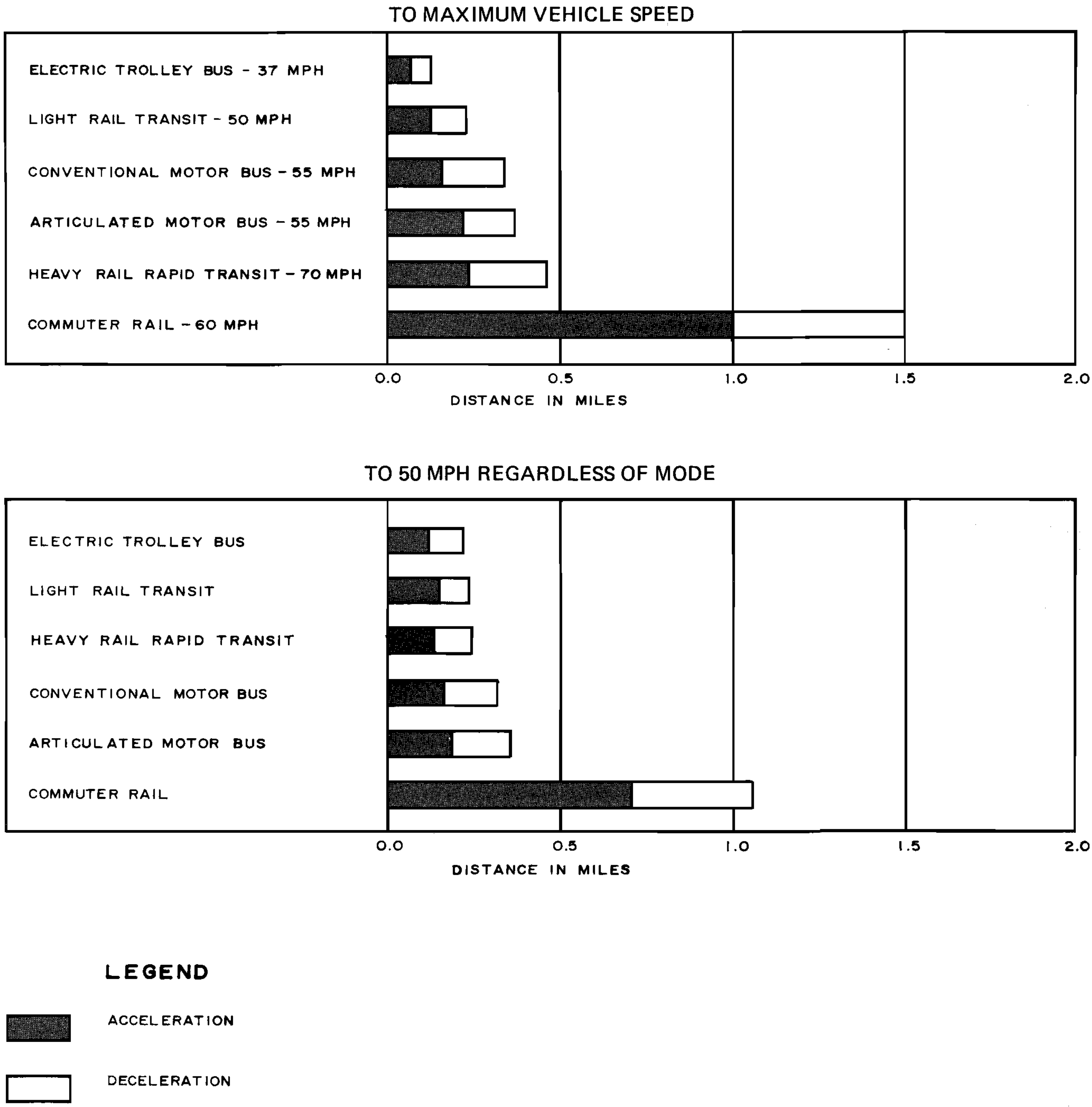
Headway Characteristics

Vehicle headways are dependent upon the vehicle performance characteristics, the passenger loadings to be carried, the desired level of service to be provided, and the manner in which schedules are designed by the transit operator. Minimum headways for diesel motor buses and electric trolley buses in revenue service may range from one-third to one-half minute, although headways as small as 2.5 seconds have been achieved under test track conditions for the diesel motor bus mode. Minimum headways for revenue service operation may range from approximately 0.5 minute to 1.5 minutes for light rail transit, from 1.5 minutes to 3.0 minutes for heavy rail rapid transit, and from 2.0 minutes to 6.0 minutes for commuter rail. Actual headways are normally greater since such headways reflect the need to efficiently serve ridership demands at a given level of service. In situations where two or more routes converge to use the same guideway or alignment, headways will necessarily be shorter. Table 22 sets forth the typical headways selected for use in the design, test, and evaluation of alternative primary transit systems under this study. The headways listed in this table were used as preliminary values, and were subject to refinement based upon the actual passenger demand exerted upon the various alternative transit routes, as determined from the simulation model studies.

Minimum headways will occur only under the heaviest travel demands, and then for only short periods of time during weekday peak travel periods. For diesel motor bus operation, electric trolley bus operation, and most light rail transit operation, vehicle spacing is under the direct control of the operator of each vehicle or train, making the minimum headways a function of the capabilities and limitations of visual, manual control. Automatic train protection and signal systems regulate vehicle movement on heavy rail rapid transit systems, some light rail transit systems, and commuter rail lines. Such train protection and signal systems have built-in safety margins which prohibit excessively short and unsafe head-

Figure 20

MINIMUM DISTANCE REQUIRED FOR PRIMARY TRANSIT VEHICLES TO ACCELERATE TO AND DECELERATE FROM MAXIMUM OPERATING SPEEDS



NOTE: These data reflect distances based upon maximum rates of acceleration and deceleration under ideal operating conditions on level guideways.

Source: SEWRPC.

Table 22

HEADWAYS FOR PRIMARY TRANSIT MODES SELECTED FOR USE IN THE MILWAUKEE AREA ALTERNATIVES ANALYSIS

Time of Operation	Headway (minutes)							
	Motor Bus on Freeways	Motor Bus on Reserved Freeway Lanes[a]	Busways	Arterial Express Lanes[a]	Light Rail Transit	Heavy Rail Rapid Transit	Commuter Rail	Electric Trolley Bus Technology
Weekday Peak Periods	5	5	5	5	5	5	30	5
Midday	10	--	10	--	10	10	60	10
Evening	15	--	15	--	15	15	60	15
Saturdays	10	--	10	--	10	10	120	10
Sundays and Holidays	15	--	15	--	15	15	180	15
Minimum Headway (seconds)	5[b]	5[b]	5	30	36	90	120	30

[a] *Operation assumed only during weekday peak periods.*

[b] *Assumes no on-line stops.*

Source: SEWRPC.

ways from occurring. Thus, higher operating speeds will require longer distances between trains to allow for longer stopping distances.

It should be recognized that headways are an important determinant of the level of service provided by any public transit system, as they affect the wait times of the transit user for a transit vehicle. Accordingly, proposed headways are a particularly important factor affecting the utilization of transit systems. Under this study, average wait times were calculated as one-half of the headway, with a minimum average wait time of five minutes during both peak and nonpeak periods. This average wait time reflects the assumption that regular transit users will arrive at the initial transit station shortly before scheduled arrival times. This also assumes schedule coordination between transit collection-distribution routes and primary transit routes.

Capacity Characteristics

The maximum passenger-carrying capacity of a primary transit system over a specific segment of vehicle route is dependent upon vehicle configuration, capacity, and headway. In general, rail transit modes are able to carry the highest passenger volumes because of the large vehicle capacities and the ability to couple the vehicles into trains. Of the rail transit modes, heavy rail rapid transit is able to meet the highest peak-hour demands. While the passenger-carrying capacities attainable by the motor bus transit technologies somewhat overlap the lower range of capacities attainable by the rail transit technologies, maximum capacities typically cited for the bus transit modes are applicable only in a nonstop, line-haul operation. Should station stops be required of most motor bus vehicles along a designated priority facility, station design may become a critical factor, since queues may form outside station areas should an insufficient number of bus berths be available. The rail transit modes do not have this potential limitation since rail transit vehicles can be coupled into trains, and stations for rail transit systems have loading platforms designed to accommodate the longest train length. The electric trolley bus mode may be expected to have capacities similar to those of diesel motor bus transit modes.

A particularly important consideration in determining the maximum capacities of each of the primary transit modes is the load factor. The load factor is defined as the ratio of the total number of passengers carried on a public transit vehicle to the seated capacity of that vehicle. A load factor of 1.00 would represent an ideal condition, since every seat would be filled—an economically desirable situation—and there would be no standees on the vehicle—a desirable situation for passenger comfort and safety. Maximum load factors vary among the different primary transit modes. Light rail vehicles and heavy rail vehicles are typically designed to accommodate large numbers of standing passengers during periods of high travel demand. This is accomplished through interior vehicle designs that reduce the number of available seats, and that provide greater floor space for standees. Since standing passengers require less floor area than do seated passengers, and since typical North American rail transit vehicles are both longer and wider than contemporary bus vehicles, rail transit vehicles will generally be able to provide a greater total capacity than can either diesel motor buses or electric trolley buses.

Based upon the characteristics of the specific vehicle designs identified in Table 17, maximum load factors for each of the primary transit modes considered were established for use in the design, test, and evaluation of alternative system plans. Diesel motor buses that operate either wholly or partially in mixed traffic on freeways may be subject to unexpected stops during periods of heavy traffic. This consideration, along with the stop-and-go operation that is possible on freeways during peak periods, creates a dangerous situation for standing passengers. For these reasons, motor bus operation on freeways, both in mixed traffic and in reserved lanes, was assigned a maximum design load factor of 1.0. High-speed motor bus operation on busways would normally not be subject to the safety hazards of high-speed motor bus operation in mixed traffic, while arterial express operation does not involve high speeds. These two motor bus modes, therefore, were assigned a maximum design load factor of 1.6.

As already noted, vehicles for both light rail transit and heavy rail rapid transit systems are typically designed with interior seating arrangements conducive to the accommodation of large numbers of standees. Accordingly, a design load factor of 2.2 was assigned to the light rail transit mode, while a design load factor of 3.0 was assigned to the heavy rail rapid transit mode. Commuter rail rolling stock, on the other hand, was assigned a design load factor of 1.0 because of the relatively long trips lengths involved as compared with those of the other primary transit modes.

Since the electric trolley bus is not readily adaptable for operation on freeways, it would be applied only in a busway or arterial express service mode for the provision of primary transit service. Like these applications of diesel motor buses, such applications of electric trolley buses were assigned a maximum load factor of 1.6.

Identified in Table 23 are the capacities for selected headways based upon the use of the primary transit vehicle designs presented in Table 17, as well as the maximum design load factors selected above. Reflected in these capacities are vehicle, train size, and headway characteristics that may reasonably be expected to be applicable for the Milwaukee area. Actual capacities for the alternative systems will, of course, depend upon the refinement of headways and train sizes based on the ridership projected for the particular system. As shown in Table 23, the rail transit modes—light rail transit, heavy rail rapid transit, and commuter rail—are capable of handling larger numbers of passengers than the diesel motor bus or electric trolley bus modes, given the same vehicle headways. This is because of the ability of rail transit modes to couple individual vehicles into trains. It should be recognized that, by shortening the headway between buses, any of the motor bus modes will be able to achieve a peak-hour capacity equal to any peak-hour capacity attainable by the rail transit modes in the Milwaukee area. Shortening the headways between buses, however, would entail a significantly larger peak-hour fleet of buses, as well as a greater number of drivers, and thus a larger labor cost component. Rail transit technology generally requires a very large initial investment in fixed plant and equipment to achieve its efficiencies and operating cost economies.

ECONOMIC CHARACTERISTICS

In order to estimate the economic viability and fiscal requirements of alternative primary transit systems, data on capital and operating costs are required. The cost data presented herein represent generalized, nonsite-specific information assembled by the Regional Planning Commission staff for primary transit systems recently constructed or expanded in other urban regions of the United States. The cost data are intended to be applicable at the systems planning level in the comparative evaluation of alternative primary transit systems. In order to facilitate application, all capital and operating costs are presented in 1979 dollars.

In any consideration of the cost data presented herein, it should be recognized that differentials may exist between the capital and operating costs in the Milwaukee area and such costs in other

Table 23

MAXIMUM LINE-HAUL CAPACITIES FOR PRIMARY TRANSIT MODES SELECTED FOR USE IN THE MILWAUKEE AREA ALTERNATIVES ANALYSIS

Length of Headway	Passengers per Hour							
	Motor Bus on Freeways	Motor Bus on Reserved Freeway Lanes	Busways[f]	Arterial Express Lanes	Light Rail Transit[f]	Heavy Rail Rapid Transit	Commuter Rail	Electric Trolley Bus Technology[g]
Maximum Peak-Hour Capacity								
One-Half-Minute Headway	8,040	8,040	12,840	12,840	- -	- -	- -	12,840
One-Minute Headway	4,020	4,020	6,420	6,420	17,640[a]	- -	- -	6,420
Two-Minute Headway.	2,010	2,010	3,210	3,210	8,820[a]	39,960[c]	- -	3,210
Five-Minute Headway.	804	804	1,284	1,284	3,528[a]	15,984[c]	7,536[d]	1,284
Midday Capacity (10-minute headway except commuter rail)	402	402	642	642	882[b]	2,664[a]	314[e]	642
Maximum Load Factor.	1.0	1.0	1.6	1.6	2.2	3.0	1.0	1.6

NOTE: Rail transit mode capacities can, within limits, be readily increased by adding cars to trains, as, for example, two cars per train for light rail transit, or a 100 percent increase; two to four cars per train for heavy rail rapid transit, or a 33 to 67 percent increase; and 12 cars per train for commuter rail, or a 300 percent increase.

[a] *Assumes two-car train.*

[b] *Assumes one-car train.*

[c] *Assumes six-car train.*

[d] *Assumes four-car train.*

[e] *Assumes two-car train operating on a 60-minute headway.*

[f] *Capacities shown apply to both Class A and Class B guideways.*

[g] *Capacities shown apply to operation both on busways and in arterial express service.*

Source: SEWRPC.

urban regions of the United States. Since such differentials will similarly affect the costs of all alternative system plans to be evaluated, any necessary adjustment can be best made in the costs of the selected plan. Based upon the construction cost indices for other selected major midwestern cities, capital costs in the Milwaukee area may be expected to be from 1 to 5 percent lower than average national costs. Operating costs for the Milwaukee area can be expected to be similar to those for other cities within the United States based upon a review of operator and driver wages.

Capital Costs

Capital costs are those monetary investments required to acquire right-of-way, construct the physical facilities, and acquire the equipment necessary for the operation and maintenance of a primary transit system. The capital costs include the costs for the acquisition of right-of-way and vehicles; the construction of, or modification to, specific guideway segments; the construction of stations and boarding facilities; the installation of a power distribution system, if necessary; the installation of signals and communication equipment; and the provision of maintenance and storage facilities.

Right-of-way acquisition costs include all costs entailed in obtaining easements over, or fee simple title to, all real property required for the development of a primary transit system. Since land acquisition costs for primary transit technologies which utilize existing rights-of-way are limited to the cost of acquiring the land required for support facilities and stations, right-of-way costs may be expected to

Table 24

TYPICAL LAND COSTS FOR FIXED GUIDEWAY RIGHTS-OF-WAY FOR PRIMARY TRANSIT MODES

Location of Right-of-Way	Land Costs (in millions of 1979 dollars per mile)	
	Busway Transit[a]	Rail Transit[b]
Central Business District . . .	3.24	4.14
High-Density Area	2.92	2.68
Medium-Density Area	2.60	2.39

NOTE: Costs are applicable in Standard Metropolitan Statistical Areas with populations of more than one million people.

[a] *Based upon land required for 41-foot-wide, dual-guideway right-of-way.*

[b] *Based upon land required for 36-foot-wide, dual-guideway right-of-way in open cut or on fill, and 30-foot-wide dual-guideway right-of-way on elevated segments or in subway segments.*

Source: D. B. Sanders and T. A. Reynen et. al., Characteristics of Urban Transportation Systems—A Handbook for Transportation Planners, National Information Service, Springfield, Virginia, 1979.

Table 25

VEHICLE ACQUISITION COSTS FOR PRIMARY TRANSIT MODES SELECTED FOR USE IN THE MILWAUKEE AREA ALTERNATIVES ANALYSIS

Vehicle Type	Capital Cost (in 1979 dollars)
Conventional Motor Bus[a]	$140,000
Articulated Motor Bus[a]	240,000
Light Rail Vehicle[b]	800,000
Heavy Rail Rapid Transit Vehicle[c] . . .	750,000
Diesel-Electric Locomotive	930,000
Bi-Level Gallery Commuter Coach[c] . . .	565,000[e]
Self-Propelled Commuter Coach[c]	960,000
Conventional Electric Trolley Bus[d] . . .	164,000

[a] *Includes air-conditioning equipment and wheelchair lift.*

[b] *Single-articulated vehicle with air-conditioning equipment but no wheelchair lift.*

[c] *Includes air-conditioning equipment.*

[d] *Does not include air-conditioning equipment or wheelchair lift. If limited off-wire capability is desired, add either $8,000 for battery package or $15,000 for generator package.*

[e] *Average cost of one control cab and three trailer coaches.*

Source: SEWRPC.

be highest for those primary transit modes which require the construction of a special guideway on new locations. These modes include bus on busway, light rail transit, and heavy rail rapid transit. In addition to the land costs, substantial legal, brokerage, and relocation costs may be incurred in the acquisition of right-of-way. Although site-specific knowledge is required for any detailed analysis of right-of-way acquisition costs, a measure of such costs is provided in Table 24, which presents typical right-of-way acquisition costs based upon recent primary transit facility construction and extension projects in the United States. These costs typically vary between $2 and $4 million per mile, depending upon the right-of-way width required and the land uses concerned. When the actual location of alternative guideway alignments has been determined, more precise right-of-way costs can be estimated based upon average residential, commercial, and industrial land values for both developed and open lands in the Milwaukee area.

The cost of primary transit vehicles is a function of the basic vehicle configuration and the options which are requested by the transit system operator. The major factors influencing vehicle costs include the overall vehicle length and weight, configuration, passenger capacity, type of propulsion, and degree of sophistication of various vehicle subsystems such as train control and communications equipment. Over the last decade, rail transit vehicle costs have escalated at a more rapid rate than have the costs of other capital items. Vehicle acquisition costs assumed for each of the technologies described earlier in this chapter are presented in Table 25. These costs range from a low of $140,000 for a conventional diesel motor bus to a high of $960,000 for a self-propelled commuter rail coach. Light rail vehicles and heavy rail vehicles may be expected to cost from three to six times as much as either diesel motor buses or electric trolley buses. Bi-level gallery coaches for commuter train service may be expected to have slightly more than half the cost of a diesel-electric locomotive or a self-propelled coach.

Guideway costs will generally constitute the largest proportion of the total capital costs of any primary transit system which requires extensive fixed guideway construction. The three primary transit modes identified in this study that require extensive guideway construction are bus on busway, light rail transit, and heavy rail rapid transit. Fixed guideway development costs are greatly affected by the horizontal and vertical alignment requirements of the guideways. Therefore, unit costs grouped according to the vertical configuration of the guideway as well as according to its location in the urbanized area were developed for application in the systems planning effort. The unit costs of the fixed guideways include, as applicable, the costs of earthwork, drainage, utilities, structures, fencing, railway trackage or roadways, electrification, signals and communications, grade-crossing protection, and incidentals. Table 26 sets forth the ranges in typical construction costs per mile for various types of guideways based upon recent construction experience in North America.

As indicated in Table 26, busway systems may be expected to have the least costly fixed guideways of the three modes considered, with typical costs ranging from $1.4 million to $6.8 million per mile for at-grade alignments; from $3.9 million to $17.7 million per mile for alignments elevated on fill or structure; and from $6.1 million to $22.2 million per mile for alignments in retained cuts. Fixed guideways for light rail transit systems are more costly than those for busways because railway trackage is more costly to construct than paved roadways, and an overhead power distribution system is required, along with signals, communication equipment, and other traffic control apparatus. Fixed guideways for light rail transit may be expected to cost between $3.7 million and $7.4 million per mile for at-grade alignments; between $6.3 million and $19.0 million per mile for alignments elevated on fill or structure; between $8.5 million and $23.5 million per mile for alignments in retained cuts; and between $38.1 million and $46.7 million per mile for alignments in a cut-and-cover subway. Fixed guideways for heavy rail rapid transit systems are more costly than those for light rail transit systems, because, although the power distribution system is less costly, the signals, communication equipment, and other traffic control apparatus are more costly. In addition, a heavy rail rapid transit system must be fully grade-

Table 26

TYPICAL CONSTRUCTION COSTS FOR PRIMARY TRANSIT FIXED GUIDEWAYS SELECTED FOR USE IN THE MILWAUKEE AREA ALTERNATIVES ANALYSIS

Type of Guideway	Construction Costs (in millions of 1979 dollars per mile)[a]		
	Heavy Rail Rapid Transit	Light Rail Transit	Busways
Medium Density			
At-Grade	4.2- 6.1	3.8- 7.4	1.4- 2.9
Elevated on Fill or Structure	6.3-12.3	6.3-12.3	3.9-10.4
Retained Cut	8.5-16.1	8.5-16.1	6.1-14.2
High Density			
At-Grade[b]	--	4.0- 5.4	3.2- 6.8
Elevated on Fill	19.6-24.5	9.3-19.0	7.0-17.7
Aerial Structure	20.9-23.6	8.6-17.1	6.3-10.1
Retained Cut	25.3-30.6	11.9-23.5	9.5-22.2
Cut-and-Cover Subway	38.0-46.6	--	--
Central Business District			
At-Grade[c]	--	3.7- 4.3	1.9- 2.7
Aerial Structure	21.0-23.8	8.8-17.2	6.3-11.3
Cut-and-Cover Subway	38.1-46.7	38.1-46.7	--

[a] *Does not include agency and contingency costs.*

[b] *Exclusive right-of-way and in reserved median areas.*

[c] *Reserved median areas and transit malls.*

Source: SEWRPC.

separated from all other streets, highways, freeways, and railway lines. Therefore, such systems may be expected to have the most costly guideways of the three primary transit modes which require new fixed guideways. Heavy rail rapid transit guideways may be expected to cost between $4.2 million and $6.1 million per mile for at-grade alignments; between $6.3 million and $24.5 million per mile for alignments elevated on fill or structure; between $8.5 million and $30.6 million per mile for alignments in retained cuts; and between $38.0 million and $46.7 million per mile for alignments in a cut-and-cover subway.

Large differences may be expected in the capital costs of the various alignment types for each of the modes that require new fixed guideways. Aerial segments may be expected to cost substantially more than surface alignments, and subway segments may be expected to cost substantially more than aerial segments. The cost of guideway construction on the surface is also dependent upon whether the alignment is at-grade or grade-separated. A decision as to what vertical configuration is desirable for a new primary transit system is fundamental to any estimate of the ultimate system cost. It is also important to recognize that the availability and use of existing rights-of-way may significantly reduce total guideway construction costs, since the use of existing rights-of-way may minimize the cost of not only land acquisition, but also earthwork and structures for the crossing of streets, highways, and railways. The use of existing rights-of-way for primary transit guideways will, however, entail an acquisition cost and a cost attendant to foregoing the use of the rights-of-way for other public or private purposes.

Of the three primary transit modes which require new fixed guideway construction, busways require the least expensive guideways, and heavy rail rapid transit requires the most expensive guideways. The capital cost advantages of light rail transit over heavy rail rapid transit can be fully exploited only when extensive use is made of nonexclusive surface alignments while minimizing investment in station facilities and sophisticated train control equipment. When a light rail facility is designed with a predominantly grade-separated right-of-way, the guideway construction costs of the two modes—light and heavy rail—become quite similar.

Guideway costs for commuter rail operation primarily represent the cost of rehabilitating existing railway trackage. Although the necessary railway alignments are of an exclusive nature, by definition commuter rail uses mainline trackage which is already in place. Guideway development costs for commuter rail will, consequently, be far less than those for the other rail transit modes. In addition to the rehabilitation of existing trackage, the construction of some ancillary trackage may be necessary prior to service initiation. The rehabilitation cost is dependent upon the extent to which each individual commuter rail line must be upgraded, a situation which varies considerably for the different potential commuter rail routes in the Milwaukee area. The cost of track rehabilitation for commuter rail service was estimated in the alternatives analysis on the basis of a segment-by-segment field inspection, and was found to range from a low of about $60,000 per track mile to a high of about $700,000 per track mile.

Three of the motor bus transit modes—reserved lane operation on freeways, motor bus operation in mixed traffic on freeways, and arterial express service—utilize existing arterial street and highway facilities. Consequently, primary motor bus service employing these modes will have minimal capital costs for guideway construction. Implementation costs for reserved lane operation on freeways and arterial streets will depend primarily on the extent to which sophisticated lane control equipment is utilized. Capital costs attendant to reserved normal flow freeway lanes may be expected to range between $12,000 and $35,000 per mile for basic lane separation and attendant signing. Contraflow freeway lanes may be expected to range in cost from $9,000 to $109,000 per mile. If the construction of an additional lane is required in order to accommodate a normal flow freeway lane, implementation costs may be expected to range between $0.5 million and $1 million per mile.

Arterial street reserved lane implementation costs will depend primarily on project location and adjacent land uses. Costs may be expected to range between $4,000 and $110,000 per mile for a normal flow reserved curb lane, between $5,000 and $140,000 per mile for a contraflow reserved curb lane, and between $20,000 and $210,000 per mile for a reserved median lane. The actual costs for such facilities will depend upon the method of lane separation—for example, striping, cones, or curb barriers—and the sophistication of lane control signing and signalization. Finally, exclusive bus malls, or bus streets, may be expected to cost between $0.7 million and $2.7 million per mile, the cost being contingent upon the extent of modification to the existing street facility.

It is possible that a new electric trolley bus system could include segments of exclusive busways, and reserved lanes or other traffic engineering measures, to grant preferential treatment for the transit vehicles. While these elements could represent a significant proportion of the capital investment required, their costs may be expected to be the same as those of similar facilities that would be utilized for a diesel motor bus primary transit system.

The capital costs of station facilities will depend primarily on the particular requirements of a mode and the site-specific considerations of a particular route or alignment. Generally, primary transit technologies which do not require the construction of new fixed guideways employ minor station facilities which require only minimal capital investment. Primary transit technologies which do require the construction of new fixed guideways generally require moderate to extensive stations

Table 27

TYPICAL CONSTRUCTION COSTS FOR PRIMARY TRANSIT FIXED GUIDEWAY STATIONS SELECTED FOR USE IN THE MILWAUKEE AREA ALTERNATIVES ANALYSIS

Type of Guideway	Construction Costs (in millions of 1979 dollars per facility)[a]			
	Light Rail Transit	Heavy Rail Rapid Transit	Busways	Commuter Rail
Medium Density				
Exclusive At-Grade Right-of-Way	0.02-3.4	0.5- 5.0	0.02-3.3	0.07-0.84
Elevated on Fill or Structure	0.2 -4.4	0.5- 5.5	0.3 -4.1	--
Retained Cut	0.3 -4.4	0.9- 6.7	0.3 -4.1	--
High Density				
Exclusive At-Grade Right-of-Way	0.2 -3.4	--	0.02-3.30	0.03-0.64
Shared Street Right-of-Way	0.02-0.09	--	0.02-3.30	--
Elevated on Fill or Structure	0.4 -4.4	1.0- 4.8	0.2 -4.2	--
Retained Cut	0.4 -4.5	1.0- 4.8	0.2 -4.2	--
Cut-and-Cover Subway	--	6.2- 9.5	--	--
Central Business District				
At-Grade[b]	0.05-0.19	--	0.02-0.19	0.12-1.14
Aerial Structure	1.6 -4.2	1.4- 5.6	1.5 -4.2	--
Cut-and-Cover Subway	2.3 -7.5	6.0-14.5	--	--

[a] *Does not include agency and contingency costs.*

[b] *Reserved median areas and transit malls.*

Source: SEWRPC.

which require a large capital investment. Three of the four primary motor bus transit applications require only minor stations, many of which may be little more than the normal curbside bus stops equipped with shelters and appropriate signing. The use of more elaborate stations may be expected at major transfer locations. For these motor bus transit technologies, curbside stops with shelters may be expected to cost between \$3,000 and \$9,000, outlying terminal locations may be expected to cost between \$5,000 and \$22,000, and major at-grade transfer stations may be expected to cost between \$20,000 and \$110,000.

The primary transit modes which require fixed guideways are bus on busway operation, light rail transit, heavy rail rapid transit, and commuter rail. Station capital costs for these modes will depend upon platform length, the specific design of the facility, park-ride lot requirements, pedestrian and automobile access, and passenger amenities. As shown in Table 27, commuter rail stations can be expected to be the least costly of the four modes considered, with costs generally ranging from \$30,000 to \$120,000 per facility. The cost of downtown facilities could exceed \$1.0 million, depending upon whether the existing intercity passenger station requires renovation or replacement. The intercity passenger train station in downtown Milwaukee—which is currently used by Amtrak—would not require replacement or major renovation. The capital cost of commuter rail stations will depend to a considerable extent upon the degree to which existing facilities can be utilized or rehabilitated. Stations for light rail transit and busway systems can be expected to cost between \$20,000 and \$4.2 million per facility, depending upon whether the facility is located on the surface, on an aerial structure, or in a retained cut. Such facilities may range from simple platforms with or without shelters to elaborate multilevel structures generally associated with heavy rail rapid transit systems. Light rail transit stations located along underground alignments will tend to be similar to heavy rail rapid transit stations in design, and can be expected to cost up to

\$7.5 million each. Heavy rail rapid transit systems may be expected to have the most costly stations of all the primary transit modes, a result of that mode's requirement for a fully grade-separated, exclusive guideway. Stations for this mode may be expected to cost between \$0.5 million and \$5.6 million if located on an alignment other than in a subway, and between \$6.0 and \$14.5 million if located along a cut-and-cover subway alignment.

The power distribution system includes those facilities required to provide electrical power for vehicle propulsion and for operation of fixed facilities. This component consists of the necessary complement of electrical wires and apparatus for the propulsion of light rail vehicles, heavy rail vehicles, and electric trolley buses. This cost component is not applicable to the other primary transit modes to be examined within this study since those modes do not require an external power distribution system. For the light rail transit and heavy rail rapid transit modes, the costs of electrical power distribution are included in the construction costs set forth for the primary transit fixed guideways, this portion of the total cost ranging from about \$900,000 to \$1,300,000 per mile. For a new electric trolley bus system constructed in the same manner as those systems already in existence—for operation at relatively low speeds over arterial street systems—the power distribution element will represent the largest capital cost, ranging between \$500,000 and \$700,000 per two-way route mile. The costs will depend upon whether a conventional feeder system or feederless system is selected, plus the extent of overhead work construction required.

The capital costs of signals and communication equipment vary considerably among the modes. Traffic control requirements and attendant systems are generally the most complex and elaborate for the rail transit modes, with heavy rail rapid transit requiring the most sophisticated apparatus because of the wide use of automated train control. The cost of signal apparatus for light rail transit varies greatly with system design, but such apparatus may be expected to be limited to relatively simple wayside block signalization and preemptive traffic signals at at-grade intersections with arterial streets. If required for operation in heavily trafficked areas, signalization for commuter rail operation will normally already be in place. As applicable, the signal and communication component of the capital costs is included in the range of construction costs per mile for primary transit fixed guideways.

Motor bus transit modes do not normally require sophisticated signalization and communication equipment since traffic control is effected principally by existing signals, wayside signs, and pavement markings. A freeway operational control system will require a central control center, traffic detectors, ramp control signals, and appropriate interconnections of the system components. Based on the limited experience of such installations in the United States, the control center may be expected to range in cost from \$2 million to \$6 million, with ramp detection and control apparatus costing approximately \$67,500 per freeway entrance ramp. The construction of ramp bypass lanes and exclusive ramp construction would entail additional costs. Arterial express bus systems may require traffic signal preemption equipment, which may be expected to cost approximately \$500 per vehicle for signal transmitters plus \$3,000 per intersection for fixed signalization equipment.

Initial costs incurred in the construction of vehicle storage yards, maintenance and servicing facilities, and repair shops relate directly to the mode, the size of the completed system, and the extent to which an existing vehicle fleet is being expanded. In the Milwaukee area, all primary rail transit modes except commuter rail would require the construction of new facilities. A commuter rail system would require only the expansion and upgrading of the facilities of the operating railway. A new primary transit system based upon the operation of express buses would be integrated with the existing motor bus services, whose basic storage and maintenance facilities are already in place. Costs for such improvements can be expected to approximate \$25,000 per vehicle for motor bus primary transit systems, \$218,000 per vehicle for light rail transit systems, \$200,000 per vehicle for heavy rail rapid transit systems, and \$75,000 per coach for maintenance facility improvements attributable to commuter rail service.

Agency costs are an unallocated allowance for engineering and administration during project implementation. Specific tasks covered under this component include engineering and architectural design, construction management, cost estimation and control, construction supervision, inspection and testing, and system start-up. Fifteen percent of total capital construction costs is allocated to cover these needs. This cost component does not apply to vehicle acquisition.

Contingencies represent an unallocated allowance which is intended to cover unforeseen and unpredictable conditions that may arise during construction. Thirty percent of total capital construction costs is allocated for this component, which applies to all capital costs except vehicle acquisition.

Related to the capital costs of a new primary transit system is the amortization period for major system components. The determination of suitable amortization periods for major components of motor bus, rail transit, and electric trolley bus systems should be properly related to the expected service life—or "useful life"—of those components. The amortization periods selected for use in this study are set forth in Table 28.

All system components except vehicles have a specific amortization period, regardless of the mode. That component with the longest useful life is the right-of-way, assumed to have an amortization period of 100 years under this study. The system component with the next longest useful life—50 years—consists of the system structures, such as overpasses, underpasses, viaducts, and subways. The remaining fixed plant and equipment—exclusive of vehicles—have a useful life of between 25 and 35 years. The amortization periods for the different modes vary only with regard to the vehicles. Rail transit vehicles have the longest useful life of any primary transit vehicles—30 years, while diesel motor buses have the shortest useful life—12 years. Electric trolley buses have a useful life of 20 years.

Operating Costs

Operating and maintenance costs for primary transit systems are normally expressed in monetary units per unit of service production, such units generally being vehicle miles or vehicle hours. Depending on the particular primary transit mode, operating costs are generally divided into five major categories which conform to accepted transit accounting practices within the United States. For motor bus transit modes, these categories include transportation, maintenance and garage, administrative and general, operating taxes and licenses, and miscellaneous expenses. For light rail transit and heavy rail rapid transit systems, these categories are maintenance of way and structures, maintenance of vehicles, power, transportation, and general and administrative. For commuter rail systems, the accounting format used is the uniform system of accounts for railroad companies as prescribed by the U. S. Interstate Commerce Commission, the categories of which are maintenance of roadways and structures, maintenance of equipment, transportation, traffic, and other costs. For any of the transit modes, the transportation category can be expected to incur the largest expense since it is this category which includes the wages for the operating personnel.

The operating costs for the various primary transit modes which are to be used in the evaluation and comparison of alternative system plans under this study are set forth in Table 29. Necessary adjustments have been made to the operating costs to assure that transit operation and driver costs for all modes reflect appropriate primary transit average overall speeds and wage rates for primary transit alternatives in the Milwaukee area. In addition, necessary adjustments have been made to the operating costs to reflect the potential for increases in future energy costs under the different

Table 28

AMORTIZATION PERIODS FOR MAJOR PRIMARY TRANSIT SYSTEM COMPONENTS SELECTED FOR USE IN THE MILWAUKEE AREA ALTERNATIVES ANALYSIS

System Component	Amortization Period in Years
Vehicles	
Motor Bus	12
Heavy Rail Rapid Transit	30
Light Rail Transit	30
Commuter Rail	30
Electric Trolley Bus	20
Right-of-Way	100
Guideways[a]	25
Structures	50
Stations, Including Parking	30
Power Distribution System	30
Control and Communication Equipment	30
Maintenance and Storage Facilities	35
Contingency and Agency Costs	30

[a]Does not account for freight service utilization.

Source: SEWRPC.

Table 29

PRIMARY TRANSIT SYSTEM OPERATING COSTS SELECTED FOR USE IN THE MILWAUKEE AREA ALTERNATIVES ANALYSIS

Primary Transit Technology	Range of Costs per Vehicle Mile Adjusted for Average Speed[b]	Cost per Vehicle Mile Adjusted for Average Speed	Cost per Vehicle Mile Adjusted for Average Speed and Energy Price[a]	
			Stable or Declining Growth Future	Moderate Growth Future
Motor Bus Transit (using conventional vehicles)	\$1.13-\$2.06[c]	\$1.61[d]	\$1.70	\$1.84
Motor Bus Transit (using articulated vehicles)	- -	\$1.87[e]	\$2.00	\$2.22
Light Rail Transit	\$2.86-\$4.04	\$3.27[f]	\$3.33	\$3.41
Heavy Rail Rapid Transit	\$3.27-\$4.55	\$4.27[g]	\$4.34	\$4.45
Commuter Rail	\$2.99-\$7.08	\$5.40[h]	\$5.67	\$6.10
Electric Trolley Bus Techology (using articulated vehicles)	- -	\$1.74[i]	\$1.77	\$1.81

NOTE: All costs are in 1979 dollars.

[a]For the testing and evaluation of primary transit system alternatives for the Milwaukee area, an alternative futures approach was used in an attempt to deal with the high level of uncertainty that exists today concerning key future conditions which influence public transit needs. These conditions include the cost of energy, which is a key difference among the alternative futures. For further information, see SEWRPC Technical Report No. 25, Alternative Futures for Southeastern Wisconsin.

[b]The average operating costs in this table have been developed from Milwaukee County Transit System data where available, and otherwise from transit systems in North America having operations which would be similar to the operations envisioned in the primary transit alternatives to be considered for the Milwaukee area. Necessary adjustments have been made to assure that transit operator or driver costs for all modes, a significant proportion of total transit operating costs, reflect appropriate primary transit average overall speeds and wage rates for primary transit alternatives in the Milwaukee area. The costs have been developed to be applied to all modes on a per-vehicle-mile basis. For the rail transit modes, the costs reflect the average costs per vehicle mile based upon the average amount of multiple-unit or train operation of vehicles on the rail primary transit systems inventoried.

The only factor not reflected in the adjustments is the potential for increases as a result of future real increase in energy costs. Generally, for all primary transit modes, power or fuel requirements were found to represent about 10 percent of total operating costs in 1979. No change in the future cost per vehicle mile of energy will result if it can be assumed that primary transit energy efficiency will increase at the same rate as will energy costs. However, if no change in energy efficiency can be assumed, and it is assumed that diesel fuel prices will increase at the same rate as will motor fuel prices, and that electrical power prices will only increase about one-sixth to one-half or, on the average, one-third as fast as will motor fuel prices as set forth in the most recent U. S. Department of Energy forecasts and supported by other long-range energy studies, then, for the stable or declining growth futures and the moderate growth futures, respectively, the cost of conventional motor bus operation would be increased by 9 to 23 cents per vehicle mile, the cost of articulated motor bus operation would be increased by 14 to 35 cents per vehicle mile, the cost of light rail transit operation would be increased by 6 to 14 center per vehicle mile, the cost of heavy rail operation would be increased by 7 to 18 cents per vehicle mile, the cost of commuter rail would be increased by 27 to 70 cents per vehicle mile, and the cost of articulated electric trolley buses would be increased by 3 to 7 cents per vehicle mile.

[c]Based on modification of systemwide average bus transit system operating costs per vehicle mile (\$1.43 to \$2.62 per vehicle mile). The modification was intended to reduce motor bus operator costs per vehicle mile by about 45 percent in order to reflect an expected 75 percent greater motor bus average speed in primary transit service than in local service. Based upon Milwaukee County Transit System 1979 financial and operations data, motor bus operator costs constitute about 50 percent of the total motor bus operating cost per vehicle mile.

[d]Based on modification of the Milwaukee County Transit System average motor bus operating cost per vehicle mile for the year 1979 (\$2.05 per vehicle mile), as in footnote c.

[e]Based on the experience of other operators of articulated motor buses, the operating cost per vehicle mile in primary transit service for such a vehicle in the Milwaukee area may be expected to be about 16 percent greater than that for conventional nonarticulated motor buses. This assumes that nonlabor operating costs for articulated buses will be about 50 percent greater than those for conventional buses.

[f]Based on the 1976 operating costs per vehicle mile for light rail transit systems in Cleveland, Newark, and Philadelphia, updated to 1979. These operating costs assume some multiple-unit or train operation during peak periods of demand.

[g]Based on the 1976 operating costs per vehicle mile for modern heavy rail rapid transit systems in Philadelphia and San Francisco-Oakland as well as the 1979 operating cost per vehicle mile for the modern heavy rail rapid transit system in Washington, D.C.

[h]Based on the 1973 operating costs per car mile for commuter rail systems operated by the Chicago & North Western Railway; the Chicago, Rock Island & Pacific Railroad; and the Milwaukee Road in the Chicago area, updated to 1979.

[i]Based on analyses for Vancouver, British Columbia, which showed conventional electric trolley bus nonlabor costs to be approximately 84 percent of conventional diesel motor bus nonlabor costs, and on the assumption that the nonlabor cost differences between conventional motor buses and articulated motor buses will also hold for conventional and articulated electric trolley buses.

Source: SEWRPC.

alternative futures.[13] The operating costs for rail transit systems include all costs incurred for operation of a system. Of the three rail transit modes, light rail transit has the lowest operating costs, ranging from $2.86 per car mile to $4.04 per car mile. The operating costs for heavy rail rapid transit range from $3.27 per car mile to $4.55 per car mile. Commuter rail has the highest operating costs of the three rail transit modes, ranging from $2.99 per car mile to $7.08 per car mile.[14]

Operating costs for motor bus primary transit systems consist of two components. The first component consists of those daily costs associated with operation of the vehicle fleet regardless of the type of guideway utilized. As already noted, these costs are expressed in monetary units per unit of service production—or dollars per vehicle mile. Based on existing urban transit systems—including the Milwaukee County Transit System—the cost of operating and maintaining a diesel motor bus fleet will range from $1.13 per vehicle mile to $2.06 per vehicle mile. Based on the experience of other operators of articulated motor buses, the operating cost per vehicle mile for such a vehicle in the Milwaukee area may be expected to be about 16 percent greater than that for a conventional nonarticulated motor bus.

The second component consists of those costs associated with the routine operation of the various bus priority treatments such as busways and reserved lanes. Such costs may or may not be shared with the local highway department or other local government agencies, depending upon the extent to which existing highway and street facilities are utilized. These costs will vary substantially with the design of the individual transit priority treatment and are therefore difficult to estimate in the absence of a specific plan. Overall, the annual operating costs for busways and reserved lanes may vary between $2,000 and $196,000 per lane mile, depending upon the sophistication of the priority treatment. The operating costs of a freeway operational control system are similarly system-specific, although such a control system for the Milwaukee area would cost approximately $800,000 a year to operate, based upon the assumed provision of ramp meters at about 50 freeway entrance ramps.

ENERGY CHARACTERISTICS

The energy requirements of primary transit technologies include not only the energy needed to propel vehicles, but also the energy needed to operate stations, maintain vehicles and system facilities, and construct the system and manufacture the vehicles. These energy needs can be classified into energy for operation—that is, for vehicle propulsion, station operation, and vehicle and facility maintenance—and energy for construction—that is, for guideway construction and vehicle manufacture. Table 30 sets forth the energy requirements for vehicle propulsion, station operation, vehicle and facility maintenance, guideway construction, and vehicle manufacture to be used in the testing and evaluation of alternative primary transit system plans for the Milwaukee area. These energy requirements are reported in British Thermal Units (BTU's), permitting the direct comparison of the energy consumption of systems using petroleum-based motor fuels and electrical power.

Energy for Operation

Vehicle propulsion energy constitutes most of the operating energy consumed by a primary transit system, and accounts for most of the variation in the overall energy use of each primary transit mode. The typical propulsion energy requirements for the primary transit modes provided herein are based on the recent actual experience of transit operators in the United States. It should be noted that the electrically propelled modes—light rail transit, heavy rail rapid transit, and electric trolley bus—directly use about one-third of the total energy content of the fuel that is required. The other two-thirds of the fuel's energy content is used up in generating and distributing the power from the power plant to the transit system substations. The energy requirements set forth in Table 30 reflect the total energy required. About

[13] *For the testing and evaluation of primary transit system alternatives for the Milwaukee area, an alternative futures approach was used in an attempt to deal with the high level of uncertainty that exists today concerning key future conditions which influence public transit needs. These conditions include the cost of energy, which is a key difference among the alternative futures. For further information, see SEWRPC Technical Report No. 25, Alternative Futures for Southeastern Wisconsin.*

[14] *These operating costs apply only to modern heavy rail rapid transit systems, such as those in San Francisco-Oakland and in Washington, D.C.*

Table 30

ENERGY REQUIREMENTS OF PRIMARY TRANSIT MODES SELECTED FOR USE IN THE MILWAUKEE AREA ALTERNATIVES ANALYSIS

Characteristic	Automobile	Motor Bus			Light Rail Transit	Heavy Rail Rapid Transit	Commuter Rail	Electric Trolley Bus
Vehicle Type	Five-passenger automobile	"New look" standard urban bus	Articulated urban bus	Advanced design bus	Single-articulated light rail vehicle	Modern heavy rail rapid transit vehicle	Bi-level gallery coaches propelled by diesel-electric locomotive	Articulated trolley bus
Energy Source	Gasoline	Diesel fuel	Diesel fuel	Diesel fuel	Electricity	Electricity	Diesel fuel	Electricity
System Operating Energy								
Vehicle Propulsion Energy[a]								
(BTU's per vehicle mile)	5,000-5,800	24,700	37,800	32,500	84,400	74,000	113,300	35,400
(BTU's per passenger mile)[b]								
Assuming Capacity Load	1,000-1,600	470[d]/300[e]	560[d]/350[e]	700[d]/430[e]	560	330	720	430
Assuming Average National Vehicle Occupancy	4,140-3,570	2,150	N/A	2,830	4,220	3,520	2,830	N/A
Station Operation and Maintenance Energy (BTU's per vehicle mile)	Negligible-2,000	Negligible-4,000	Negligible-4,000	Negligible-4,000	Negligible-5,100	12,200	Negligible-3,200	Negligible-4,000
Vehicle Maintenance Energy[c] (BTU's per vehicle mile)	1,600	900	1,300	900	2,000	2,100	3,800	2,000
System Construction Energy								
Guideway Construction (billion BTU's per dual-guideway mile)								
Surface Guideway	34.0	34.0	34.0	34.0	24.6	24.6	30	60.2
Elevated Guideway	153.2	153.2	153.2	153.2	111.0	111.0	Not applicable	268.4
Subway Guideway	N/A	Not applicable	Not applicable	Not applicable	234.0	234.0	Not applicable	Not applicable
Vehicle Manufacture[c] (million BTU's per vehicle)	125	1,020	1,530	1,020	5,500	4,100	6,800	1,530

NOTE: N/A indicates data not available.

[a] *Energy conversion losses associated with electricity production, which can be 200 to 250 percent of the amount of electricity used or purchased, have been included in the propulsion energy requirements for light rail transit, heavy rail rapid transit, and electric trolley coach technologies. Transmission and distribution losses in the electric overhead wire system of light rail transit and the electric trolley coach, and in the third rail of heavy rail rapid transit, are also included and have been estimated to be about 30 percent of the total electricity used or purchased.*

[b] *The propulsion energy requirements per passenger mile for each of the primary transit modes selected for use in this study reflect maximum design load factors of transit vehicles, and range from 1.0 for commuter rail and bus on freeway to 1.6 for light rail and bus or trolley bus on busway to 3.0 for heavy rail, thus providing an indication of the potential propulsion energy efficiency attainable under peak-travel-period conditions. Actual load factors during nonpeak periods can be expected to be significantly lower, and propulsion energy requirements can be expected to be significantly higher. Actual load factors over an entire average weekday will be a function of passenger demand—both peak and nonpeak—which is, in turn, a function of specific route configuration, level of service, and adjacent land use, and can only be determined through testing and evaluation of alternative plans. Average vehicle occupancies used in this table are based on national statistics, which are 1.4 passengers per automobile, 11.5 passengers per nonarticulated motor bus, 20.0 passengers per light rail vehicle, 20.0 passengers per modern heavy rail rapid transit vehicle, and 40.0 passengers per commuter rail coach.*

[c] *Estimates of vehicle maintenance and manufacture energy were reported for standard nonarticulated primary transit vehicles; these estimates were extrapolated on the basis of vehicle size and weight to obtain an estimate of the energy required to manufacture and maintain typical single-unit articulated motor bus, light rail transit, and electric trolley coach vehicles.*

[d] *Reflects motor bus operation on freeways.*

[e] *Reflects motor bus operation on busways.*

Source: Congressional Budget Office, U. S. Department of Transportation, and SEWRPC.

30 percent of the energy that is directly used accounts for transmission and distribution losses between the transit system substations and the vehicle motors.

In terms of propulsion energy per vehicle mile, the motor bus and electric trolley coach have the lowest energy requirements, ranging from 24,700 to 37,800 BTU's per vehicle mile. The rail modes require substantially more energy for vehicle propulsion, requiring from two to four times as much energy as the motor bus and electric trolley bus modes. Of the rail technologies, heavy rail rapid transit and light rail transit require the least amount of propulsion energy, 74,000 and 84,400 BTU's per vehicle mile, respectively. Commuter rail requires about 113,300 BTU's per vehicle mile.

Because vehicle propulsion energy tends to be greater for high-passenger-capacity vehicles than for lower-capacity vehicles, consideration of potential vehicle passenger loads is important to any comparison of modal energy efficiencies. The minimum potential energy used by each mode per passenger mile can be compared by assuming that each mode is carrying passengers at its maximum design load factor. Under this assumption, as indicated in Table 30, vehicles with the lower design load factors have the higher energy requirements per passenger mile. Motor bus-on-freeway modes and commuter rail, which have a maximum load factor of 1.0, require between 560 and 720 BTU's per passenger mile. The motor bus-on-busway, light rail transit, and electric trolley bus modes, which have a design load factor of 1.6, require between 350 to 560 BTU's per passenger mile under this assumption.

Because heavy rail vehicles are typically designed to accommodate large numbers of standing passengers, a design load factor of 3.0 is used, resulting in the lowest propulsion energy requirements of all the primary transit modes, about 330 BTU's per passenger mile. It should be noted that because these propulsion energy requirements assume maximum design load factors, they are an indication of the propulsion energy efficiency attainable under peak-period conditions only. Such high load factors can be expected to be achieved only during morning and afternoon peak travel periods and over limited segments of the total transit system. Actual average weekday load factors, as opposed to theoretical maximum peak-period load factors, are a function of passenger demand, which is, in turn, a function of specific route configuration, level of service, and adjacent land use type and intensity within a particular corridor, and can only be determined through testing and evaluation of alternative primary transit system plans.

Energy used to maintain vehicles and stations typically constitutes from 10 to 20 percent of the propulsion energy required per vehicle mile. Maintenance energy needs for diesel motor buses are about 1,300 BTU's per vehicle mile, and for heavy rail rapid transit, light rail transit, and electric trolley bus vehicles, about 2,000 BTU's per vehicle mile. Commuter rail maintenance energy requirements are estimated to be much higher—about 3,800 BTU's per vehicle mile.

The amount of energy required for station operation varies widely among the various modes, being particularly high only for heavy rail rapid transit, which normally has elaborate grade-separated stations with air conditioning and escalators. An average of 12,000 BTU's per vehicle mile is required to operate heavy rail rapid transit stations, about twice as much as is required for stations on other fixed guideway systems. Station energy requirements for the other primary transit modes vary from negligible for stations consisting of only small paved areas marked with appropriate signing to 5,100 BTU's per vehicle mile for larger station facilities consisting of specially constructed platforms, lighting and support facilities—such as telephone service, rest rooms, and fare collection facilities—and a heated shelter building.

Construction Energy

Guideway construction and vehicle manufacture energy can constitute a significant portion of the energy requirements of primary transit. Construction energy requirements are similar for light rail transit and heavy rail rapid transit guideways. The energy used to rehabilitate commuter rail guideways can be expected to be some proportion of the energy that would be used if a new guideway were to be constructed, that proportion depending upon the extent of rehabilitation required. About 40 percent more energy is required to construct busways than to construct light rail transit and heavy rail rapid transit systems, and, because it requires an overhead power distribution system, an electric trolley bus guideway has greater construction energy requirements than does a busway for diesel motor buses.

Motor bus and electric trolley bus manufacturing is estimated to require between 1,000 and 1,500 million BTU's per vehicle. Rail transit vehicles generally require two to four times as much energy to manufacture, with commuter rail vehicles requiring the largest amount of manufacturing energy—about 6,800 million BTU's per vehicle.

SUMMARY AND CONCLUSIONS

The purpose of this chapter has been to identify and describe those transit technologies and their specific modes of application which are capable of providing a primary level of transit service within the Milwaukee area over the 20-year planning horizon of this alternatives analysis. It has been established that three transit technologies—motor bus transit, electric trolley bus, and rail transit—have the potential to provide such service. Included within these three technologies are eight urban public transit modes which are capable of providing high-speed and high-capacity primary transit service within the Milwaukee area. Of these eight modes, four are motor bus modes, three are rail transit modes, and one is the electric trolley bus mode.

Of the four motor bus modes, three—motor bus operation on freeways in mixed traffic, motor bus operation on freeways over reserved lanes, and express bus operation on arterial streets—make use of existing freeways and surface arterial streets and highways. The fourth motor bus mode—motor bus operation on busways—as well as two of the three rail transit modes—light rail transit and heavy rail rapid transit—require the construction of new fixed guideways. The fixed guideways for light rail transit and busway systems may be located on existing surface street rights-of-way and need not be fully grade-separated, while fixed guideways for a heavy rail rapid transit system must be fully grade-separated. The commuter rail mode also makes use of existing facilities—specifically, mainline railway trackage which is shared with intercity freight and passenger train traffic. The eighth mode—the electric trolley bus—is considered to be capable of providing a primary level of service only if special hardware design provisions are included and the mode operates over busways or in an arterial express mode.

Motor Bus Primary Transit Technology

The motor bus is the technology most commonly used to provide primary transit service in urbanized areas of North America. Two of the motor bus modes suitable for primary transit service operate over existing freeway rights-of-way, either in mixed traffic or over reserved lanes. Motor bus operation in mixed traffic on freeways is defined as the operation of either conventional or high-capacity diesel motor buses over existing freeway lanes which are open to all forms of motor vehicle traffic. The freeway may be uncontrolled, in which case the motor buses will be subject to the same peak-period traffic conditions experienced by all other vehicles using the facility, or it may be operationally controlled. Freeway operational control serves to constrain automobile and motor truck access to the freeway system during peak travel periods, reducing the potential for freeway traffic breakdown and ensuring high rates of traffic flow and reasonably high operating speeds. A typical operational control system would consist of interconnected demand-responsive freeway ramp meters installed at freeway entrance ramps to constrain automobile and motor truck access, while providing uncontrolled access lanes either in the form of bypass lanes at freeway entrance ramps or exclusive entrance ramps for the sole use of high-occupancy vehicles such as motor buses.

Motor bus operation on reserved freeway lanes involves the operation of either conventional or high-capacity diesel motor buses over existing freeway lanes that are reserved for the exclusive use of transit vehicles during certain times of the day. The reserved lanes may be dedicated in either a normal flow direction—with the flow of other motor vehicle traffic—or in a contraflow direction—against the flow of other motor vehicle traffic.

For both of these bus-on-freeway modes, passenger boarding and deboarding is from curb level, with fare collection taking place on board the vehicles. Stations are generally minimal facilities, in many cases consisting only of waiting platforms with shelters, although more elaborate facilities may be justified at special locations, such as at transit centers that serve a timed-transfer network of routes. Principally because of the need to safely maneuver buses within, into, and out of freeway traffic, stations for these modes are not normally located within the freeway right-of-way. Thus, the motor buses normally travel nonstop over the line-haul portion of the route and perform passenger collection and distribution at either or both ends of the route, using arterial streets and local bus stops, park-ride lots, or transit malls. However, stations can be facilitated for the operation of motor buses on freeways in mixed traffic by the provision of specialized stopping lanes either within the freeway right-of-way but separated from other traffic, or near exit and entrance ramps at interchanges between freeways and arterial streets and highways, where a motor bus can readily exit and re-enter the freeway.

On the basis of the findings of the inventories conducted under this study of alternative primary transit systems for the Milwaukee area, it was determined that only one bus-on-freeway mode—bus on operationally controlled, or ramp-metered, freeway—merits further consideration. This is because a freeway operational control system is already partially in place in the Milwaukee area, and the adopted long-range transportation system plan for the area calls for its expansion and improvement. The provision of additional ramp meters and the interconnection of all such meters into a centrally controlled system are programmed for implementation in the near future.[15] The existing ramp meters have proven to be capable of significantly increasing operating speeds and improving traffic flow on some of the most congested segments of the freeway system in the Milwaukee area. Moreover, one of the purposes of considering the bus-on-freeway transit alternative in this study was to use that alternative as a basis for comparatively evaluating more capital-intensive exclusive guideway alternatives. Buses operating over operationally controlled freeways should present a more attractive low-capital investment alternative for this purpose, as well as a more attractive public transit alternative for future implementation in the Milwaukee area, than buses operating in mixed fic on potentially congested freeways.

Buses operating over operationally controlled freeways are also a more attractive alternative for the Milwaukee area than buses operating on a reserved lane freeway system. Both would provide preferential treatment of buses with higher operating speeds at relatively low cost. There are, however, additional advantages attendant to the bus-on-operationally controlled freeways alternative. First, preferential treatment and higher freeway speeds for buses can be achieved with operational control without restricting freeway capacity for automobile travel to the same extent as would a reserved lane freeway system, and therefore without producing as much diversion of automobile traffic from the freeway to the surface street system. Second, under the operational control alternative, the restriction on freeway traffic occurs in the same direction in which the improved bus service is provided, thus encouraging transit utilization. Because of existing levels of traffic volume and congestion, extensive segments of reserved freeway lanes in the Milwaukee area would have to be provided in the contraflow direction, and, as a result, the trips made by automobiles being restricted by the implementation of reserved lanes could not be diverted to the bus service. Third, and perhaps even more importantly, reserved bus lanes cannot be practically provided

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[15] *The adopted 1978 transportation systems management plan for the Milwaukee area, as documented in SEWRPC Community Assistance Planning Report No. 21, A Transportation Systems Management Plan for the Kenosha, Milwaukee, and Racine Urbanized Areas in Southeastern Wisconsin: 1978, recommended that, as a condition of the inclusion of additional freeway ramp meters in the annual transportation improvement program for the Milwaukee area, a prospectus for a preliminary engineering study of an areawide freeway traffic management system be prepared. The study itself was to provide recommendations concerning the extent of a freeway ramp-meter system and related preferential treatments for motor buses at freeway entrance ramps in the greater Milwaukee area; the speeds and volumes to which the area freeway system should be controlled; and, importantly, the degree of metering which should be achieved at each entrance ramp to achieve those freeway speeds and volumes. The study was to address the potential costs and benefits of freeway traffic management, including resultant freeway and surface arterial street congestion and travel speeds, freeway entrance ramp queues and the impacts of such queues on connecting surface arterial streets, and the costs and equity of freeway traffic management. On March 26, 1979, the requested prospectus was unanimously approved by a steering committee created by the Commission to assist the Commission staff in the preparation of the prospectus, and the Commission itself approved the prospectus on June 7, 1979. The necessary funds to conduct the study could not, however, be obtained. As a consequence, the Intergovernmental Coordinating and Advisory Committee on Transportation System Planning and Programming for the Milwaukee Urbanized Area decided to continue the incremental implementation of a freeway traffic management system in the Milwaukee area through its consideration of individual freeway traffic management projects in its annual review of the transportation improvement program for the Milwaukee area.*

at low cost over the entire area freeway system, while freeway operational control can, and, in fact, works best when it is applied systemwide. One of the reasons that reserved lanes cannot be practically provided systemwide in the Milwaukee area is the frequent presence of left-hand entrance and exit ramps. Developing freeway reserved lanes at these locations would entail significant reconstruction costs. Also, implementation of reserved lanes on some segments of freeway in the Milwaukee area, whether normal flow or contraflow, would cause significant volumes of freeway traffic to be diverted. Some segments of the Milwaukee area freeway system which would not permit the development of reserved lanes at low cost and within reasonable disruption of automobile traffic include the East-West Freeway in Milwaukee County, portions of the Zoo and Airport Freeways, and the North-South Freeway near its interchange with the East-West Freeway in Milwaukee County.[16] These segments of freeway are presently, and may be expected to remain, the most heavily congested freeways in the area; may be expected to have the greatest affect on transit travel times over freeways; and may be expected to carry the most intense motor bus-on-freeway operations. Fourth, operational control has a distinct advantage over contraflow reserved lanes from a safety standpoint in that it does not require buses to operate at high speeds with no physical separation between freeway traffic traveling in an opposite direction, as do contraflow reserved bus lanes.

The two motor bus transit modes which do not use existing freeway rights-of-way are operation on busways and arterial express operation. Busways are special-purpose roadways designed for either the exclusive or predominant use of motor buses in order to improve vehicle movement and passenger travel times. These facilities can be constructed on an existing freeway rights-of-way, other existing rights-of-way, or a newly acquired right-of-way. Busways may be classified as either Class A or Class B, depending upon the overall level of service provided. Class A busways provide high-speed, high-capacity, fully grade-separated rapid transit service, very similar to that provided by the heavy rail rapid transit mode. Class B busways are intended to serve somewhat shorter trip lengths at lower overall speeds, and therefore provide a somewhat lower quality of service. Station or stop frequency is usually greater than along Class A busways, and at-grade crossings with arterial streets are generally incorporated into the facility design.

In arterial express service, motor buses are operated over arterial streets but are given preferential treatment over other motor vehicle traffic. Preferential treatment for buses operating in the arterial express bus mode can be provided by operation over reserved lanes on existing surface arterial streets;[17] by preferential treatment at signalized intersections; or preferably, by both measures if a level of service approaching that of primary transit is to be achieved. If one or more arterial street lanes are dedicated for the exclusive all-day use of buses with sufficient separation from adjacent mixed motor vehicle traffic, then a Class B surface busway is, in effect, created.

As with the other motor bus transit modes, passenger boarding and deboarding for both Class A and Class B busways is normally from curb level, with fares being collected on board the vehicles. Also, busway stations are generally similar to those utilized for other motor bus transit modes. However, unlike the bus-on-freeway modes, which do not have stations situated along line-haul portions of the route, busways—whether constructed on exclusive or shared rights-of-way—may have station spacings similar to those of either light rail transit or heavy rail rapid transit systems. In many cases,

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[16] *For a more detailed discussion of the traffic congestion and diversion problems which could be expected to be caused by the implementation of reserved freeway lanes, as well as of the use of left-hand entrance and exit ramps, in the Milwaukee area, see Chapter VII of SEWRPC Technical Report No. 23, Transit-Related Socioeconomic, Land Use, and Transportation Conditions and Trends in the Milwaukee Area.*

[17] *Reserved lanes on arterial streets can be implemented in either a normal flow or contraflow direction, and can be located adjacent to one of the curbs or in the median area. An extension of the arterial reserved lane concept is the transit mall, or exclusive transit street, typically implemented only in major business and shopping areas.*

such stations consist of little more than a waiting platform, shelters, and proper signing and access. More elaborate facilities may be warranted at special locations such as major traffic generators and transit centers. Passenger collection and distribution for bus transit in the central business district is accomplished by the use of reserved lanes or transit malls.

Support requirements for the bus transit modes consist of vehicle storage and maintenance facilities, guideway and station maintenance, and traffic control apparatus. Power supply and fare collection equipment do not represent significant hardware requirements for the motor bus modes, since both items are carried on board the vehicles. For a city such as Milwaukee, where a large diesel-powered bus fleet is already in service, storage, maintenance, and repair facility needs may be accommodated through an expansion of the existing facilities. The maintenance of guideways, structures, rights-of-way, stations, and other fixed facilities may be expected to be minimal except where an extensive busway system is involved. Traffic control for the bus modes largely involves the use of passive control devices, such as signing, pavement markings, channelization, and signals. Much of this apparatus will already be in place, since existing facilities are used to a large extent. Active traffic control devices for motor bus transit include signal priority at intersections and operational control systems for freeways.

The maximum vehicle speed for conventional and articulated rubber-tired diesel motor buses is 55 miles per hour (mph). Maximum operating speeds for motor buses in mixed traffic operation on freeways will vary from 45 to 55 mph along uncongested freeways, and will be below 35 mph on congested freeways, with traffic congestion further reducing these speeds on occasion, making this mode somewhat unreliable. The provision of operational control on otherwise congested freeways will permit consistent operating speeds of from 35 to 45 mph. Maximum operating speeds for motor buses on busways are 20 mph along transit malls, and between 40 and 55 mph on line-haul segments, depending upon whether the alignment is reserved or exclusive, as well as upon the degree of grade separation provided. Assuming typical station spacings, overall average speeds may be expected to vary between 11 and 34 mph for Class B busways, and between 21 and 39 mph for Class A busways. Overall average speeds for buses on operationally controlled freeways under mixed traffic conditions may be expected to vary between 20 and 39 mph, depending on the number of intermediate stations. The use of such stations at a spacing typical of a bus-on-busway system, however, may be expected to reduce the average speeds of the bus-on-freeway mode to, and sometimes to below, those of a bus-on-busway system. An increase in vehicle headways such that they are closer to those found on a bus-on-busway system would thus also be required along with the increased station stops to maintain primary transit performance levels, which would result in capacity characteristics similar to those of a bus-on-busway system.

The maximum passenger-carrying capacity of a motor bus primary transit system is dependent not only upon vehicle capacity, configuration, and headway, but also upon the maximum design load factor assigned to the specific mode. Based on the use of an articulated motor bus with a maximum design load factor of 1.0, the maximum peak-hour capacity for motor bus operation on freeways in mixed traffic at a 30-second headway will be about 8,000 passengers per hour. Based on the use of an articulated motor bus with a maximum design load factor of 1.6, the maximum peak-hour capacity for motor bus operation on busways at a 30-second headway will be about 12,800 passengers per hour. Although 30 seconds is a reasonable minimum peak-period headway, motor bus headways can be as short as five seconds, this situation occurring only under special operating conditions—that is, an unusually high demand, and assuming nonstop line-haul service. Through the operation of buses at extremely short headways, and by providing sufficient berthing areas for the boarding and deboarding of passengers at station facilities, this capacity could be increased to a maximum of about 48,000 passengers per lane per hour for freeway operation in mixed traffic, and to about 77,000 passengers per lane per hour for busway operation. The bus-on-freeway mode could provide even greater capacity, as a multi-lane freeway would be available for its use.

An important advantage of any motor bus mode is that, since motor buses can be operated over any public street or highway, they can offer a "one-seat, no-transfer" ride between a relatively large number of trip origins and destinations. The same motor bus can perform a passenger collection function, a high-speed, line-haul function, and a distribution function. Also, a single motor bus primary transit route can be operated over any combination of priority treatments within a single corridor.

Because existing freeway facilities are utilized for the operation of both the bus-on-freeway in mixed traffic and bus-on-reserved freeway lane modes, and because the local transit system in the Milwaukee area uses buses exclusively, the initial capital costs of these two bus-on-freeway modes would be limited primarily to vehicle acquisition, although some additional capital costs for the expansion of existing, or provision of new, maintenance and storage facilities may be required. The cost in 1979 dollars of a typical urban bus varies from $140,000 for a conventional bus to $240,000 for an articulated bus. The articulated bus typically can carry about 40 percent more seated passengers and about 50 percent more standees than a conventional bus. The articulated bus, however, has about a 20 percent lower acceleration rate, and the lowest acceleration rate of all primary transit vehicles except commuter rail vehicles. In freeway operation, an articulated bus requires more energy for propulsion per vehicle mile—37,800 BTU's, compared with 24,700 BTU's for a conventional "new look" bus—and per passenger mile—560 BTU's, compared with 470 BTU's for a conventional "new look" bus—at a maximum design load factor of 1.0. The operating cost of an articulated bus per vehicle mile in primary transit service would be about 16 percent greater, $1.87 compared with $1.61, but per passenger mile at the maximum load factor for freeway operation would be nearly 20 percent less, 2.8 cents compared with 3.4 cents. Principally for this reason, the articulated bus was used in all bus primary transit alternative systems considered under this study.

The use of a freeway operational control system for the bus-on-freeway in mixed traffic mode would represent some additional cost, but the cost of ramp modification, necessary traffic control apparatus at ramps, and the provision of a central control center would represent a small fraction of the cost of a fixed guideway system of similar extent. Based upon the limited experience of such installations in the United States, the control center can be expected to range in cost from $2 million to $6 million, with ramp detection and control apparatus costing approximately $67,500 per freeway entrance ramp. Ramp bypass lanes and exclusive ramp construction would entail additional costs of between $50,000 and $220,000 per improvement. The conversion of an existing freeway lane to an exclusive bus lane also costs a fraction of the provision of a new guideway. Another advantage of the bus-on-freeway modes is that their implementation period is relatively short, and community disruption is minimal.

If reserved lanes on existing arterial streets and highways are utilized for Class B busways, initial capital costs may be quite low—from $5,000 to $200,000 per lane mile—depending upon the sophistication of traffic control equipment modification and the complexity entailed in reserving surface arterial street lanes for the exclusive use of transit vehicles. The implementation period, as well as community disruption, may also be minimal.

The provision of motor bus-on-busway primary transit service may be expected to entail capital costs similar to those entailed by the bus-on-freeway modes for the provision or expansion of maintenance and storage facilities, and for vehicle acquisition. Operating costs, however, will be different. Because the maximum design load factor for the bus-on-busway mode is 1.6 passengers per seat, or 60 percent higher than that for the bus-on-freeway mode, an articulated bus on busway at its maximum design load factor will have an operating cost of about 1.7 cents per passenger mile, about 40 percent lower than the same cost for an articulated bus on freeway. A conventional bus on busway at its maximum design load factor will have an operating cost of about 2.2 cents per passenger mile, about 35 percent less than the operating cost of a conventional bus on freeway operating in a primary level of transit service.

The implementation of busways involves major facility construction, and therefore may take relatively long periods of time compared with the implementation periods of other motor bus primary transit modes. The capital costs of a Class A busway may approach those of some rail transit modes, and the potential for community disruption during the implementation phase may be high. The average construction cost, not including the cost of right-of-way or stations, of a two-lane busway varies from under $2 million per mile to about $7 million per mile when at-grade, and from under $4 million per mile to nearly $20 million per mile when elevated, expressed in 1979 dollars. Specialized design considerations are required for exclusive bus subways because of the need for adequate ventilation, especially in underground station areas. For this reason, plus the fact that there are few such facilities in actual service, underground busway segments will receive no further consideration within this study.

The propulsion energy per passenger mile for an articulated bus on busway at its maximum design load factor, 350 BTU's, is about 38 percent lower than that for an articulated bus on freeway. The propulsion energy per passenger mile for a conventional bus on busway is about 300 BTU's, about 36 percent less than that for the same bus on freeway.

Electric Trolley Bus Technology

The electric trolley bus mode may be defined as the operation of electrically propelled rubber-tired transit buses over paved roadways. The electrical power is distributed to the vehicles via a system of twin overhead contact wires. Except for the type of vehicle propulsion, the electric trolley bus would differ little from the motor bus in primary transit operation over reserved lanes on surface arterials or over busways. Both have similar roadway requirements and similar overall performance characteristics, including speed, headway, and capacity. Generally, existing electric trolley bus systems are operated in mixed traffic over arterial streets and highways, providing a tertiary level of service. In order for the electric trolley bus mode to be considered a primary transit mode, the trolley bus must operate in an arterial express service with substantial preferential treatment, or over a busway facility. Electric trolley bus vehicles are available in either a standard nonarticulated version or high-capacity articulated version. Loading and unloading is typically at curbside, and fares are collected on board.

Maximum vehicle speeds for most trolley bus vehicles are about 40 mph, owing to the conventional rigid overhead power distribution system of this mode and the design of the electric traction motor used for propelling the vehicle. However, use of elastic overhead power distribution systems and lower gear ratios on electric trolley buses should permit maximum speeds of up to 55 mph, the maximum speed attainable by diesel motor buses, although with a possible loss in acceleration and hill-climbing ability. Typical maximum operating speeds for trolley buses vary between 20 and 40 mph, depending upon the route alignment. With typical station spacing, overall average speeds for the electric trolley bus vary between 11 and 39 mph, depending upon the degree to which an exclusive guideway is provided. Based upon the experience of existing electric trolley bus systems in North America, it can be concluded that the overall performance of the diesel motor bus and the electric trolley bus in local and express service is quite similar, and the two modes can be considered to be basically interchangeable in daily operation. Based on the use of an articulated electric trolley bus with a maximum load factor of 1.6, the maximum peak-hour capacity for this mode with a 30-second headway is about 12,800 passengers per hour. This capacity could be increased several times by a reduction in the headway, but this would require a significantly expanded power distribution system.

Electric trolley bus systems generally use existing paved roadways, making the construction of a new fixed guideway unnecessary—although the overhead power distribution system and attendant support facilities do represent a major capital investment. The overhead wire system does not permit immediate route changes or detours, nor does it permit vehicles to readily overtake and pass each other without either the removal of the power collection poles from the contact wires, or the provision of additional overhead wires and switches. Electric trolley bus vehicles can be equipped with batteries or small gasoline engines for limited off-wire operation for such purposes as bypassing route blockages or moving around garage areas not fully equipped with overhead wire.

Electric trolley bus transit entails capital costs for new vehicles, stations, guideways, maintenance facilities, and the expansion of existing, or the provision of new, storage facilities. New storage facilities may consist simply of outside yards, since trolley buses are electrically powered. The average guideway construction cost for the trolley bus will be the same as that for the motor bus, with the addition, however, of the cost of the overhead power distribution system. The cost in 1979 dollars of a conventional trolley bus is estimated at $164,000.

The operating cost of an articulated trolley bus vehicle—operating in a primary level of service—averages $1.74 per vehicle mile in 1979 dollars, or about 1.6 cents per passenger mile at its maximum design load factor of 1.6 passengers per seat. The propulsion energy requirements of the trolley bus mode are 35,400 BTU's per vehicle mile, or 430 BTU's per passenger mile at its maximum design load factor.

The electric trolley bus mode is generally applicable only in the provision of secondary and tertiary levels of service because of the speed limitations imposed by current vehicle and overhead wire designs. The mode, however, has the potential to provide high-quality line-haul service equaling that offered by motor buses—in terms of speed and capacity—over reserved arterial street lanes and exclusive busways, but only if special provision is made in the design of the vehicles and power distribution system. As a consequence, it was determined that, following full development of the motor bus primary transit alternatives, the electric trolley bus mode should be considered further in this study only as a special alternative to the diesel motor bus—capable of achieving similar performance but differing in certain respects, including environmental impact, energy requirements, and costs—and only if the evaluation of the alternative transit plans resulted in the recommendation that a busway plan be implemented.

Rail Primary Transit Technology

There are three distinct and separate modes by which rail transit technology may be applied in the provision of a primary level of transit service: light rail transit, heavy rail rapid transit, and commuter rail. Each of these modes is an individual "self-contained" system that can function only as a line-haul carrier, and not as a passenger collection and distribution service, because each mode requires vehicles which can operate only on a particular type of fixed guideway, and not on paved roadways as can motor buses.

Light rail transit involves the operation of electrically propelled, dual-rail vehicles over predominantly reserved, but not necessarily grade-separated, rights-of-way. The principal feature distinguishing light rail transit from the other rail transit modes is that light rail vehicles, like motor buses, have the flexibility to operate safely and effectively at-grade over existing public street rights-of-way, as well as along exclusive, grade-separated rights-of-way. As a consequence, costly and disruptive elevated and underground facilities need not be used in high-density areas or in central business districts where no exclusive grade-separated right-of-way may be readily available.

Light rail vehicles can be of a nonarticulated, single-articulated, or double-articulated configuration and can be coupled into trains of up to four vehicles. Access to the vehicles may be from curb-level or high-level platforms. Power is supplied from an overhead power distribution system. Fares can be collected on board the vehicles or at stations, or self-service ticketing fare collection procedures may be used. Station design can range from simple stops with passenger shelters to a complex station of the type required for heavy rail rapid transit. The large variety of design options available to light rail transit permits it, like motor bus transit, to provide a wide range of passenger capacities and performance capabilities at a relatively moderate cost.

Like busways, light rail transit systems may incorporate Class A or Class B guideways. Class A guideways for light rail transit make extensive use of exclusive rights-of-way with relatively gentle horizontal curves and gradients and with grade separations at arterial street crossings. Class A guideways provide a level of service incorporating high speeds approaching those of heavy rail rapid transit. Class B light rail transit guideways provide little or no grade separation and involve extensive use of public street rights-of-way, with trackage situated in reserved lanes or within street medians. In addition, Class B alignments may utilize sharper, street railway-like, horizontal curves and steeper gradients than do Class A alignments.[18]

The maximum vehicle speed for current state-of-the-art light rail transit vehicles is about 50 mph, the lowest of all primary transit modes except the electric trolley bus. However, because vehicle propulsion is provided by electric traction motors, light rail vehicles have high acceleration and deceleration rates, up to twice those of an articulated bus, and up to 50 percent greater than those of heavy rail vehicles. Typical light rail transit maximum operating speeds are 20 mph along transit malls, 40 mph along reserved arterial street rights-of-way, and 45 to 50 mph on exclusive rights-of-way, depending upon whether or not the guideway is grade-separated. At typical station spacing, overall average speeds for this mode will range between 11 and 36 mph for Class B alignments and between 23 and 39 mph for Class A alignments.

Headways for light rail transit can be as short as 36 seconds. The passenger capacity of a light rail facility, however, can be readily increased by simply coupling additional cars together into a train. Based on the use of a train of two single-articulated light rail vehicles with a maximum load factor of 2.2, the maximum peak-hour capacity of a light rail transit facility operating at a 60-second headway will be about 17,600 passengers per hour.

[18] *It is important to recognize that although some light rail transit system components resemble electric street railway system components, the level of service provided by light rail transit is significantly higher because of the high degree of priority provided over other traffic in congested areas. Accordingly, the inherent performance characteristics of light rail transit distinguish it as a unique and separate rail transit mode.*

Light rail transit entails capital costs for new vehicles, stations, guideways, maintenance facilities and equipment, and the expansion of existing, or the construction of new, storage facilities. However, new storage facilities may consist simply of outside yards. The average construction cost of a light rail dual guideway in 1979 dollars is between $4 and $8 million when located at-grade, $6 and $19 million when elevated, and $38 and $50 million when located in cut-and-cover subway. The cost in 1979 dollars of a single-articulated light rail vehicle, the type of light rail vehicle configuration which maximizes passenger capacity without a significant loss of performance in comparison to that offered by nonarticulated vehicles, is $800,000.

The operating cost of a light rail vehicle is about $3.27 per vehicle mile, expressed in 1979 dollars, or about 2.2 cents per passenger mile at its maximum design load factor of 2.2 passengers per seat. The propulsion energy requirements of a light rail vehicle are 84,400 BTU's per vehicle mile, or 560 BTU's per passenger mile at its maximum design load factor.

Heavy rail rapid transit consists of dual-rail vehicles propelled by electricity distributed through a side-running third rail. Because of its use of a third rail, plus the characteristic high operating speeds and the use of semi-automated train control, this mode can operate only over exclusive, fully grade-separated guideways.

Heavy rail vehicles are typically semi-permanently coupled into pairs which can be made up into trains of up to 10 vehicles. Station facilities are the most elaborate of those of any of the primary transit modes and are designed with separate levels for fare collection areas and for passenger loading, which is effected from high-level platforms. The principal function of this mode is to provide high-speed, high-capacity primary transit service in the most heavily traveled corridors of an urban area.

The maximum vehicle speed for heavy rail rapid transit vehicles is 80 mph, the highest of all the primary transit modes. In the absence of constraints such as sharp curves, steep gradients, stations, and junctions, typical maximum operating speeds will range from 60 mph to 80 mph. Depending upon the station spacing, overall average speeds for this mode will range between 26 and 49 mph. Headways can be as short as 90 seconds. Based on the use of a six-car train and a maximum design load factor of 3.0, the maximum peak-hour capacity for the heavy rail rapid transit mode with a 120-second headway will be about 40,000 passengers per hour.

Because of its ability to couple vehicles together into relatively long trains, the heavy rail rapid transit mode has a capacity generally exceeding that of all other primary transit modes. In addition, because of its exclusive, fully grade-separated guideway, the mode is capable of high speeds and a high level of reliability. However, heavy rail rapid transit is normally the most capital-intensive primary transit technology, requiring a major investment to produce a usable segment. The development of this mode requires a lengthy implementation period, along with significant community disruption. These aspects are particularly true of systems requiring the construction of lengthy subway segments. Heavy capital costs are incurred for new vehicles, stations, guideways, maintenance facilities and equipment, and the expansion of existing, or the provision of new, storage facilities. Storage facilities may simply consist of outside yards. The average construction cost of a heavy rail rapid transit dual guideway in 1979 dollars is between $4 and $6 million when located at-grade, $6 and $25 million when elevated, and $38 and $50 million when located in cut-and-cover subway. The cost of a heavy rail rapid transit vehicle, which is one-half of the typical married pair of vehicles, is about $750,000, also based on 1979 dollars.

The operating cost of a heavy rail vehicle averages $4.27 per vehicle mile, expressed in 1979 dollars, or 1.9 cents per passenger mile at its maximum design load factor of 3.0 passengers per seat. The propulsion energy requirements of a heavy rail vehicle are 74,000 BTU's per vehicle mile, or 330 BTU's per passenger at its maximum design load factor.

Commuter rail involves the operation of large, mainline railroad-sized rolling stock over railway trackage and right-of-way shared with intercity freight and passenger train service. This mode is intended to serve the longest trips in metropolitan areas at high speeds with relatively few station stops. Various vehicle configurations are available for use in commuter rail service. The rolling stock configuration considered under this study consists of a bi-directional train of bi-level gallery coaches propelled by a diesel-electric locomotive which uses petroleum-based fuels. Such trains typically are up to six coaches in length, and boarding may be from either low- or high-level platforms. This assumption does not preclude the examination and comparison of electrified, or self-propelled, coaches in later, more detailed planning efforts.

Fare collection for commuter rail is usually by means of tickets which are sold at stations or by mail and then collected on board the trains. Stations for the commuter rail mode typically consist of the intercity passenger terminal in the central business district, and of newly constructed platforms in suburban areas where there are no existing facilities.

The maximum practical speed for the diesel-electric locomotives used in commuter rail service is 65 mph, although the proposed level of mainline railway track rehabilitation assumed in this study would limit most operating speeds to a maximum of 60 mph. Typical maximum operating speeds are 25 to 40 mph in high- and medium-density urban areas, and 50 to 60 mph in low-density and suburban areas. Depending on typical station spacing, the overall average speeds for the commuter rail mode as tested under this study range between 26 and 33 mph. Headways can be as short as two minutes, although this extreme can be reached only under special operating conditions. Coupling additional coaches to existing scheduled trains is a more practical means of increasing the passenger-carrying capacity. Based on the use of a four-car train of bi-level gallery coaches with a maximum load factor of 1.0, a maximum peak-hour capacity for this mode with a five-minute headway is about 7,500 passengers per hour.

Commuter rail rolling stock is manufactured to mainline railway standards with respect to suspension, size and strength, and seating arrangement. This, together with relatively long station spacings, characterizes the mode as providing a very high level of riding comfort. In addition, commuter rail utilizes standard railroad right-of-way and trackwork, and therefore does not require the construction of a new exclusive guideway system, resulting in capital cost savings. The implementation of new commuter rail routes or extension of existing routes is confined primarily to existing railway trackage and rights-of-way, although rehabilitation and additional grade-crossing protection along fixed way facilities may be required prior to the initiation of any service. Between $118,000 and $484,000 per mile in 1979 dollars would be required for such rehabilitation and grade-crossing protection on the six potential commuter rail routes in the Milwaukee area.

Commuter rail would, however, entail capital costs for vehicles, stations, and maintenance and storage facilities. At the end of each commuter line, servicing and overnight storage facilities would be required at an estimated cost of $200,000 each. Other maintenance and storage facilities could be provided by the railroad providing the service. These facility needs could be accommodated through the expansion of existing facilities or the provision of new facilities. A typical diesel-electric locomotive costs approximately $930,000 in 1979 dollars, and a bi-level gallery coach, $565,000. The operating cost of a commuter train is about $5.40 per car mile, or 3.4 cents per passenger mile at its maximum design load factor of one passenger per seat. The propulsion energy requirements of commuter rail are about 113,300 BTU's per coach mile, or 720 BTU's per passenger mile at its maximum design load factor.

CONCLUDING REMARKS

On the basis of an inventory of the current state-of-the-art of primary transit technology, five urban transit modes were determined to merit further consideration in the Milwaukee area for the provision of primary transit service: bus in mixed traffic on operationally controlled freeway; bus on busway; light rail transit; heavy rail rapid transit; and commuter rail. The inventory findings indicated that, of the motor bus modes, motor bus operation in mixed traffic on operationally controlled freeways would be superior to the bus-on-freeway in mixed traffic and bus-on-reserved freeway lane modes for providing primary transit service in the Milwaukee area. Therefore, the latter two modes were eliminated from further consideration under the Milwaukee area primary transit system alternatives analysis. Express bus operation over arterial streets was considered along with the busway mode, since, with the necessary preferential treatment, arterial express service was found to have cost and performance characteristics similar to those of a Class B surface busway. The electric trolley bus mode was determined to be a special variation of the motor bus mode, as it could provide similar performance but only with special design provisions. Accordingly, it was determined to further consider the electric trolley bus mode only if the evaluation of the alternative transit plans resulted in the recommendation that a busway plan be implemented.

The five primary transit modes identified above provide the Milwaukee area with a broad range of possibilities for the provision of primary transit service with respect to travel speed, capital and operating costs, and energy requirements. In Table 31, the major differences between these modes are illustrated by a comparison of the salient physical, economic, performance, and energy characteristics of each mode.

modes are illustrated by a comparison of the salient physical, economic, performance, and energy characteristics of each mode.

The selection of specific vehicle configurations to be used in the design, test, and evaluation of alternative system plans is important to the performance and economics of such alternative systems. Articulated diesel motor buses are assumed under both the motor bus operation in mixed traffic-on-operationally controlled freeway mode and the motor bus-on-busway mode. Under the light rail transit mode, single-articulated, bi-directional light rail vehicles are assumed to be used; these vehicles can be coupled into trains of up to two vehicles. The heavy rail rapid transit mode was assumed to utilize trains consisting of vehicles semi-permanently coupled ("married") into pairs which can be made up into up to six-car trains. Finally, the commuter rail mode is assumed to use diesel-electric locomotives propelling bi-level gallery coaches equipped for bi-directional—or "push-pull"—operation. Primary transit modes which incorporate motor bus technology employ the basic guidance principle of rubber-tired vehicles operating over roadway pavements, while primary transit modes which incorporate rail transit technology employ the principle of flanged steel-wheel vehicles operating on a track structure consisting of steel rails attached to a roadbed surface. Because rubber-tired vehicles are capable of operating in mixed traffic over existing streets and highways, in addition to freeways, reserved lanes, or busways, motor buses can be used in primary transit service to perform collection and distribution functions, thus offering the potential for a "one-seat, no-transfer" ride between a large number of trip origins and destinations. This is an important advantage of diesel motor bus technology over rail transit technology, which requires a fixed guideway separated from all other traffic and thus must rely on park-ride or feeder bus facilities and services for local collection and distribution.[19]

[19] *Similarly, electric trolley buses would also be limited to the overhead power distribution network under the current state-of-the-art of this technology.*

An important distinction between the five modes is that three require new fixed guideway construction, while two can use existing facilities as guideways. The motor bus-on-freeway mode would use existing operationally controlled freeways. It would require only completion of the planned expansion of the present freeway operational control system in the Milwaukee area and the provision of preferential bus ramps at those metered ramps where park-ride lots would be located. The commuter rail mode, the other mode which would use existing facilities, would use existing mainline railways, and would require only some track rehabilitation and grade-crossing protection. The principal advantage of these modes is that they can use existing facilities, and therefore have lower capital costs than do the modes requiring new guideway construction. The disadvantage is that primary transit service cannot be provided by these modes in areas where the required facilities do not exist. In addition, these two modes must share existing facilities with other traffic: the motor bus mode with automobile and truck traffic, and the commuter rail mode with intercity freight and passenger train service. The use, however, of a freeway operational control system would limit the detrimental effects of bus operation in mixed traffic on freeways, as it would restrain automobile and truck traffic from entering the freeway during peak travel periods so as to ensure a reasonable travel speed on the freeway for the motor bus. Similarly, commuter rail could receive preferential use of the shared railway facilities during peak travel periods through the coordinated dispatching of train movements.

There are important distinctions among the three fixed guideway modes of motor bus on busway, light rail transit, and heavy rail rapid transit with respect to guideway needs. The motor bus-on-busway mode and the light rail transit mode can use either Class A guideways, which are exclusive and fully grade-separated, or Class B guideways, which may be only semi-exclusive and partially grade-separated. Class A guideways require elevated or subway sections in high-density and central business district areas, while Class B guideways can use reserved lanes on surface arterial streets or some other portion of the street right-of-way such as the median area. Heavy rail rapid transit requires fully grade-separated, exclusive rights-of-way over the entire length of all guideways. The level of service afforded by Class B light rail transit and busway alignments in street rights-of-way, however, will be affected to some degree by cross traffic at intersections and by parallel traffic on the same street. Arterial street capacity will also be constrained, both on the streets where the reserved lane is implemented and on cross streets, if transit vehicles receive priority at signalized intersections.

The typical average speeds between stations for the five primary transit modes are quite similar, although the motor bus-on-freeway mode has slightly higher average speeds of about 35 mph because it usually provides nonstop, line-haul service. This compares with average speeds of from 20 mph to 30 mph for the other modes when station spacings are up to one mile. The addition of any reasonable amount of time for collection and distribution at the origin and destination end of a motor bus-on-freeway route, such as a central business district, will lower the average speed, bringing it into the range of the other modes. The lower end of the speed range—about 11 mph—for the bus modes reflects operation in a transit mall and on reserved street lanes. Commuter rail and heavy rail rapid transit do not have such lower ranges in speeds because they cannot operate over transit malls or reserved lanes on existing streets. Average speeds for commuter rail systems will range between 26 and 33 mph, and average speeds for heavy rail rapid transit systems will range between 26 and 49 mph. Heavy rail rapid transit requires elevated or subway alignments, which do not impose an operating speed restriction as do transit malls and reserved lanes. Some of the difference in average speeds among the modes is also attributable to differences in station spacings, particularly the larger spacings for the heavy rail rapid transit and commuter rail modes. Longer distances between stations increase travel speeds, but reduce accessibility to a system by the most convenient form of access, walking.

In order to determine average speeds for the various technologies, the performance characteristic of the vehicles used by each of the primary transit modes must be evaluated. Vehicles must have time to operate between stations or other stops at the maximum allowable speed, in addition to having time for acceleration and deceleration, in order for a primary transit mode to be effective in offering high-speed service in urbanized areas. The typical station spacings selected for use under this study reflect this concern. In fact, while most primary transit vehicles can attain relatively high average speeds with stations located between one-half and one mile apart, it must be recognized that commuter rail, because of its low acceleration and deceleration rates, cannot provide high-speed service with these station spacings. Commuter rail will typically require station spacings no closer than two-and-one-half to three miles apart, thus reducing accessibility to the system. Therefore, since such large station spacings are required, commuter rail can be expected to be most effective when accommodating the longest transit trips within southeastern Wisconsin, and cannot be expected to function efficiently if station spacings are similar to those required for the light rail transit, heavy rail rapid transit, or motor bus modes.

Light rail transit and motor bus operation over transit malls in a central business district have definite cost advantages. There is little difference in the unit costs of at-grade, elevated, and subway guideway segments for the three modes requiring new guideways. At-grade fixed guideways can be expected to cost between $1 million and $7 million per mile, depending upon the mode and surrounding land uses. Elevated guideway segments, regardless of the mode, may be expected to cost between $4 million and $25 million per mile, or up to four times as much as an at-grade guideway. Subway segments may be expected to cost between $38 million and $47 million per mile, or five to 15 times as much as at-grade guideway segments. Because the heavy rail rapid transit mode requires a fully grade-separated guideway, its capital costs greatly exceed those of the motor bus-on-busway and light rail transit modes. The basic difference between the guideway requirements of the various modes to be considered within this alternatives analysis is important, because it determines the nature of fixed facilities, as well as the magnitude of the capital costs required to implement one or more of the modes. For new primary transit systems requiring new fixed guideways, the construction of the guideways can be expected to be the most costly element of the total system.

Other important elements of the cost of the five primary transit modes are vehicles, stations, and maintenance and storage facilities. The vehicle cost for the motor bus mode is substantially less than that for the other modes. However, more motor buses would be necessary to carry equivalent numbers of passengers, and the estimated life of buses is less than half that of the vehicles of the other modes. In the Milwaukee area the motor bus modes, and perhaps also the commuter rail mode, have a capital cost advantage over the light rail transit and heavy rail rapid transit modes in that existing maintenance facilities, equipment, and procedures could be used. The light rail transit and heavy rail rapid transit modes, however, have the advantage over the motor bus modes of not requiring indoor storage since they are electrically propelled and heated. Commuter rail rolling stock, although stored outside, requires special provision in cold weather.

The costs of stations may be expected to be lowest for the motor bus-on-freeway and commuter rail modes. The motor bus-on-freeway mode would likely require only relatively simple park-ride lots in outlying areas. The commuter rail mode could use the existing intercity downtown passenger train terminal and existing outlying stations with simple low-level platforms. The unit costs for stations in subway segments or on elevated segments are similar for the motor bus-on-busway, light rail transit, and heavy rail rapid transit modes. The overall cost of stations is generally much higher for heavy rail rapid transit than for any other modes, since this mode requires the use of fully grade-separated, exclusive guideways, which in turn generally require elaborate station facilities.

Motor bus systems have the lowest operating costs per vehicle mile—$1.87—followed by light rail transit systems—$3.27—heavy rail rapid transit systems—$4.27—and, lastly, commuter rail systems—$5.40. In terms of costs per passenger mile at maximum design capacity, however, bus-on-busway systems have the lowest operating costs—1.7 cents—followed by heavy rail rapid transit systems—1.9 cents—light rail transit systems—2.2 cents—motor bus-on-freeway systems—2.8 cents—and commuter rail systems—3.4 cents. No primary transit system will, of course, operate at maximum design load factors except for relatively short periods of peak travel demand. Consequently, only upon consideration of alternative system plans and determination of transit travel demand under those plans can the actual operating cost of each mode for the Milwaukee area be estimated.

With respect to energy use, perhaps the most significant consideration is that the light rail transit, heavy rail rapid transit, and electric trolley bus modes use electricity, while the diesel motor bus modes use diesel fuel. Diesel fuel, like other petroleum-based motor fuels, has been subject to rapid increases in price over the recent past and to disruptions in supply. Long-term availability of such liquid fuels is in question, and short-term supply may be subject to further disruptions. It should be noted, however, that there are concerns as well about the provision of electricity, with current controversies focusing on the environmental impacts of coal and nuclear power utilization for the generation of electrical power. Coal and nuclear power are the current sources of electrical power generated for the Milwaukee area.

The motor bus modes are by far the most efficient primary transit modes in terms of the amount of energy used per vehicle mile. Diesel motor buses require about 38,000 BTU's per vehicle mile, while heavy rail rapid transit vehicles require about 74,000, light rail transit vehicles about 84,000, and commuter rail rolling stock about 113,000. The determination of the amount of energy used per vehicle mile is based on the energy lost in the conversion of other sources of power to electrical power and the energy lost in the transmission and distribution of that electrical power. Heavy rail rapid transit and motor bus on busways are by far the most efficient modes in terms of the amount of energy used per passenger mile when loaded to maximum design capacity, requiring 330 BTU's and 350 BTU's, respectively, followed by motor bus on freeways and light rail transit, both of which require 560 BTU's per passenger mile, and, lastly, commuter rail, which requires 720 BTU's per passenger mile. It should also be noted that a significant amount of energy is used in the construction of new fixed guideways for transit service—between 25 million and 234 billion BTU's per mile. This construction energy can differ by a factor of 10, depending on whether an at-grade fixed guideway or an underground fixed guideway is required. The energy used in the construction of even an average at-grade fixed guideway is significant in itself, being equivalent to the energy expended in an extensive operation of primary transit over that guideway for at least five years.

The passenger-carrying capacities of primary transit modes are a function of the size of vehicles used, the number of vehicles which can be trained together, and the necessary headways between vehicles. If used in nonstop operation over guideways, all five of the potential primary transit modes could provide capacities substantially greater than those necessary for the Milwaukee area, because they could then operate at absolute minimum headways. The motor bus on freeway and motor bus on busway, however, are the only modes having the potential to operate in a nonstop fashion, since only buses can pick up and discharge passengers at stations located off, and away from, fixed guideways or park-ride lots, and can perform collection and distribution services on surface arterial streets. The highest capacities of the fixed guideway primary transit modes designed with station stops are provided by the heavy rail rapid transit mode because of its ability to train many vehicles together at smaller headways than allowable by the commuter rail mode. Light rail transit provides less capacity than do these two rail modes as it has a more limited potential to train vehicles together.

Presently, vehicles cannot physically be trained together under the motor bus-on-busway mode. However, the capacity of a busway could be increased to accommodate the capacity provided by any rail mode by operating motor buses at very short headways from station to station, and by designing stations to facilitate the boarding and deboarding of several vehicles at the same time. It must be recognized, however, that primary transit modes which do incorporate fixed guideways are generally considered to be capable of providing the highest level of service for the transport of the largest numbers of people per hour at the most economical operating cost. Whether or not fixed guideway technologies can exploit these efficiencies given the future primary transit system demands forecast for the Milwaukee area will be determined through alternative system plan, test, and evaluation under this study.

The characteristics of the primary transit modes presented in Table 31 and discussed in this summary represent reasonable midpoints in the range of characteristics of each of the five modes. With special design provisions and operation, it may be possible to improve on some of these characteristics. However, the improvement of some characteristics may adversely affect other characteristics. The characteristics presented are considered sufficient for the preparation of alternative system plans and for a determination at a systems planning level of the best primary transit system for the Milwaukee area and, in particular, a determination of whether such a system should include major capital investment in fixed guideways for primary transit over the next two decades.

Table 31

SUMMARY OF PRIMARY TRANSIT MODES SELECTED FOR USE IN THE MILWAUKEE AREA ALTERNATIVES ANALYSIS

Element	Motor Bus on Operationally Controlled Freeway (articulated bus)	Motor Bus on Busway (articulated bus)		Light Rail Transit (articulated vehicle)		Heavy Rail Rapid Transit (married pair of single-unit vehicle)	Commuter Rail (diesel-electric locomotive and bi-level coach)
Guideway Requirements	Existing freeway	Class A	Class B	Class A	Class B	Exclusive and fully grade-separated	Existing mainline *double-track railway*
Stations							
Typical Average Station Spacing							
Central Business District	¼ mile	¼ mile	¼ mile	¼ mile	¼ mile	½ mile	Intercity Rail Terminal
High Density	½-1 mile	1 mile	½ mile	1 mile	½ mile	1 mile	2 ½ miles
Medium Density	1-2 miles	2 miles	1 mile	2 miles	1 mile	2 miles	3 miles
Speeds							
Selected Vehicle Maximum Speed (mph)	55	55		50		70	65
Maximum Operating Speed (mph)		Class A	Class B	Class A	Class B		
Transit Mall	$20	- -	20	- -	20	- -	- -
Surface Arterial Reserved Lane	(Ranges from	- -	30-40	- -	40	- -	- -
Exclusive Nongrade-Separated	40 to speed	- -	45	- -	45	- -	50
Exclusive Grade-Separated	limit)	55	- -	50	- -	70	60
Average Speed (mph)	36 to 47	21 to 39	11 to 34	23 to 39	11 to 36	26 to 49	26 to 33
Costs							
Selected Vehicle Capital Cost (1979 dollars)	$240,000	$240,000		$800,000		$750,000	$930,000 for locomotive; $565,000 for coach
Guideway Capital Cost (1979 dollars)							
At-Grade	Existing[a]	$1.4 to $ 6.8 million		$ 3.7 to $ 7.4 million		$ 4.2 to $ 6.1 million	$60,000-700,000[b]
Elevated	Existing[a]	$3.9 to $17.7 million		$ 6.3 to $19.0 million		$ 6.3 to $24.5 million	- -
Subway (cut and cover)	- -	- -		$38.1 to $46.7 million		$38.0 to $46.7 million	- -
Operating Cost (1979 dollars)							
Per Vehicle Mile	$1.87[c]	$1.87[c]		$3.27		$4.27	$5.40
Per Passenger Mile at Maximum Design Load Factor (cents)	2.8	1.7		2.2		1.9	3.4
Energy							
Propulsion Source	Diesel fuel	Diesel fuel		Electricity		Electricity	Diesel fuel
Propulsion Energy per Vehicle Mile (BTU's)	37,800	37,800		84,400		74,000	113,300
Propulsion Energy per Passenger Mile at Maximum Design Load Factor (BTU's)	560	350		560		330	720
Guideway Construction Energy per Mile (billion BTU's)	- -	34.0-153.2		24.6-234.0		24.6-234.0	30.0 (for new construction
Capacity							
Seats per Selected Vehicle	67	67		68		74	157
Capacity per Selected Vehicle at Maximum Design Load Factor	67	107		147		222	157
Selected Reasonable Maximum Train Length	1	1 (platooning possible)		2 (3 possible)		6 (10 possible)	4
Selected Reasonable Minimum Headway	5 seconds per freeway lane	30 seconds		60 seconds		120 seconds	5 minutes
Resultant Reasonable Maximum Hourly Capacity	48,240	12,840 (over 50,000 possible)		17,640 (over 25,000 possible)		39,960 (over 75,000 possible)	7,536 (over 30,000 possible)

[a] *Capital costs for guideway are limited to traffic control apparatus and ramp modifications.*

[b] *Costs reflect rehabilitation for existing trackage.*

[c] *Adjusted for average speed of vehicles in primary transit service.*

Source: SEWRPC.

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Chapter V

ALTERNATIVE FUTURES FOR SOUTHEASTERN WISCONSIN

INTRODUCTION

Traditionally, long-range transportation systems planning has involved the preparation of a single forecast of future levels of population and economic activity and of such factors as the cost of automobile operation, and the use of these forecasts in the test and evaluation of alternative land use and transportation system plans. This approach has worked well in periods of relative stability, when historic trends in the factors underlying and influencing population and economic change and motor fuel cost could be reasonably expected to extend over the plan design period. However, during periods of major changes in social and economic conditions, and particularly during times when external factors such as the cost and availability of motor fuel are subject to rapid change, the assumption that historic trends will continue becomes uncertain and different procedures become necessary.

For the study of primary, or rapid, transit alternatives in the Milwaukee area, a new approach, termed alternative futures, was accordingly used in an attempt to deal with the high level of uncertainty that exists today about key future conditions which influence public transit needs. These conditions include energy cost and availability as well as population lifestyles and land use centralization. Under the alternative futures approach, the design, testing, and evaluation of alternative primary transit system plans is based upon a number of alternative futures which are intended to define the range of future conditions that may be expected to occur over the plan design period. The purpose of the alternative futures approach is to identify those alternative system plans that perform well under a wide range of future conditions. In this way, "robust" system plans that can be expected to remain viable under greatly varying future conditions can be identified and recommended for implementation. In addition, the alternative futures approach is intended to permit the identification of those system options which work best under particular futures, so that actions can be taken to avoid foreclosing those options.

The identification of the alternative futures under which the primary transit system plans were to be tested was accomplished in three phases. First, key factors external to the Region influencing future public transit needs were identified, and alternative scenarios of future change in these factors were developed. The external factors included were energy cost and availability; technology and the conservation of energy; population lifestyles; and economic conditions. These factors may affect transit needs directly—for example, by affecting the cost of urban travel—or indirectly, by affecting regional growth or decline. Two scenarios were developed to represent consistent and reasonable extremes of future conditions as they relate to potential transit utilization. The more optimistic scenario, termed the moderate growth scenario, envisions particularly favorable conditions for public transit, with the external factors leading to moderate population and economic growth in the Region, and to significantly higher energy prices and the potential for motor fuel supply restrictions to act as incentives for increased transit use. The less optimistic scenario, termed the stable or declining growth scenario, envisions conditions less favorable to transit utilization, with the external factors leading to a stable economy, a slight population decline, and moderately higher energy prices which, when combined with the increased fuel efficiency, would result in a slight decrease in the real cost of automobile travel. The second phase of the alternative futures process was the development of future regional population and employment levels for each of the two scenarios based upon assumptions consistent with the scenarios. In the third phase of the process, centralized and decentralized land use plans representing the reasonable extremes of land use distribution and intensity that could be expected to result under each scenario were developed.

ALTERNATIVE FUTURE SCENARIOS

External Factors Affecting Regional Growth

Because of factors operating largely external to the Region, the magnitude and character of the future overall development of the Southeastern Wisconsin

Region are uncertain. Four external factors have been identified as a basis for the development of two alternative future scenarios defining the widest reasonable range of conditions influencing primary transit system needs in the Milwaukee area. These factors are: energy cost and availability, technology and conservation, population lifestyles, and economic conditions.

Energy Cost and Availability: The future cost and availability of energy is an important external factor affecting transit needs in southeastern Wisconsin because of its influence on the future cost and convenience of travel and its possible effects on regional growth patterns. Total energy use in the United States has risen from 42.8 quadrillion British Thermal Units (BTU's) in 1960 to 78 quadrillion BTU's in 1978, an increase of 82 percent over 19 years. Petroleum use in the nation increased from 17 to 39 quadrillion BTU's, or by 130 percent, over the same period. The amount of petroleum imported to the United States has increased by over 400 percent over this same time period. By 1978, the United States was importing almost 50 percent of its petroleum. This increased dependence on foreign petroleum has been a factor in major increases in the cost of motor fuel and periodic disruptions in motor fuel supply in the United States. Imported petroleum prices have risen rapidly, principally only since the early 1970's, from less than $5.00 per barrel in 1960 to $26.00 per barrel by late 1979, causing the average price of petroleum per barrel in the United States to increase from less than $4.00 to $20.00 over the same period. This situation is more than especially critical to the transportation sector, which accounts for about 25 percent of the total national energy use and about 60 percent of the total national petroleum consumption. Prospects for the economy and for transportation in the United States are highly uncertain, largely because of this dependency upon imported petroleum, but also because high rates of usage and future increases in the costs of energy, particularly motor fuel, are likely. Furthermore, the potential remains for future disruptions in supply, with attendant short- and long-term impacts on transportation. Thus, major readjustments will be necessary to deal with this problem.

Technology and Conservation: The greatest potential for departure from past trends in energy use lies with the more efficient use of energy and increased conservation. It is unlikely that the domestic production of petroleum can be increased significantly over current levels, either by conventional or unconventional means, without significant price increases. In addition, a variety of environmental, public health, and safety concerns may be expected to constrain significant increases in the use of such other conventional energy sources, as coal and nuclear power, in the next two decades. Questions of the technological and economic feasibility of unconventional energy sources such as solar power and synthetic fuels—liquified coal or biomass—coupled with the long lead time likely to be needed to develop and implement these new energy sources can be expected to limit their impact on overall energy consumption patterns over the next two decades. For similar reasons, it appears unlikely that radical changes in automobile technology, such as the introduction of new propulsion systems (e.g., electric automobiles), will have any significant influence on the overall demand for petroleum. Thus, the prospects for a simple technological solution to the current energy situation are poor, and fuel costs may be expected to continue to become an increasingly large component of the unit costs of urban travel over the next two decades. While this does not preclude important shifts in the efficiency of transportation technology, it does imply that major technological changes will not solve the transportation energy crisis in the near-term future.

In the face of significantly higher energy costs and the potential for disruptions in supply, conservation is the most likely response to the energy problem over the next two decades. The increasing involvement of the federal government in programs to reduce dependence on foreign oil, as well as economic pressures on consumers and producers, points toward the more efficient use of energy in the future. Conservation of energy is attainable through increased automobile efficiency, better residential space heating systems, and improvements in industrial process steam generation. Automobile use, residential space heating, and industrial process steam generating currently represent about one-third of total national energy use. Through future conservation in these three energy uses, the rate of growth in national energy demand could be reduced from the 3.5 percent annual rate of increase experienced from 1960 through 1975, to a 2.5 percent annual rate of increase. It is expected that, even to meet this reduced energy demand, the use of coal in direct combustion will at least double in the nation over the next 20 years, as will the use of electric power generated through greater use of coal and nuclear resources.

Accordingly, it appears that two key factors will influence the future development of the Region: 1) the future cost and availability of energy, particularly of petroleum-based fuels but of other fuels as well; and 2) the degree to which energy conservation measures are implemented, particularly with respect to automobile travel. Future transit needs in the Milwaukee area may be expected to be affected directly by the future cost of petroleum-based motor fuel and the fuel consumption efficiency of the automobile, and indirectly by the subsequent changes in future levels of tripmaking and travel patterns in the area brought about by changes in the distribution of employment and population in the Region.

Population and Lifestyles: In recent years, significant changes have occurred in the lifestyles and attendant socioeconomic characteristics of the residents of the Region and the nation. Family pattern changes have included lower fertility rates, higher female labor force participation rates, increased rates of divorce, and reductions in average household size. Residential lifestyle changes have included changes in inter- and intraregional rates of population migration.

The long-established, traditional, family-centered lifestyle marked by a husband as the sole provider, a wife who cares for home and family, and two or three children has been changing toward a more individualistic orientation, with increased numbers of nonfamily households. This shift has resulted from a number of factors, including the changing role of women in society, a more individualistic orientation of people, and changing economic conditions which require families to have more than one wage earner to maintain a desired standard of living. These changes have led to increases in the labor force participation of women, a decline in birthrates, and a consequent general aging of the population. These changes, coupled with higher rates of divorce, differentials in male and female mortality rates, and the increased tendency of younger and older adults to live independently, have resulted in a substantial reduction in average household size and rapid increases in the number of one- and two-person households. Residential development patterns in the past have emphasized single-family housing in the suburban and rural areas of the Region and have resulted in declines in the population of the central cities of the Region. However, if the number of nontraditional households continues to grow, a shift to a demand for multiple-unit housing may be expected, along with a decrease in the demand for single-unit housing, perhaps accompanied by a trend toward centralization of development in the Region.

The key external factors influencing the future population lifestyles of the Region include: 1) the degree to which the changing role of women in society affects the composition of the labor force; 2) future changes in fertility rates; and 3) future changes in household size. These three key external factors may be expected to affect transit needs in the Milwaukee area principally by influencing future levels of population, employment, and households. A continuation of recent lifestyle trends would result in a continued increase in female labor force participation; the maintenance of below-replacement-level fertility rates; and decreases in household size as the number of one- and two-person households accounts for increasingly larger proportions of the population. On the other hand, if a substantial portion of the population currently in its twenties and thirties ultimately decides to enter family formation, albeit at later ages than has been traditional, some moderation of recent trends toward nontraditional family lifestyle patterns may be expected. A slowing of the rate of increase in female labor force participation would occur, along with decreased fertility rates and a stabilization in household size. To an extent, these factors will be influenced by the state of the economy of the Region and the nation.

Economic Conditions: The future level of economic activity in the nation and Region will greatly influence future transportation system development needs because employment levels and income are important determinants of population size and lifestyles, and of the overall amount of travel. In considering the future levels of economic activity in the Region, the influence of a number of factors must be addressed, including the size of the regional population; labor force participation rates; the age structure of the population; levels of work force productivity; and changes in the price and availability of energy resources, especially imported petroleum. A particularly important consideration is the extent to which southeastern Wisconsin will be able to compete effectively with other areas of the nation in the maintenance and expansion of its present, and the attraction of new, business and industry.

The key external factors influencing the future economic conditions of the Region include: 1) the degree to which the Region will be able to compete with other areas of the nation for business and industry; and 2) the future change in real income. Future transit needs in the Milwaukee area will be affected by these changes in economic conditions in that changes in area employment and population levels will directly affect total demand for travel in the area. Future levels of income will have the additional effect of influencing future levels of automobile ownership, levels of tripmaking, and choice of mode of travel.

To bring about a strong and expanding future economy in southeastern Wisconsin, conditions leading to increasing consumer demand for goods and services and favorable conditions for business and industry expansion in the Region are necessary. Factors that would lead to an increasing demand for goods and services include an increase in population size, an age structure of population with large proportions of work force age, lower rates of inflation, and increased levels of income. In addition, the ability of the Region to compete with other regions of the United States for business and industry expansion and development, particularly with regard to the manufacturing industry, would need to be maintained and enhanced. Such a situation would result from a reduced differential in labor and energy costs and taxation between the Region and other parts of the country, as well as from enhanced conditions in the Region for economic development.

A weak economy in southeastern Wisconsin could result from a failure of the Region to compete effectively with other areas of the country and from continued high rates of interest and inflation, which would cause a slowdown in business expansion and in the demand for goods and services. A period of stability or decline in total population levels would further add to a decrease in demand for goods and services. Finally, declines in capital investment for production could further reduce demand for goods and services in that increases in productivity, and consequently personal income, would not be encouraged.

Alternative Scenarios

Two alternative scenarios with quite different implications for the development of the Region were developed by linking opposite endpoints of the range of future prospects of each of these key external factors. These alternative future scenarios are intended to comprise a reasonable combination of the endpoints of the future range of factors external to the Region. One scenario represents optimistic conditions for transit system utilization, and the other represents conditions that are pessimistic for transit system use. As shown in Table 32 and Figure 21, the key external factors that may be expected to influence development in the Region differ considerably under the two scenarios. The optimistic, or moderate growth, scenario points toward a significant increase in the cost of automobile travel brought about by relatively high fuel costs and a relatively low degree of conservation; a stabilization of lifestyle trends accompanied by a small increase in female labor force participation and a stabilization of household size; and moderate economic growth in the Region as a result of its ability to compete with other regions in attracting business and industry. Such conditions may be expected to results in economic conditions conducive to transit use as well as in a sizable market of potential transit users. The pessimistic, or stable or declining growth, scenario, on the other hand, postulates conditions less conducive to transit use, including a decrease in the real cost of automobile travel as a result of successful efforts at conservation, increased automobile fuel efficiency, a low rate of increase in fuel prices, a more individualistic lifestyle with a high level of female labor force participation, low fertility rates and small household sizes, and a declining economy with substantial out-migration from the Region.

The Moderate Growth Scenario: The moderate growth scenario was developed to represent the most optimistic conditions for future primary transit system development. Thus, transit alternatives that were determined to be infeasible under this future were dropped from further consideration under less transit-oriented futures. The moderate growth scenario assumes a severe energy situation, and moderate growth in regional employment and population. Under this scenario, conservation is marked by only limited success, and alternative fuel sources are only moderately successful in reducing the demand for petroleum-based fuels. Consequently, there is a continued high degree of dependency upon petroleum as a source of energy accompanied by continued high levels of petroleum imports. The use of energy in the nation is assumed to continue to increase at a rate of 3 percent per year to the year 2000, and average automobile fuel efficiency is assumed to reach 27.5 miles per gallon. To meet the increases in national energy needs, the use of electricity and coal in direct combustion would more than double, and the use of liquid fuels, including some synthetic fuels, would increase by about one-third to one-half. Even with such increases and with some success at conserving petroleum, the use of petroleum still increases. As a result, the average price of oil produced in the United States is assumed to increase rapidly to the world prices, and then to rise at a rate of about 5 percent per year in constant 1979 dollars. Under these conditions, gasoline prices are projected to increase to $2.30 per gallon by 2000, expressed in constant 1979 dollars—a 130 percent real increase over 1979 levels.

The moderate growth scenario envisions a continuation of the types of population change experienced in the Region during the 1960's and early part of the 1970's. A partial return to a family-oriented lifestyle is assumed, as is a desire by many persons now in their twenties or early thirties, and who currently live in one- and two-person households, to form traditional families. Under this scenario, fertility rates continue at below replacement levels into the 1980's, followed by a slight increase to replacement level by the year 2000. In addition, there is a balance between in- and out-migration of population between 1970 and the year 2000. These fertility rates, coupled with a general aging of the population, are expected to create significant shifts in the age composition of the resident population, with a small decrease in number of school-age children and major increases in the numbers of people in the work force and retirement age groups. Low fertility, coupled with some continuation in the trend of increasing numbers of one- and two-person households, is expected to lead to an average household size in the Region of between 2.9 and 3.1 persons in the year 2000, and to a rate of increase in households that is greater than the rate of increase in population between 1970 and 2000. The total number of households in the Region is expected to range between 680,000 and 740,000, as compared to the 1970 level of 536,500. Under the moderate population growth scenario, the resident population of the Region is expected to increase by about 463,000 persons, or about 26 percent, between 1970 and 2000—from about 1,756,100 persons in 1970 to about 2,219,300 persons by the year 2000.

The economic changes that may be expected to occur under the moderate growth scenario represent a continuation of the changes that have occurred historically in the regional economy. This scenario can be characterized as long-term economic growth at a rate at or slightly below national averages. Growth in the regional economy will result from the interaction of several factors explicitly assumed as a part of the moderate growth scenario, and this growth will be met by a growing demand for goods and services because of the increase in the Region's population. An increased proportion of the population will be of work force age, and there will be increased female labor force participation as a result of the growing regional labor force and the continued ability of the Region to compete economically with other regions of the nation. Under the moderate growth scenario, the number of jobs available in the Region will increase by about 274,000, or about 37 percent, between 1970 and 2000—from a 1970 level of 741,600 jobs, to about 1,016,000 jobs in the year 2000. Average household income will increase to between $29,600 and $32,000 in the year 2000, or by about 38 to 49 percent over the 1970 level of $21,400 as measured in constant 1979 dollars.

<u>The Stable or Declining Growth Scenario</u>: The stable or declining growth scenario represents the combination of levels of motor fuel availability and price, and population and economic activity, that would be least oriented to transit use in the future. The stable or declining growth scenario envisions a moderate increase in petroleum prices, no major disruptions in the supply of petroleum, and a high degree of conservation in all sectors of the economy. Under this scenario, efforts to conserve energy are successful, and there is a substantial substitution of coal, synthetic fuels, and other fuel sources for petroleum fuels. The use of coal and electricity generated through coal and nuclear power plants is assumed to double by the year 2000. Continued reliance on oil imports, but at a reduced level, is anticipated under this future, and average automobile fuel efficiency is projected to reach 32 miles per gallon in the year 2000. As a result of these efforts, little or no increase in petroleum use over the next 20 years is postulated. The price of oil in the United States is anticipated to converge rapidly with world oil prices and to rise in real terms at a rate of 2 percent or less per year thereafter. Because of greater efficiency and moderate fuel price increases, the cost of automobile travel per mile is somewhat less than the current level in constant dollars.

Population changes under the lower scenario can perhaps be best characterized as an acceleration of the regional population change experienced in the late 1970's, when the Region experienced

Table 32

ALTERNATIVE FUTURE SCENARIOS OF EXTERNAL FACTORS

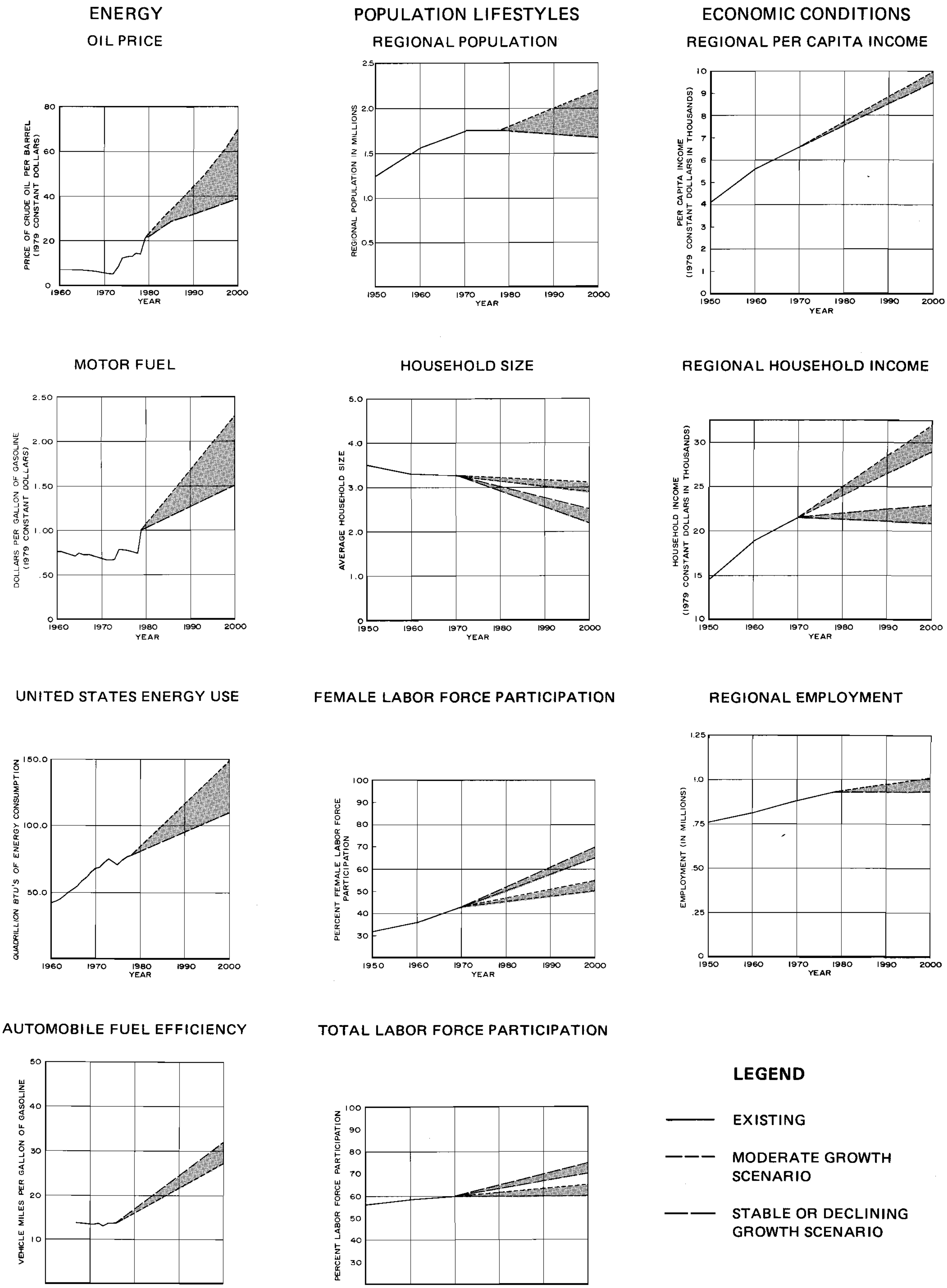
Key External Factor	Moderate Growth Scenario	Stable or Declining Growth Scenario
Energy		
The future cost and availability of energy, particularly of petroleum	Oil price to converge with world oil price, which will increase at 5 percent annual rate to $72 per barrel in the year 2000 (1979 dollars) Petroleum-based motor fuel to increase to $2.30 per gallon by the year 2000 (1979 dollars) Assumes some potential for major and continuing disruptions in oil supply	Oil price to converge with world oil price, which will increase at 2 percent annual rate to $39 per barrel in the year 2000 (1979 dollars) Petroleum-based motor fuel to increase to $1.50 per gallon by the year 2000 (1979 dollars) Assumes no major or continued disruptions in oil supply
The degree to which energy conservation measures are implemented, particularly with respect to the automobile	Low degree of conservation in all sectors, resulting in increase in energy use of 3 percent Automobile fuel efficiency of 27.5 miles per gallon	High degree of conservation in all sectors, resulting in increase in energy use of 2 percent or less Automobile fuel efficiency of 32 miles per gallon
Population Lifestyles		
The degree to which the changing role of women affects the composition of the labor force	Female labor force increases to 50 to 55 percent and total labor force participation is 60 to 65 percent	Female labor force increases to 65 to 70 percent and total labor force participation is 70 to 75 percent
The future change in fertility rates	A continuation of below-replacement-level fertility rates during the next decade, followed by an increase to replacement level by the year 2000	A continuation of below-replacement-level fertility rates to the year 2000
The future change in household sizes	Average household size stabilizes	Average household size continues to decline
Economic Conditions		
The degree to which the Region will be able to compete with other areas of the nation for the preservation and expansion of its economic base	Region is considered to have relatively high attractiveness and competitiveness	Region is considered to have relatively low attractiveness and competitiveness
The future change of real income	Per capita and household income increase envisioned as a result of the attractiveness and competitiveness of Region, an increased proportion of the population being of work force age, and increased population labor force participation	Per capita increase likely but no household income increase envisioned as a result of the lack of attractiveness and competitiveness of Region, but increased proportion of the population is of work force age, and there is increased population labor force participation

Source: SEWRPC.

a decline in its rate of growth. Fertility rates at below replacement levels are assumed to continue to the year 2000. This assumption, combined with a rate of net out-migration sufficiently large to offset all natural increases in regional population, will produce a slight population decrease in the Region by the year 2000. Thus, it is also assumed under this scenario that the Region will be unable to compete effectively with other regions of the country for economic development, and that persons presently in their twenties and thirties will continue to have a low rate of family formation. Under this scenario, Kenosha, Milwaukee, and Racine Counties—all of which experienced population losses between 1975 and 1978—will continue to lose population through the year 2000. Con-

Figure 21

RANGES OF EXTERNAL FACTORS CONSIDERED IN THE ALTERNATIVE FUTURE SCENARIOS



Source: SEWRPC.

tinued low fertility rates in concert with the general aging of the population, and high levels of regional out-migration in the age groups below 45 years of age, will create significant shifts in the age composition of the resident population, with major decreases in school-age population and slight increases in the work force age group and retirement age population.

Lower fertility rates, coupled with a continuation of nonfamily-oriented household formation patterns, will lead to a major decrease in average household size to between 2.2 and 2.5 persons in the year 2000, as compared with the 1978 national rate of 2.81, and to an increase in the total number of households to between 674,000 and 750,000, as compared with the 1970 level of 536,500. This increase in households would occur in spite of the fact that the total population will decrease slightly between 1980 and 2000 under this scenario. Population under this scenario will decline to 1,690,000 persons in the year 2000, a loss of about 66,000 persons, or about 4 percent, from the 1970 level. The difference in total regional population in the year 2000 under the two alternative future scenarios is about 529,000 persons.

The anticipated economic changes that may be expected to occur under this scenario represent a departure from existing regional trends. This departure is based on a decline in population level, along with an assumed inability of the Region to compete with other sectors of the nation economically. As a result, employment levels may be expected to show only moderate increases over 1970 levels in the year 2000, with most of the increase occurring during the 1970's. It is assumed that the rate of increase in regional employment will be significantly below the national rates of increase, particularly after 1980. Employment growth that does occur is assumed to be accommodated by increases in the labor force participation rate and by the slight increase in the size of the population in labor force age groups.

Under this scenario, the number of jobs in the Region may be expected to increase over 1970 levels by about 145,400 jobs, or about 20 percent, to about 887,000 jobs in the year 2000. The difference in total regional employment in the year 2000 under the two alternative future scenarios is about 129,000 jobs. Average household income is envisioned as ranging from its 1970 level of $21,400, measured in constant 1979 dollars, to $23,700, an 11 percent real increase.

REGIONAL DEVELOPMENT ALTERNATIVES

The third step in the development of the alternative futures under which alternative primary transit plans are to be designed, tested, and evaluated was the preparation of alternative land use plans. Two alternative land use plans were prepared for each of the two scenarios to represent the range of possible development patterns of the Region. These plans consist of a centralized land use plan and a decentralized land use plan. The centralized plans developed for each of the scenarios represent a planned continuation of historic development trends evident within the Region prior to 1950, with new urban development proposed to occur at largely medium densities in concentric rings along the periphery of, and outward from, existing urban centers. Urban development would be encouraged to occur only in those areas of the Region having soils suitable for development, not subject to special hazards such as flooding, and having sanitary sewer, public water supply, and other essential urban services readily available. The decentralized land use plans developed for each scenario represent a continuation of historic development trends evident within the Region since 1950, and particularly since 1963. Much of the new urban development under the plan would occur at low densities, and in noncontiguous enclaves well beyond the periphery of existing urban centers, particularly Milwaukee County. Also, much of this new urban development would be located in areas beyond existing and planned future sanitary sewer service areas, but where soils are suitable for onsite sewage disposal systems. New urban development would not, under any of the land use plans, be located in primary environmental corridors or in areas of poor soil conditions. Furthermore, under all of the land use plans the conversion of prime agricultural land to urban use would be minimized.

Land Use Plans for Moderate Growth Scenario

Under the centralized plan for the moderate growth scenario, virtually all new urban development would occur in concentric rings along the periphery of, and outward from, existing urban centers, following the development pattern which occurred within the Region prior to 1950 (see Map 15 and Table 33). Existing developed areas in Milwaukee County would maintain at least the same density of occupied housing units as in 1970. New urban development under this plan would occur primarily at medium and high densities consistent with the economical provision of important urban facilities and services, including public transit. In contrast, under the decentralized land use plan much of the new urban development would occur in a highly diffused pattern that is discontinuous both radially and circumferentially, and would be of low urban and suburban density, thus following the more recent trends of land use development in the Region (see Map 16 and Table 34).

Under the centralized plan, the population of Milwaukee County would increase by more than 95,000 persons over the 1978 level to 1,049,600 persons in the year 2000, an increase of 10 percent, as shown in Table 35. The number of households in Milwaukee County would increase by more than 41,000 to a total of 392,700 by the year 2000, or nearly 12 percent over the 1975 level, and the number of jobs would increase by more than 31,000 to a total of 593,600 in the year 2000, or nearly 6 percent over the 1978 level (see Tables 36 and 37). Under the decentralized plan, the levels of population, households, and employment in Milwaukee County would all decline from the base year levels. Employment would decline by more than 38,000 jobs, or nearly 7 percent, to a total of 523,400 jobs; population would decline by 56,000 persons, or over 5 percent, to a total of 898,500 persons; and the number of households would decline by more than 55,000, or over 15 percent, to a total of 295,600 households.

In the three outlying counties contiguous to Milwaukee County—Ozaukee, Washington, and Waukesha Counties—population under the centralized plan would increase by nearly 234,000 persons, or about 53 percent over the 1978 level, to a total of 677,600 persons. Employment in these three counties would increase by more than 96,000 jobs, or over 63 percent over the 1978 level, to a total of 231,400 jobs in the year 2000. Under the decentralized land use plan, population in these three counties would increase by more than 343,000 persons over the 1978 level, or by 78 percent, to a total of 786,700 persons, and employment would increase by 133,000 jobs, or 94 percent, to a total of 274,800 jobs. Because the decentralized land use plan would accommodate the new and redistributed urban development in the Region to the year 2000 primarily at suburban population densities, the population density of the developed area of the Region under this plan would decline from a 1970 level of 4,350 persons per square mile to fewer than 2,300 persons per square mile. Under the centralized land use plan, population density would decline to about 3,500 persons per square mile.

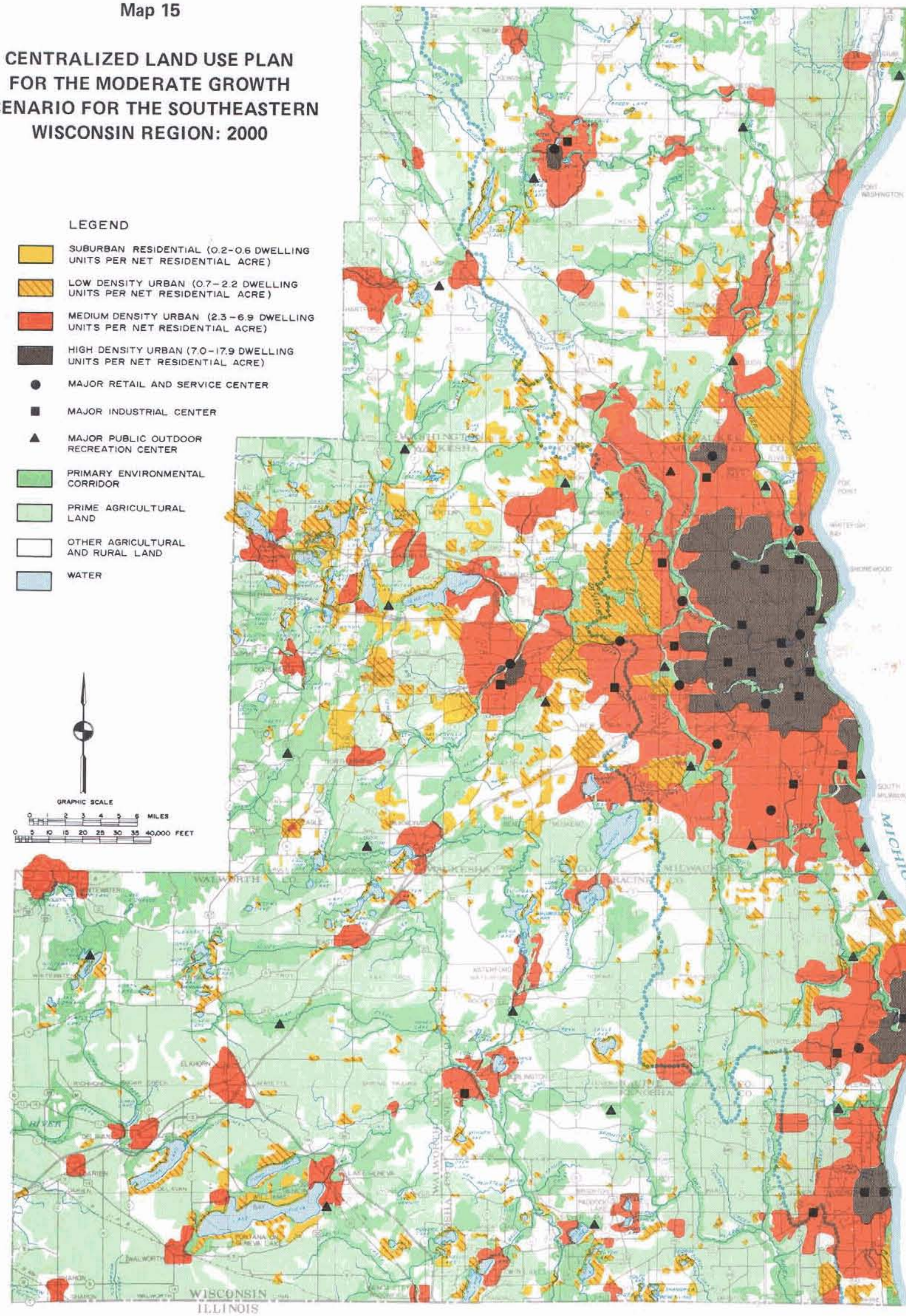
The centralized land use plan would accommodate the forecast population and employment increases in the Region through the conversion of 72,518 acres of land, or about 113 square miles, from rural to urban use from 1970 to the year 2000. The greatest amounts of increase would occur in urban medium-density residential land use, which would increase by 41,046 acres, or 111 percent, over the 1970 level; industrial land use, which would increase by 6,672 acres, or 66 percent; and transportation, communication, and utility land use, which would increase by 21,441 acres, or 20 percent. Overall, the plan proposes a 20 percent increase in urban land between 1970 and the year 2000 to accommodate a 26 percent increase in population, a 38 percent increase in households, and a 37 percent increase in jobs. In contrast, the decentralized land use plan would require the conversion of 150,299 acres of land, or about 234 square miles, from rural to urban use, or over a 45 percent increase in urban land, as shown in Table 34. Major increases would occur in urban medium-density residential land use, which would increase by 43,888 acres, or 118 percent, over the 1970 level; suburban residential land use, which would increase by 64,889 acres, or 294 percent; industrial land use, which would increase by 3,847 acres, or 38 percent; and transportation, communication, and utility land use, which would increase by 33,788 acres, or 31 percent. Under the decentralized land use plan, nearly 109,000 acres of new residential development would be added to the Region, compared with 38,600 acres under the centralized plan.

Land Use Plans for the Stable or Declining Growth Scenario

Under the centralized plan for the stable or declining growth scenario, virtually all new urban development would occur in concentric rings along the periphery of, and outward from, existing urban centers following the development pattern which occurred within the Region prior to 1950, as shown on Map 17. Existing developed areas in Milwaukee County would maintain at least the same density of occupied housing units as in 1970. New urban development under this plan would occur primarily at medium and high densities consistent with the economical provision of important urban facilities and services, including public transit (see

Map 15

CENTRALIZED LAND USE PLAN FOR THE MODERATE GROWTH SCENARIO FOR THE SOUTHEASTERN WISCONSIN REGION: 2000



The centralized land use plan for the moderate growth scenario represents a continuation of historic development trends apparent within the Region prior to 1950, with urban development proposed to continue to occur largely in concentric rings along the full periphery of, and outward from, existing urban centers, and at densities consistent with the provision of centralized public sanitary sewer, public water supply, and public transit facilities. Under the centralized land use plan, 62 percent of the new urban residential development would be located within a distance of 20 miles from the central business district of Milwaukee by the year 2000. Primary environmental corridors would be protected from further urban development and the conversion of prime agricultural lands to urban uses would be minimized.

Source: SEWRPC.

Table 33

EXISTING AND PROPOSED LAND USE IN THE REGION: 1970 AND 2000
CENTRALIZED LAND USE PLAN FOR THE MODERATE GROWTH SCENARIO

Land Use Category	Existing 1970		Planned Increment		Total 2000	
	Acres	Percent of Major Category	Acres	Percent Change	Acres	Percent of Major Category
Urban Land Use						
Residential						
Urban High Density	24,389	7.4	371	1.5	24,760	6.2
Urban Medium Density	37,092	11.3	41,046	110.7	78,138	19.5
Urban Low Density	72,701	22.2	- 7,689	- 10.6	65,012	16.2
Suburban Density	22,079	6.7	4,862	22.0	26,941	6.7
Subtotal	156,261	47.6	38,590	24.7	194,851	48.6
Commercial	6,517	2.0	698	10.7	7,215	1.8
Industrial	10,038	3.1	6,672	66.5	16,710	4.2
Governmental and Institutional	16,628	5.1	951	5.7	17,579	4.4
Transportation, Communication, and Utilities[a]	109,430	33.4	21,441	19.6	130,871	32.7
Recreation	28,982[b]	8.8	4,166[c]	14.4	33,148	8.3
Urban Land Use Subtotal	327,856	100.0	72,518	22.1	400,374	100.0
Rural Land Use						
Residential	- -[d]	- -	22,306	- -	22,306	1.7
Agriculture	1,040,119	74.7	- 79,779	- 7.7	960,340	72.7
Other Open Lands[e]	353,125	25.3	- 15,045	- 4.3	338,080	25.6
Rural Land Use Subtotal	1,393,244	100.0	- 72,518	- 5.2	1,320,726	100.0
Total	1,721,100	- -	- -	- -	1,721,100	- -

[a] *Includes off-street parking uses.*

[b] *Includes net site area of public and nonpublic recreation sites.*

[c] *Includes only that net site area recommended for public recreation use.*

[d] *Included in land use inventory as part of urban residential land use.*

[e] *Includes woodlands, water, wetlands, unused lands, and quarries.*

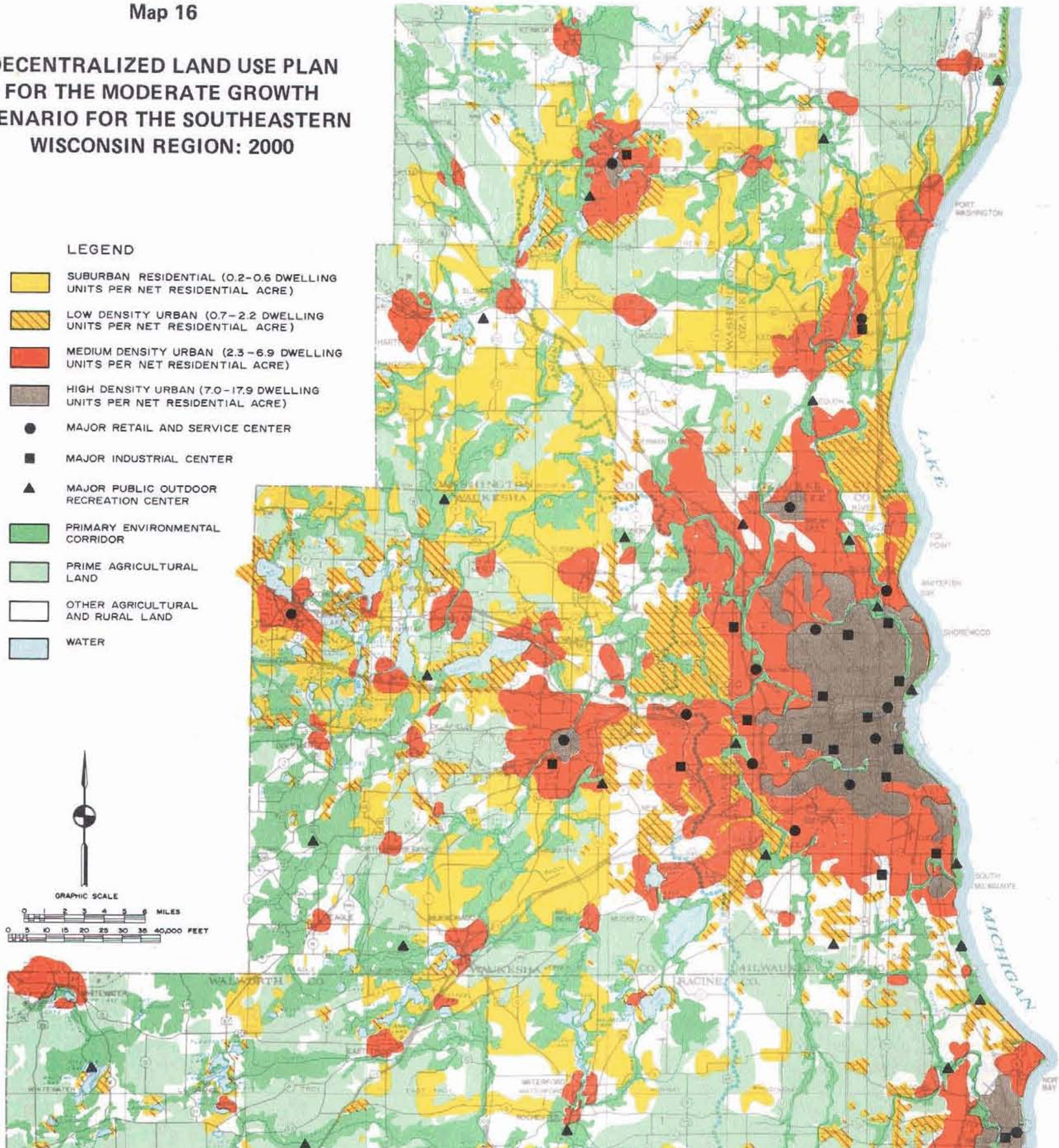
Source: SEWRPC.

Table 38). In contrast, under the decentralized land use plan, much of the new urban development would occur in a highly diffused pattern which is discontinuous both radially and circumferentially. Such development would be of low urban and suburban density, thus following the land use development trends evident within the Region since 1950, particularly since 1963 (see Map 18 and Table 39).

Under the centralized plan, the population of Milwaukee County would decrease by only 124,000 persons from the 1978 level to a level of 830,000 in the year 2000, largely as a result of a significant decline in average household size (see Table 40). The number of households in Milwaukee County would increase by more than 37,000, or nearly 11 percent over the 1975 level, to a total of 388,300 by the year 2000, and the number of jobs

Map 16

DECENTRALIZED LAND USE PLAN FOR THE MODERATE GROWTH SCENARIO FOR THE SOUTHEASTERN WISCONSIN REGION: 2000



The decentralized land use plan for the moderate growth scenario represents a continuation of the highly diffused, low-density development trends observed within the Region since 1963. Most new urban development under this plan would take place in outlying areas of the Region beyond the periphery of existing urban centers, at low densities, and in noncontiguous enclaves. Under this plan only 27 percent of the new urban residential development would be within 20 miles of the central business district of Milwaukee. New urban development would not, however, be placed in the primary environmental corridors, and the conversion of prime agricultural lands to urban uses would be minimized. However, nearly three times as much prime agricultural land, and twice as much other agricultural lands, would be converted from rural to urban uses under the decentralized plan as would under the centralized plan for this scenario.

Source: SEWRPC.

Table 34

EXISTING AND PROPOSED LAND USE IN THE REGION: 1970 AND 2000
DECENTRALIZED LAND USE PLAN FOR THE MODERATE GROWTH SCENARIO

Land Use Category	Existing 1970		Planned Increment		Total 2000	
	Acres	Percent of Major Category	Acres	Percent Change	Acres	Percent of Major Category
Urban Land Use						
Residential						
Urban High Density	24,389	7.4	- 2,548	- 10.4	21,841	4.6
Urban Medium Density	37,092	11.3	43,888	118.3	80,980	16.9
Urban Low Density	72,701	22.2	- 2,423	- 3.3	70,278	14.7
Suburban Density	22,084	6.7	64,889	293.8	86,973	18.2
Subtotal	156,266	47.6	103,806	66.4	260,072	54.4
Commercial	6,517	2.0	385	5.9	6,902	1.4
Industrial	10,039	3.1	3,847	38.3	13,886	2.9
Governmental and Institutional	16,617	5.1	2,735	16.5	19,352	4.0
Transportation, Communication, and Utilities[a]	109,407	33.4	33,788	30.9	143,195	30.0
Recreation	28,996[b]	8.8	5,738[c]	19.8	34,734	7.3
Urban Land Use Subtotal	327,842	100.0	150,299	45.8	478,141	100.0
Rural Land Use						
Residential	- -[d]	- -	4,782	- -	4,782	0.4
Agriculture	1,040,122	74.7	- 141,070	- 13.6	899,052	72.3
Other Open Lands[e]	353,136	25.3	- 14,011	- 4.0	339,125	27.3
Rural Land Use Subtotal	1,393,258	100.0	- 150,299	- 10.8	1,242,959	100.0
Total	1,721,100	- -	- -	- -	1,721,100	- -

[a] *Includes off-street parking uses.*

[b] *Includes net site area of public and nonpublic recreation sites.*

[c] *Includes only that net site area recommended for public recreation use.*

[d] *Included in land use inventory as part of urban residential land use.*

[e] *Includes woodlands, water, wetlands, unused lands, and quarries.*

Source: SEWRPC.

would decline by 10,000 from the 1978 level to a total of 552,300 by the year 2000, as shown in Tables 41 and 42. Under the decentralized plan, the levels of households, population, and employment all would decline in Milwaukee County from the base year levels. Employment would decline by more than 36,000 jobs, or nearly 7 percent, to a total of 525,300 jobs; population would decline by 254,000 persons, or over 26 percent, to a total of 700,000 persons; and the number of households would decline by more than 50,000, or over 14 percent, to a total of 300,500 households.

In the three outlying counties contiguous to Milwaukee County—Ozaukee, Washington, and Waukesha Counties—population under the centralized plan would increase by nearly 37,000 persons, or about 8 percent, over the 1978 level to a total of 480,000 persons. Employment in these three counties would increase by more than 40,500 jobs, or over 29 percent, over the 1978 level to a total of 181,900 jobs in the year 2000. Under the decentralized land use plan, population in these three counties would increase by more than 161,000 persons over the 1978 level, or by 36 percent, to

Table 35

POPULATION BY COUNTY IN THE REGION: 1978 AND 2000 MODERATE GROWTH SCENARIO-CENTRALIZED AND DECENTRALIZED LAND USE PLANS

County	Total Population 1978	Centralized Plan			Decentralized Plan		
		Total Population 2000	Anticipated Change 1978-2000		Total Population 2000	Anticipated Change 1978-2000	
			Number	Percent		Number	Percent
Kenosha	126,200	174,800	48,600	38.5	202,800	76,600	60.7
Milwaukee . . .	954,100	1,049,600	95,500	10.0	898,500	- 55,600	- 5.8
Ozaukee	70,400	114,000	43,600	61.9	148,900	78,500	111.5
Racine	177,500	217,700	40,200	22.6	224,700	47,200	26.6
Walworth. . . .	69,200	99,600	30,400	43.9	106,600	37,400	54.0
Washington . .	84,100	143,000	58,900	70.0	174,500	90,400	107.5
Waukesha . . .	289,000	420,600	131,600	45.5	463,300	174,300	60.3
Region	1,770,500	2,219,300	448,800	25.3	2,219,300	448,800	25.3

Source: Wisconsin Department of Administration and SEWRPC.

Table 36

HOUSEHOLDS BY COUNTY IN THE REGION: 1975 AND 2000 MODERATE GROWTH SCENARIO-CENTRALIZED AND DECENTRALIZED LAND USE PLANS

County	Total Households 1975	Centralized Plan			Decentralized Plan		
		Total Households 2000	Anticipated Change 1975-2000		Total Households 2000	Anticipated Change 1975-2000	
			Number	Percent		Number	Percent
Kenosha	39,000	56,400	17,400	44.6	63,800	24,800	63.6
Milwaukee . . .	351,200	392,700	41,500	11.8	295,600	- 55,600	- 15.8
Ozaukee	18,000	32,500	14,500	80.6	41,700	23,700	131.7
Racine	53,400	67,800	14,400	27.0	68,100	14,700	27.5
Walworth. . . .	20,700	29,900	9,200	44.4	32,900	12,200	58.9
Washington . .	21,300	42,200	8,600	40.4	50,900	29,600	138.9
Waukesha . . .	71,900	117,900	46,000	64.0	128,100	56,200	78.2
Region	575,500	739,400	163,900	28.5	681,100	105,600	18.3

Source: SEWRPC.

Table 37

EMPLOYMENT BY COUNTY IN THE REGION: 1978 AND 2000 MODERATE GROWTH SCENARIO-CENTRALIZED AND DECENTRALIZED LAND USE PLANS

County	Total Employment 1978	Centralized Plan			Decentralized Plan		
		Total Employment 2000	Anticipated Change 1978-2000		Total Employment 2000	Anticipated Change 1978-2000	
			Number	Percent		Number	Percent
Kenosha	44,500	54,300	9,800	22.0	76,600	32,100	72.1
Milwaukee . . .	562,200	593,600	31,400	5.6	523,400	- 38,800	- 6.9
Ozaukee	23,800	38,000	14,200	59.7	53,300	29,500	123.9
Racine	74,800	95,500	20,700	27.7	94,500	19,700	26.3
Walworth. . . .	28,900	41,200	12,300	42.6	46,700	17,800	61.6
Washington . .	24,700	36,000	11,300	45.7	59,100	34,400	139.3
Waukesha . . .	92,900	157,400	64,500	69.4	162,400	69,500	74.8
Region	851,800	1,016,000	164,200	18.5	1,016,000	164,200	19.3

Source: Wisconsin Department of Industry, Labor and Human Relations and SEWRPC.

a total of 605,000 persons, and employment would increase by 65,500 jobs, or 46 percent, to a total of 206,900 jobs. Because the decentralized land use plan would accommodate the new and redistributed urban development in the Region to the year 2000 primarily at suburban population densities, the population density of the developed area of the Region under this plan would decline from a 1970 level of 4,350 persons per square mile to about 1,720 persons per square mile. Under the centralized land use plan, population density would decline to about 2,650 persons per square mile. Much of the decline in density under each plan would result from the decline in household size under the scenario. Expressed in terms of number of households per square mile, residential density in the developed urban areas of the Region will decline from 1,430 households per square mile in 1970 to 1,180 households per square mile under the centralized plan, and 690 households per square mile under the decentralized plan.

The centralized land use plan would accommodate the forecast population and employment increases in the Region through the conversion of 71,900 acres of land, or about 112 square miles, from rural to urban use from 1970 to the year 2000. The greatest amounts of increase would occur in urban medium-density residential land use, which would increase by 42,300 acres, or 114 percent, over the 1970 level; and transportation, communication, and utility land use, which would increase by 17,700 acres, or 16 percent. Overall, the plan proposes a 20 percent increase in urban land to accommodate a 40 percent increase in households. In contrast, the decentralized land use plan would require the conversion of 167,000 acres of land, or about 261 square miles, from rural to urban use, for about a 51 percent increase in urban land use. Major increases would occur in urban medium-density residential land use, which would increase by 35,500 acres, or 95 percent, over the 1970 level; suburban residential land use, which would increase by 109,300 acres, or 50 percent; and transportation, communication, and utility land use, which would increase by 34,000 acres, or 31 percent. Under the decentralized land use plan, nearly 129,000 acres of new residential development would be added to the Region, compared with 47,000 acres under the centralized plan.

SUMMARY AND CONCLUSIONS

Because of the uncertainty associated with future changes in social and economic conditions which may affect transit needs, an alternative futures approach has been used for the primary transit alternatives analysis for the Milwaukee area. The approach involved first the identification and analysis of key external factors affecting the future of the Region, and, in particular, its transit needs. The range of future prospects for these factors of energy, population lifestyles, and economic conditions was determined, and two alternative scenarios of the endpoints of this range were developed. One scenario was developed to represent a reasonably extreme optimistic future for transit in the Region, and the other was developed to represent a reasonably extreme pessimistic future. Future regional population and employment levels consistent with these two scenarios were determined, and centralized and decentralized land use plans for the two scenarios were then developed.

As shown in Table 43, these four alternative futures were intentionally chosen to span the range of logical possibilities of future change which may affect transit needs in the Region. They are not singly, or collectively, forecasts of future change in the Region. The four futures will be used to identify those alternative primary transit systems and system elements that may be expected to be viable under a wide range of future conditions in the Region, as well as to identify those alternatives which work particularly well under certain futures. The former systems and system elements are to be considered for implementation, and the latter are to be considered in terms of actions required to avoid their implementation being foreclosed in the future. From this effort, the following conclusions can be drawn with regard to future change in key external factors, regional population and economic activity, and regional land use distribution:

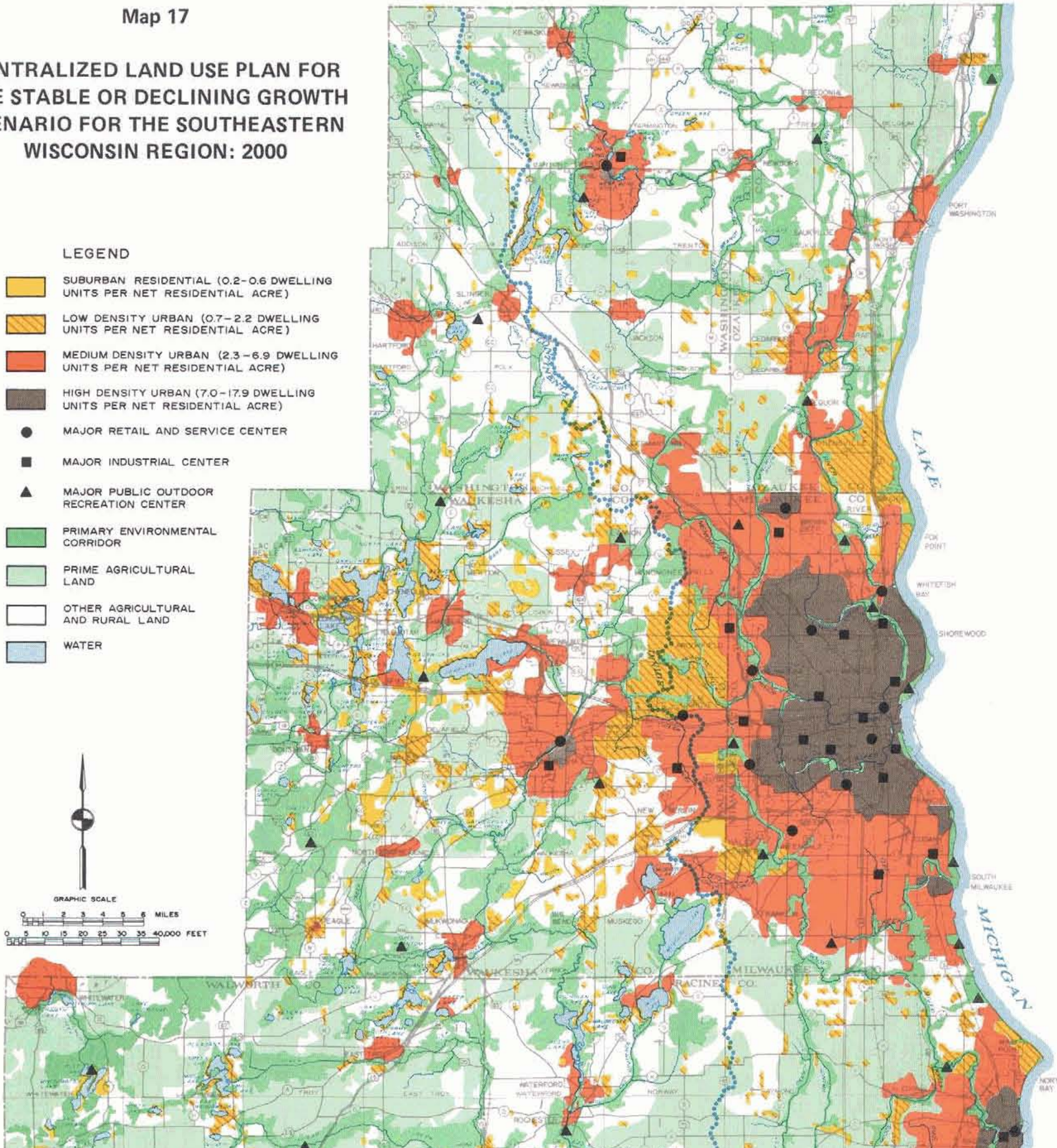
Key External Factors

As shown in Table 43, three factors external to the Region were considered as being critical to the establishment of the future range of transit needs in the Region. These three factors are energy, population lifestyles, and economic conditions.

- The cost and availability of energy may be expected to continue to be a major concern of the nation and the Region for the foreseeable future. Because of the high degree of dependency upon imported petroleum, and because of the time required to adjust demand patterns, it is likely that increases in petroleum prices will continue to occur in the future. However, whether such increases will be rapid and will occur in conjunction

Map 17

CENTRALIZED LAND USE PLAN FOR THE STABLE OR DECLINING GROWTH SCENARIO FOR THE SOUTHEASTERN WISCONSIN REGION: 2000



The centralized land use plan for the stable or declining growth scenario, like the centralized land use plan for the moderate growth scenario, represents a continuation of the historic development trends of compact medium- and high-density development which occurred within the Region prior to 1950. Under this plan, urban development is proposed to occur largely in concentric rings along the full periphery of, and outward from, existing urban centers, and at medium and high densities consistent with the provision of centralized public sanitary sewer, public water supply, and public transit services. Under the centralized land use plan, 42 percent of the new urban residential development would be located within 20 miles of the central business district of Milwaukee. Primary environmental corridors would be protected from further urban development, and the conversion of prime agricultural lands to urban uses would be minimized.

Source: SEWRPC.

Table 38

EXISTING AND PROPOSED LAND USE IN THE REGION: 1970 AND 2000 CENTRALIZED LAND USE PLAN FOR THE STABLE OR DECLINING GROWTH SCENARIO

Land Use Category	Existing 1970		Planned Increment		Total 2000	
	Acres	Percent of Major Category	Acres	Percent Change	Acres	Percent of Major Category
Urban Land Use						
Residential						
Urban High Density	24,389	7.4	1,974	8.1	26,363	6.6
Urban Medium Density	37,092	11.3	42,303	114.0	79,395	19.9
Urban Low Density	72,701	22.2	- 13,297	- 18.3	59,404	14.8
Suburban Density	22,079	6.7	15,840	71.7	37,919	9.5
Subtotal	156,261	47.6	46,820	30.0	203,081	50.8
Commercial	6,517	2.0	587	9.0	7,104	1.8
Industrial	10,038	3.1	2,304	23.0	12,342	3.1
Governmental and Institutional	16,628	5.1	801	4.8	17,429	4.4
Transportation, Communication, and Utilities[a]	109,430	33.4	17,712	16.2	127,142	31.8
Recreation	28,982[b]	8.8	3,655[c]	12.6	32,637	8.1
Urban Land Use Subtotal	327,856	100.0	71,879	21.9	399,735	100.0
Rural Land Use						
Residential	--[d]	--	--	--	--	--
Agriculture	1,040,119	74.7	- 58,439	- 5.6	981,680	74.3
Other Open Lands[e]	353,125	25.3	- 13,440	- 3.8	339,685	25.7
Rural Land Use Subtotal	1,393,244	100.0	- 71,879	- 5.2	1,321,365	100.0
Total	1,721,100	--	--	--	1,721,100	--

[a] *Includes off-street parking uses.*

[b] *Includes net site area of public and nonpublic recreation sites.*

[c] *Includes only that net site area recommended for public recreation use.*

[d] *Included in land use inventory as part of urban residential land use.*

[e] *Includes woodlands, water, wetlands, unused lands, and quarries.*

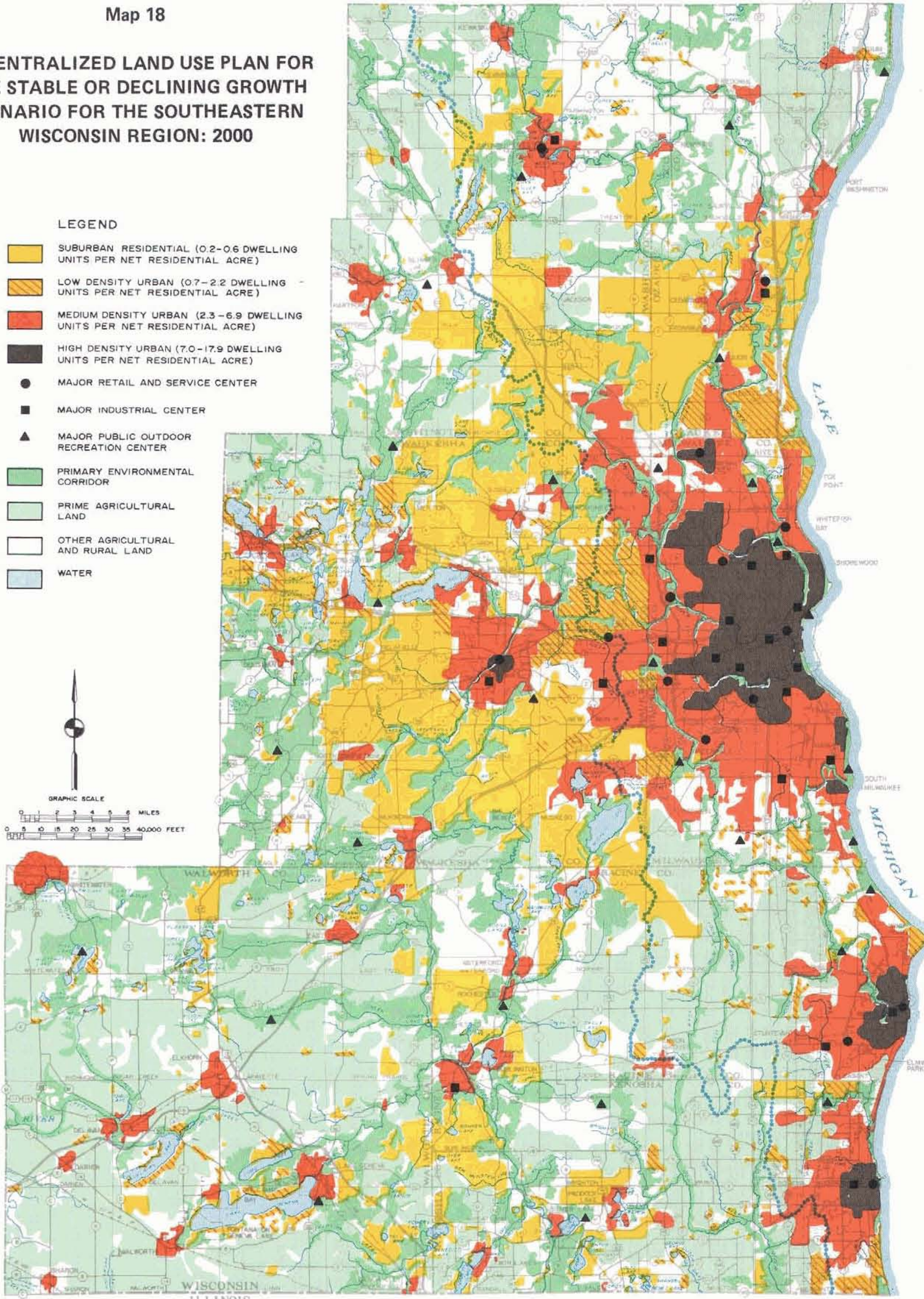
Source: SEWRPC.

with disruptions in supply is not clear. This energy situation may be expected to have a significant impact upon the need for and use of public transit through its effects upon the cost and amount of automobile travel and upon urban development patterns.

The greatest potential for a departure from past trends in energy use and a reduction in the level of dependency upon imported petroleum lies in greater efficiency in energy use and in increased conservation of energy. Major increases in the domestic production of petroleum are unlikely, as is radical technological change in energy production and usage that will lead to significant changes in overall energy consumption patterns. The price of petroleum-based motor fuels is therefore projected to increase to a level of between \$1.50 and \$2.30 per gallon by the

Map 18

DECENTRALIZED LAND USE PLAN FOR THE STABLE OR DECLINING GROWTH SCENARIO FOR THE SOUTHEASTERN WISCONSIN REGION: 2000



The decentralized land use plan for the stable or declining growth scenario, like the decentralized land use plan for the moderate growth scenario, represents a continuation of the highly diffused, low-density development trends observed within the Region since 1963. Most new urban development under this plan would take place at low densities in noncontiguous enclaves beyond existing urban centers. Under this plan, 37 percent of the new urban residential development would be within 20 miles of the central business district of Milwaukee. New urban development would not, however, be placed in the primary environmental corridors, and the conversion of prime agricultural lands to urban uses would be minimized. However, under this plan over three times as much prime agricultural land, and twice as much other agricultural land, would be converted to urban uses in the Region as would under the centralized plan for this scenario.

Source: SEWRPC.

Table 39

EXISTING AND PROPOSED LAND USE IN THE REGION: 1970 AND 2000 DECENTRALIZED LAND USE PLAN FOR THE STABLE OR DECLINING GROWTH SCENARIO

Land Use Category	Existing 1970		Planned Increment		Total 2000	
	Acres	Percent of Major Category	Acres	Percent Change	Acres	Percent of Major Category
Urban Land Use						
Residential						
Urban High Density	24,389	7.4	- 2,848	- 11.7	21,541	4.4
Urban Medium Density	37,092	11.3	35,479	95.7	72,571	14.7
Urban Low Density	72,701	22.2	- 13,371	- 18.4	59,330	12.0
Suburban Density	22,079	6.7	109,300	495.0	131,379	26.5
Subtotal	156,261	47.6	128,560	82.3	284,821	57.6
Commercial	6,517	2.0	361	5.5	6,878	1.4
Industrial	10,038	3.1	2,084	20.8	12,122	2.4
Governmental and Institutional	16,628	5.1	526	3.2	17,154	3.5
Transportation, Communication, and Utilities[a]	109,430	33.4	33,986	31.1	143,416	29.0
Recreation	28,982[b]	8.8	1,481[c]	5.1	30,463	6.1
Urban Land Use Subtotal	327,856	100.0	166,998	50.9	494,854	100.0
Rural Land Use						
Residential	--[d]	--	--	--	--	--
Agriculture	1,040,119	74.7	- 154,028	- 14.8	886,091	72.2
Other Open Lands[e]	353,125	25.3	- 12,970	- 3.7	340,155	27.8
Rural Land Use Subtotal	1,393,244	100.0	- 166,998	- 12.0	1,226,246	100.0
Total	1,721,100	--	--	--	1,721,100	--

[a] *Includes off-street parking uses.*

[b] *Includes net site area of public and nonpublic recreation sites.*

[c] *Includes only that net site area recommended for public recreation use.*

[d] *Included in land use inventory as part of urban residential land use.*

[e] *Includes woodlands, water, wetlands, unused lands, and quarries.*

Source: SEWRPC.

year 2000, as measured in constant 1979 dollars. Automobile fuel efficiency is anticipated to increase to between 27.5 and 32 miles per gallon of motor fuel.

- In recent years, the lifestyles of the residents of the nation and the Region have changed significantly. These changes have resulted in a shift from a more traditional family-oriented lifestyle to a more individualistic lifestyle, and have resulted in lower fertility rates, higher female labor force participation rates, and a reduction in average household size. The future direction of such changes is not clear at this time, since this shift may only reflect a postponement of family formation by the large portion of the regional population that is now in the traditional family formation ages.

- The major determinant of the health of the regional economy appears to be the extent to which the Region can remain competitive with other regions of the nation in preserving and expanding its economic base. Employment within the Region has histori-

Table 40

POPULATION BY COUNTY IN THE REGION: 1978 AND 2000 STABLE OR DECLINING GROWTH SCENARIO-CENTRALIZED AND DECENTRALIZED LAND USE PLANS

County	Total Population 1978	Centralized Plan			Decentralized Plan		
		Total Population 2000	Anticipated Change 1978-2000		Total Population 2000	Anticipated Change 1978-2000	
			Number	Percent		Number	Percent
Kenosha	126,200	130,000	3,800	3.0	125,000	- 1,200	- 1.0
Milwaukee . . .	954,100	830,000	- 124,100	- 13.0	700,000	- 254,100	- 26.6
Ozaukee	70,400	75,000	4,600	6.5	100,000	29,600	42.0
Racine	177,500	180,000	2,500	1.4	180,000	2,500	1.4
Walworth. . . .	69,200	70,000	800	1.2	80,000	10,800	15.6
Washington . .	84,100	95,000	10,900	13.0	115,000	30,900	36.7
Waukesha . . .	289,000	310,000	21,000	7.3	390,000	101,000	34.9
Region	1,770,500	1,690,000	- 80,500	- 4.5	1,690,000	- 80,500	- 4.5

Source: Wisconsin Department of Administration and SEWRPC.

Table 41

HOUSEHOLDS BY COUNTY IN THE REGION: 1975 AND 2000 STABLE OR DECLINING GROWTH SCENARIO-CENTRALIZED AND DECENTRALIZED LAND USE PLANS

County	Total Households 1975	Centralized Plan			Decentralized Plan		
		Total Households 2000	Anticipated Change 1975-2000		Total Households 2000	Anticipated Change 1975-2000	
			Number	Percent		Number	Percent
Kenosha	39,000	58,800	19,800	50.8	50,500	11,500	29.5
Milwaukee . . .	351,200	388,300	37,100	10.6	300,500	- 50,700	- 14.4
Ozaukee	18,000	30,700	12,700	70.6	36,500	18,500	102.8
Racine	53,400	79,300	25,900	48.5	70,700	17,300	32.4
Walworth. . . .	20,700	29,500	8,800	42.5	32,000	11,300	54.6
Washington . .	21,300	39,000	17,700	83.1	42,200	20,900	98.1
Waukesha . . .	71,900	125,000	53,100	73.9	141,200	69,300	96.4
Region	575,500	750,600	175,100	30.4	673,600	98,100	17.0

Source: SEWRPC.

Table 42

EMPLOYMENT BY COUNTY IN THE REGION: 1978 AND 2000 STABLE OR DECLINING GROWTH SCENARIO-CENTRALIZED AND DECENTRALIZED LAND USE PLANS

County	Total Employment 1978	Centralized Plan			Decentralized Plan		
		Total Employment 2000	Anticipated Change 1978-2000		Total Employment 2000	Anticipated Change 1978-2000	
			Number	Percent		Number	Percent
Kenosha	44,500	43,200	- 1,300	- 2.9	43,200	- 1,300	- 2.9
Milwaukee . . .	562,200	552,300	- 9,900	- 1.8	525,300	- 36,900	- 6.6
Ozaukee	23,800	29,300	5,500	23.1	37,300	13,500	56.7
Racine	74,800	78,400	3,600	4.8	78,400	3,600	4.8
Walworth. . . .	28,900	31,200	2,300	8.0	33,200	4,300	14.9
Washington . .	24,700	28,500	3,800	15.4	33,500	8,800	35.6
Waukesha . . .	92,900	124,100	31,200	33.6	136,100	43,200	46.5
Region	851,800	887,000	35,200	4.1	887,000	35,400	4.1

Source: Wisconsin Department of Industry, Labor and Human Relations; and SEWRPC.

Table 43

ALTERNATIVE FUTURES

Key External Factor	Moderate Growth Scenario	Stable or Declining Growth Scenario
Energy		
The future cost and availability of energy, particularly of petroleum	Oil price to converge with world oil price, which will increase at 5 percent annual rate to $72 per barrel in the year 2000 (1979 dollars) Petroleum-based motor fuel to increase to $2.30 per gallon by the year 2000 (1979 dollars) Assumes some potential for major and continuing disruptions in oil supply	Oil price to converge with world oil price, which will increase at 2 percent annual rate to $39 per barrel in the year 2000 (1979 dollars) Petroleum-based motor fuel to increase to $1.50 per gallon by the year 2000 (1979 dollars) Assumes no major or continued disruptions in oil supply
The degree to which energy conservation measures are implemented, particularly with respect to the automobile	Low degree of conservation in all sectors, resulting in increase in energy use of 3 percent Automobile fuel efficiency of 27.5 miles per gallon	High degree of conservation in all sectors, resulting in increase in energy use of 2 percent or less Automobile fuel efficiency of 32 miles per gallon
Population Lifestyles		
The degree to which the changing role of women affects the composition of the labor force	Female labor force increases to 50 to 55 percent and total labor force participation is 60 to 65 percent	Female labor force increases to 65 to 70 percent and total labor force participation is 70 to 75 percent
The future change in fertility rates	A continuation of below-replacement-level fertility rates during the next decade, followed by an increase to replacement level by the year 2000	A continuation of below-replacement-level fertility rates to the year 2000
The future change in household sizes	Average household size stabilizes	Average household size continues to decline
Economic Conditions		
The degree to which the Region will be able to compete with other areas of the nation for the preservation and expansion of its economic base	Region is considered to have relatively high attractiveness and competitiveness	Region is considered to have relatively low attractiveness and competitiveness
The future change of real income	Per capita and household income increase envisioned as a result of the attractiveness and competitiveness of Region, an increased proportion of the population being of work force age, and increased population labor force participation	Per capita increase likely but no household income increase envisioned as a result of the lack of attractiveness and competitiveness of Region, but increased proportion of the population is of work force age, and there is increased population labor force participation

Attendant Regional Change	Moderate Growth Scenario	Stable or Declining Growth Scenario
Population of the Region in Year 2000		
Size	2,219,300 persons	1,688,400 persons
Age Distribution	29.2 percent—0-19 years of age 58.5 percent—20-64 years of age 12.3 percent—65 years of age or older	26.8 percent—0-19 years of age 60.6 percent—20-64 years of age 12.6 percent—65 years of age or older
Number of Households	681,100 to 739,400	673,600 to 750,600
Household Size	Average of 2.9 to 3.1 persons	Average of 2.2 to 2.5 persons
Economic Activity of Region in Year 2000		
Employment	1,016,000 jobs	887,000 jobs
Structure	Manufacturing. . . . 32 percent Services. . . . . 40 percent Other . . . . 28 percent	Manufacturing. . . . 30 percent Services. . . . . 41 percent Other . . . . 29 percent
Personal Income	$29,600 to $32,000 per household in 1979 dollars (38 to 50 percent increase over 1970, or a 1.1 to 1.4 percent annual rate of increase) $10,000 per capita in 1979 dollars (54 percent increase over 1970, or a 1.4 percent annual rate of increase)	$21,400 to $23,700 per household in 1979 dollars (0 to 11 percent increase over 1970, or a 0.0 to 0.3 percent annual rate of increase) $9,500 per capita in 1979 dollars (46 percent increase over 1970, or a 1.3 percent annual rate of increase)

Table 43 (continued)

Land Use Plan Characteristics	Moderate Growth Scenario		Stable or Declining Growth Scenario	
	Centralized Plan	Decentralized Plan	Centralized Plan	Decentralized Plan
Urban Growth and Density				
New Urban Residential Land	Occurs primarily at medium residential densities along the periphery of, and outward from, existing urban centers	Occurs primarily at suburban residential densities in a diffused pattern in areas proximate to, and removed from, existing urban centers	Occurs primarily at medium residential densities along the periphery of, and outward from, existing urban centers	Occurs primarily at suburban residential densities in a diffused pattern in areas proximate to, and removed from, existing urban centers
Urban Density	Existing developed portions of Milwaukee County generally maintain residential density existing in 1970	Existing developed portions of Milwaukee may decrease in residential density between 1970 and 2000	Existing developed portions of Milwaukee County generally maintain residential density existing in 1970	Existing developed portions of Milwaukee may decrease in residential density between 1970 and 2000
Population Distribution				
Milwaukee County	1,049,600 persons	898,500 persons	830,000 persons	700,000 persons
Percent Change from 1970	- 0.4	- 14.8	- 21.3	- 33.6
Percent Change from 1978	10.0	- 5.8	- 13.0	- 26.6
Outlying Counties (Ozaukee, Washington, Waukesha)	677,600 persons	786,700 persons	480,000 persons	605,000 persons
Percent Change from 1970	93.8	125.0	37.2	73.1
Percent Change from 1978	52.8	77.4	8.2	36.4
Employment Distribution				
Milwaukee County	593,600 jobs	523,400 jobs	552,300 jobs	525,300 jobs
Percent Change from 1970	16.2	2.4	8.1	2.8
Percent Change from 1978	5.6	- 6.9	- 1.8	- 6.6
Outlying Counties (Ozaukee, Washington, Waukesha)	231,400 jobs	274,800 jobs	181,900 jobs	206,900 jobs
Percent Change from 1970	119.5	160.7	72.6	96.3
Percent Change from 1978	63.6	94.3	28.6	46.3

Source: SEWRPC.

cally increased steadily and considerably—from 552,700 jobs in 1950, to 647,900 jobs in 1960, to 741,600 jobs in 1970, and to 835,100 jobs in 1977. Manufacturing employment in the Region, however, has declined since its peak of 276,600 jobs in 1960 to 246,800 jobs in 1977. Manufacturing employment within the United States has continued to increase since 1960, and the increase in the total employment rate of the nation has been greater than that of the Region since 1960—a 2.3 percent annual rate in the nation compared with a 1.5 percent annual rate in the Region.

Two scenarios linking opposite endpoints of these external factors were developed. The scenarios were developed to provide extreme, but yet reasonable, futures with regard to transit need and use in the Region.

- As shown in Table 43, the moderate growth scenario represents the future change in the key external factors that would create the most optimistic future for transit need and use within the Region. This scenario postulates a severe energy situation and an attendant significant increase in the cost of automobile travel; a stabilization of lifestyle trends with relatively small increases in female labor force participation; a return of replacement-level fertility rates and a stabilization of household size; and a competitive and attractive economic base in the Region which, when combined with the population lifestyles postulated under this scenario, will result in little net population in- or out-migration.

- As shown in Table 43, the stable or declining growth scenario represents the future change in the key external factors that would create the most pessimistic future for transit need and use within the Region. This scenario postulates a moderately severe energy situation accompanied by successful conservation efforts and a slight decrease in the cost of automobile travel; a continuation of the trend toward individualistic population lifestyles and an attendant decline in household size; a significantly higher female labor force participation rate, and continued below-replacement-level fertility rates; and a declining economy in the Region leading to only stable employment levels and, when combined with the population lifestyles envisioned under this scenario, substantial population out-migration.

Attendant Regional Change

The level of regional change in population and economic activity consistent with each scenario was determined.

- Under the moderate growth scenario, the level of employment in the Region will increase to 1,016,000 jobs, or 19 percent over the 1978 level. Manufacturing employment will increase by 62,500 jobs, or 24 percent; services employment will increase by 53,200 jobs, or 15 percent; and all other employment will increase by 48,500 jobs, or 20 percent. The population of the Region will increase by 448,800 persons, or 35 percent over the 1978 level of 1,770,500 persons. The average household size in the Region is anticipated to be between 2.9 and 3.1 persons; as a result, the number of households in the Region is envisioned to increase from the 1975 level of 575,500 households to between 681,000 and 739,000 households. Increases in household income will be modest, ranging from a real 1.1 to 1.4 percent annual rate of increase.

- Under the stable or declining growth scenario, the level of employment in the Region will not change significantly from the existing level of 851,800 jobs, increasing only to 887,000 jobs. Manufacturing employment will increase by 8,500 jobs, or 3 percent; services employment will increase by 7,500 jobs, or 2 percent; and all other employment will increase by 19,200 jobs, or 8 percent. The population of the Region will decline by 4 percent under this scenario—from 1,770,500 persons in 1978 to 1,690,000 persons in the year 2000. Because average household size will continue to decline in the Region to between 2.2 and 2.5 persons under this scenario, the number of households in the Region will increase to between 674,000 and 751,000 households. Increases in household income will range from no real increase to just over a 0.3 percent annual rate of increase.

Land Use Plans

Two land use plans were developed for each scenario. The plans, one representing a centralized land use distribution and the other a decentralized land use distribution, were developed to encompass the reasonable range of future land use patterns which could influence transit needs under each scenario.

- The centralized land use plan developed for the moderate growth scenario is the most optimistic of the four futures for transit use. Under this plan, occupied housing unit densities within Milwaukee County attain at least the same densities as in 1970, when Milwaukee County population reached its recorded peak. New urban residential growth occurs at medium densities along the full periphery of and outward from existing urban centers, consistent with the provision of economical transit service. The Milwaukee County population increases by 10 percent over the 1978 level to a total of 1,049,600 persons, while its employment increases by 6 percent to 593,600 jobs. Population in the outlying counties of Ozaukee, Washington, and Waukesha continues to grow rapidly, and increases 53 percent over the 1978 level to 677,600 persons, and employment in these areas increases by 63 percent to 231,400 jobs. These increases in population and employment activity are accommodated by the conversion of about 113 square miles of land from rural to urban use between 1970 and the year 2000, or an increase of 20 percent in urban land.

- Under the decentralized land use plan for the moderate growth scenario, housing unit density levels in Milwaukee County decline from 1970 levels, as do urban population density levels in the Region. A significant portion of new urban residential growth occurs in a diffused pattern at suburban densities in noncontiguous enclaves removed from existing urban centers. Under such a future, the Milwaukee County population declines by 5 percent to 898,500 persons, and employment declines by 6 percent to 523,400 jobs from 1970 levels. Population in the three counties outlying Milwaukee County increases by 78 percent between 1978 and the year 2000 to 786,700 persons, and employment increases by 94 percent to 274,800 jobs. Because of the low densities at which new development occurs, future population and employment growth require the conversion of 234 square miles of land from rural to urban use between 1970 and the year 2000, or over a 45 percent increase in urban land.

- Under the centralized land use plan for the stable or declining growth scenario, the Region's population will be redistributed such that housing unit densities in Milwaukee County are maintained at 1970 levels. In addition, new urban growth will occur at medium densities along the full periphery of, and outward from, existing urban areas. Nevertheless, the Milwaukee County population will still decline under this plan by 13 percent from the 1978 level to a total of 830,000 persons. Employment in Milwaukee County will increase by 2 percent to 552,000 jobs. The number of households in Milwaukee County will increase by 37,000, or 11 percent, over the 1975 level. The population in the outlying counties of Ozaukee, Washington, and Waukesha will continue to grow, increasing by 8 percent over the 1978 level to 480,000 persons, and employment in these Counties will increase by 29 percent to 181,900 jobs. The increases in population and employment activity will be accommodated by the conversion of about 112 square miles of land from rural to urban use between 1970 and 2000, or an increase of 20 percent in urban land.

- The decentralized land use plan for the stable or declining growth scenario is the most pessimistic future for transit use. Under this plan, the population of the Region will be redistributed such that housing unit densities in Milwaukee County decline significantly from 1970 levels. New urban growth will occur in a highly diffused pattern at suburban densities in noncontiguous enclaves removed from existing urban centers. Under such a future, the Milwaukee County population will decline by 27 percent to 700,000 persons, and employment will decline by 7 percent to 36,900 jobs from 1978 levels, while population in the three counties outlying Milwaukee County will increase by 36 percent to 605,000 persons, and employment will increase by 46 percent to 206,900 jobs. Because of the low densities at which new development will occur under this plan, future population and employment growth will require the conversion of 261 square miles of land from rural to urban use between 1970 and the year 2000, or about a 51 percent increase in urban land.

Chapter VI

ALTERNATIVE PLAN PREPARATION, TEST, AND EVALUATION

INTRODUCTION

The design, test, and evaluation of alternative transit system plans, and the synthesis of recommendations for transit system development from such design, test, and evaluation, are perhaps the most critical steps in any transit system planning effort. It is in these steps that the degree to which agreed-upon transit system development objectives can be met by alternative transit system plans is determined and compared, and the recommendations for adoption and implementation of the plan which best meets the objectives are prepared.

The design, test, and comparative evaluation of alternative transit system plans was more extensive and complex, and the formulation of recommendations was more difficult, under this primary transit systems alternatives analysis than under most transportation planning studies. This was because this analysis was based not upon a single forecast of probable future conditions, but rather upon a number of alternative futures carefully selected to represent the range of future conditions affecting transit needs and use which may be reasonably expected to occur within the Region over the plan design period. Under this approach, the performance of alternative transit system plans was evaluated under four sets of future conditions. This was done so that those primary transit alternatives that performed well under a wide range of future conditions could be identified and differentiated from those alternatives that performed well under only a few or a single set of future conditions. In this way, a "robust" primary transit system plan could be formulated which may be expected to remain viable under greatly varying future development conditions within the Region. The four alternative futures under which alternative transit system plans were tested and evaluated were summarized in Chapter V of this report.

This chapter provides a summary of the design and test of alternative primary transit system plans under these four alternative futures, and documents the key findings of the evaluation and comparison of these alternative plans with respect to the anticipated attainment of the adopted transit system development objectives. Based on that comparative evaluation, recommendations for primary transit system development for the Milwaukee area are set forth. The process by which the alternative plans were designed, tested, and evaluated, as well as the attendant key fundings and conclusions, are documented in greater detail in SEWRPC Technical Report No. 26, Milwaukee Area Alternative Primary Transit System Plan Preparation, Test, and Evaluation.

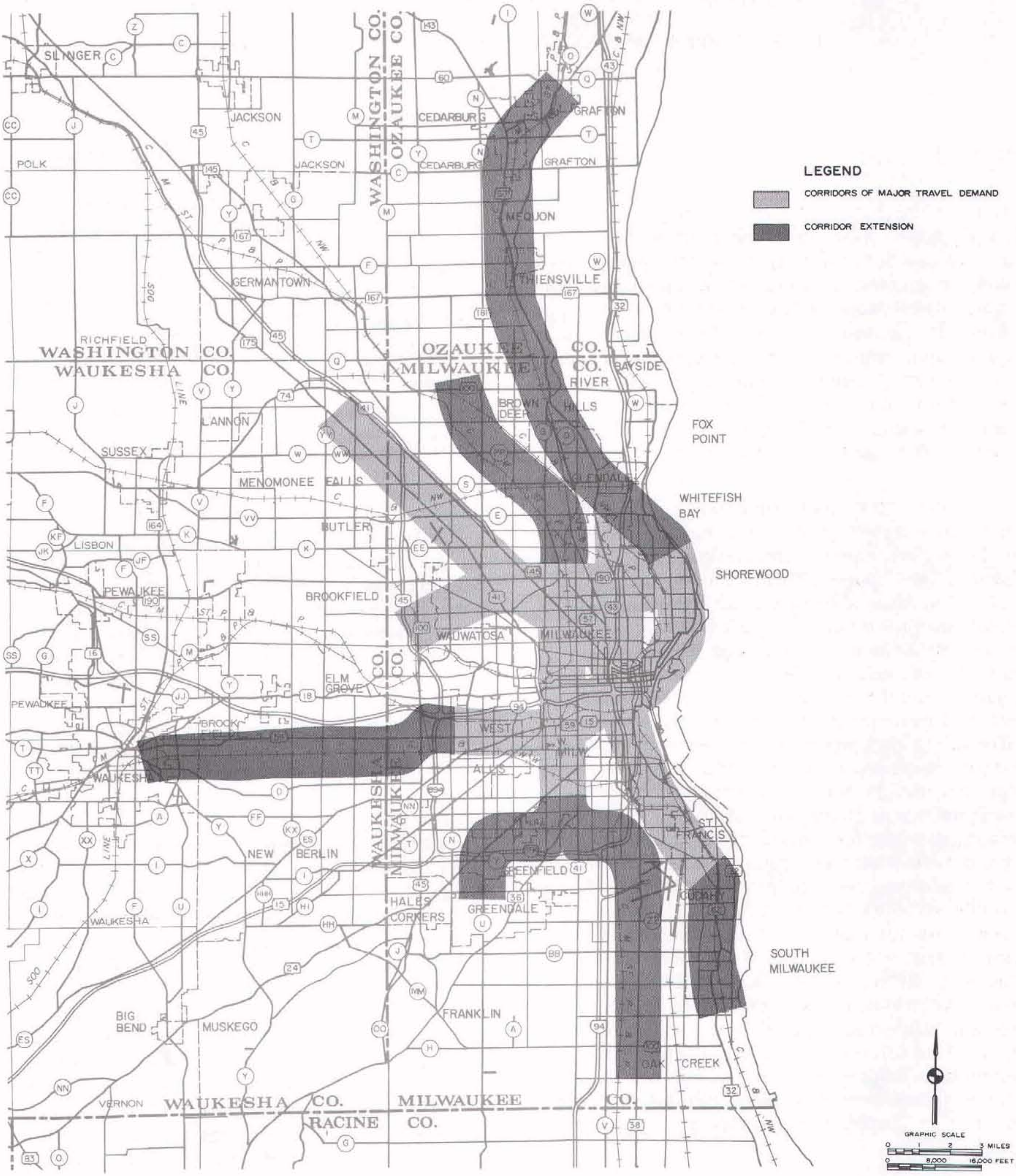
DESIGN OF ALTERNATIVE PRIMARY TRANSIT SYSTEM PLANS

In order to ensure that no primary transit technology option was overlooked in the study, the alternative primary transit system plans were initially designed and tested for all primary transit technologies determined to be proven and available for application in the Milwaukee area over the next two decades. As described in Chapter IV of this report, five alternative primary transit modes were found to have potential for such application, and therefore to warrant the preparation of plans under this study: 1) motor bus operation on freeways, 2) motor bus operation on busways, 3) light rail transit, 4) heavy rail rapid transit, and 5) commuter rail.

In order to ensure that the potential for primary transit service to be provided to any part of the greater Milwaukee area was not overlooked under the study, maximum extent alternative system plans were initially designed for each of these five primary transit modes which served all corridors of major travel demand and which made extensive use of available facilities and rights-of-way for primary transit use. The corridors of major travel demand as shown on Map 19, were defined by considering the locations of existing and proposed regional activity centers, probable future concentrations of travel desire lines, probable future concentrations of arterial streets with heavy traffic volumes and congestion, and existing heavily used transit routes. The available facilities and rights-of-way considered in this maximum extent system plan design included freeways and their medians, shoulders, and nonroadway rights-of-way; active and abandoned railways and associated rights-of-

Map 19

CORRIDORS OF MAJOR TRAVEL DEMAND IN THE MILWAUKEE AREA



For primary transit system planning purposes, a network of seven corridors of major travel demand was identified in the Milwaukee area. In addition, a set of six corridor extensions was identified which extends the reach of five of the seven corridors into outlying areas of the Region. These extensions have been included in the network of major corridors of travel demand because of the availability of at least one right-of-way in the corridor that offers a potential opportunity for fixed guideway development at a minimum of cost and disruption. Such corridor extensions permit the maximum network to reach the Village of Grafton to the north, the Granville area of the City of Milwaukee to the northwest, the City of Waukesha to the west, the Village of Greendale to the southwest, and the Cities of Oak Creek and South Milwaukee to the south.

Source: SEWRPC.

way; former electric interurban and street railway rights-of-way; and the medians and parking lanes of arterial streets having at least three lanes in each direction.

The resultant maximum extent networks of potential corridors for each alternative primary transit mode were developed into system plans in sufficient detail to permit test and evaluation by application of travel and traffic simulation models. For each alternative network, both physical and operational configurations were prepared. The design of the physical configuration involved selecting specific alignments for each alternative primary transit mode from among the available facility and right-of-way options in each potential maximum extent corridor. The design of the operational plan involved identifying routes, stops, and stations for each mode on each of the selected alignments.

The resultant maximum extent system plans for bus on freeway, light rail transit and busway, heavy rail rapid transit, and commuter rail in the Milwaukee area are shown on Maps 20, 21, 22, and 23. Map 24 shows the status quo or base plan which was used in the study as a benchmark against which the performance of the alternative plans could be measured.

Base Plan

The base plan envisions no long-range primary transit improvement in the Milwaukee area. It is comprised of the existing Milwaukee area transit system, and of those short-range improvements to that system recommended in the Milwaukee County five-year transit development program adopted by the Milwaukee County Board in September 1980. It should be noted that reevaluation of this adopted plan began in 1981, with the other alternative plans being considered proposing fewer facilities and services. Primary transit service under the base plan would be provided by conventional motor buses—possibly supplemented by articulated motor buses—operating nonstop over existing freeways in mixed traffic on routes between outlying park-ride lots and the Milwaukee central business district. A total of 16 such primary transit routes with a combined length of 449 miles and with 20 stations would be provided under the base plan, with only a single route providing service outside Milwaukee County.[1] Under the range of future conditions tested, average speeds on the routes would range from 19 to 24 miles per hour (mph), and service headways would range from 5 to 30 minutes during the peak periods. No evening off-peak-period bus-on-freeway service would be provided, and midday off-peak-period bus-on-freeway service would be limited to one route with headways ranging from 15 to 30 minutes. The service area of the supporting local transit system would be limited to Milwaukee County, and seven secondary, or limited-stop express, bus routes with a combined length of about 300 route miles would be provided to supplement the high-speed primary transit service. The tertiary, or local, transit system would consist of 43 routes having a combined length of about 1,000 route miles. Under the range of future conditions tested, the base plan would entail the provision of between 59,300 and 94,800 bus miles of transit service on an average weekday, requiring a fleet of between 576 and 900 buses. Under the base plan, the current fares are assumed to increase with general price inflation. The fare would thus remain at $0.50 per ride, expressed in constant 1979 dollars, for local and express bus service. The primary service fare would remain at $0.60 within Milwaukee County, and would increase with distance from Milwaukee County to $1.25 from the City of Waukesha—the limit of primary service under the base plan.

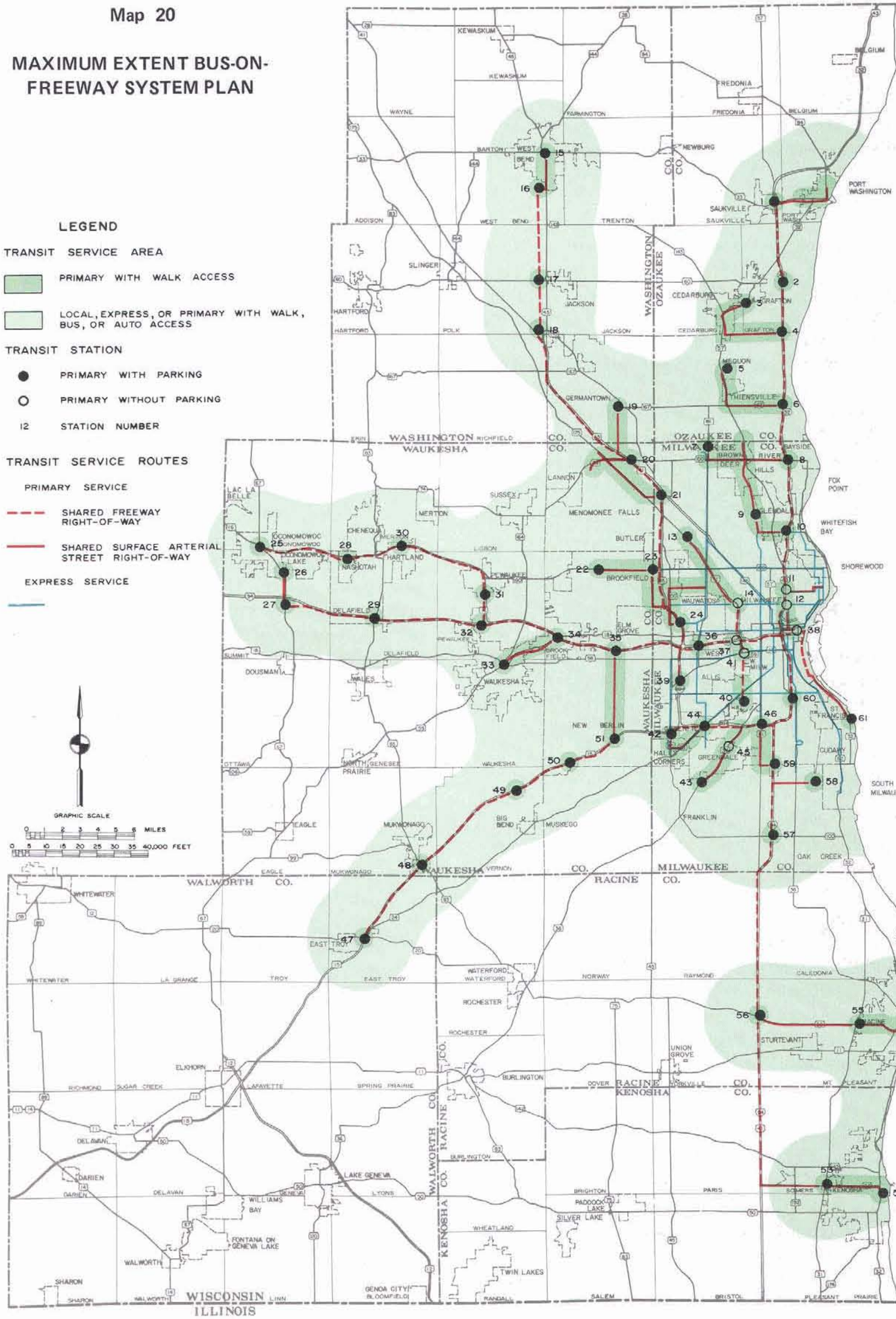
Maximum Extent Fixed Guideway Plans—Light Rail Transit, Busway, and Heavy Rail Rapid Transit

The maximum extent light rail transit, busway, and heavy rail rapid transit system plans would provide primary transit service throughout Milwaukee

[1] *During the design, test, and evaluation of rapid transit alternatives for the Milwaukee area, transit service was extended from Milwaukee County into Waukesha County on seven routes. Four of these routes provided bus-on-freeway service from the Milwaukee central business district to the communities of Menomonee Falls, Brookfield, Oconomowoc, and Mukwonago in Waukesha County. The remaining three routes were extensions of existing local routes operated by the Milwaukee County Transit System, extending service over W. Blue Mound Road to the Brookfield Square Shopping Center, over N. 124th Street to the Village of Butler in Waukesha County, and over W. Greenfield Avenue and Moorland Road to the New Berlin Industrial Park. Local transit service was also initiated on 10 routes in the City of Waukesha. After six months, service to the Village of Butler was terminated, and after seven months, service to the New Berlin Industrial Park was terminated because of insufficient ridership.*

Map 20

MAXIMUM EXTENT BUS-ON-FREEWAY SYSTEM PLAN



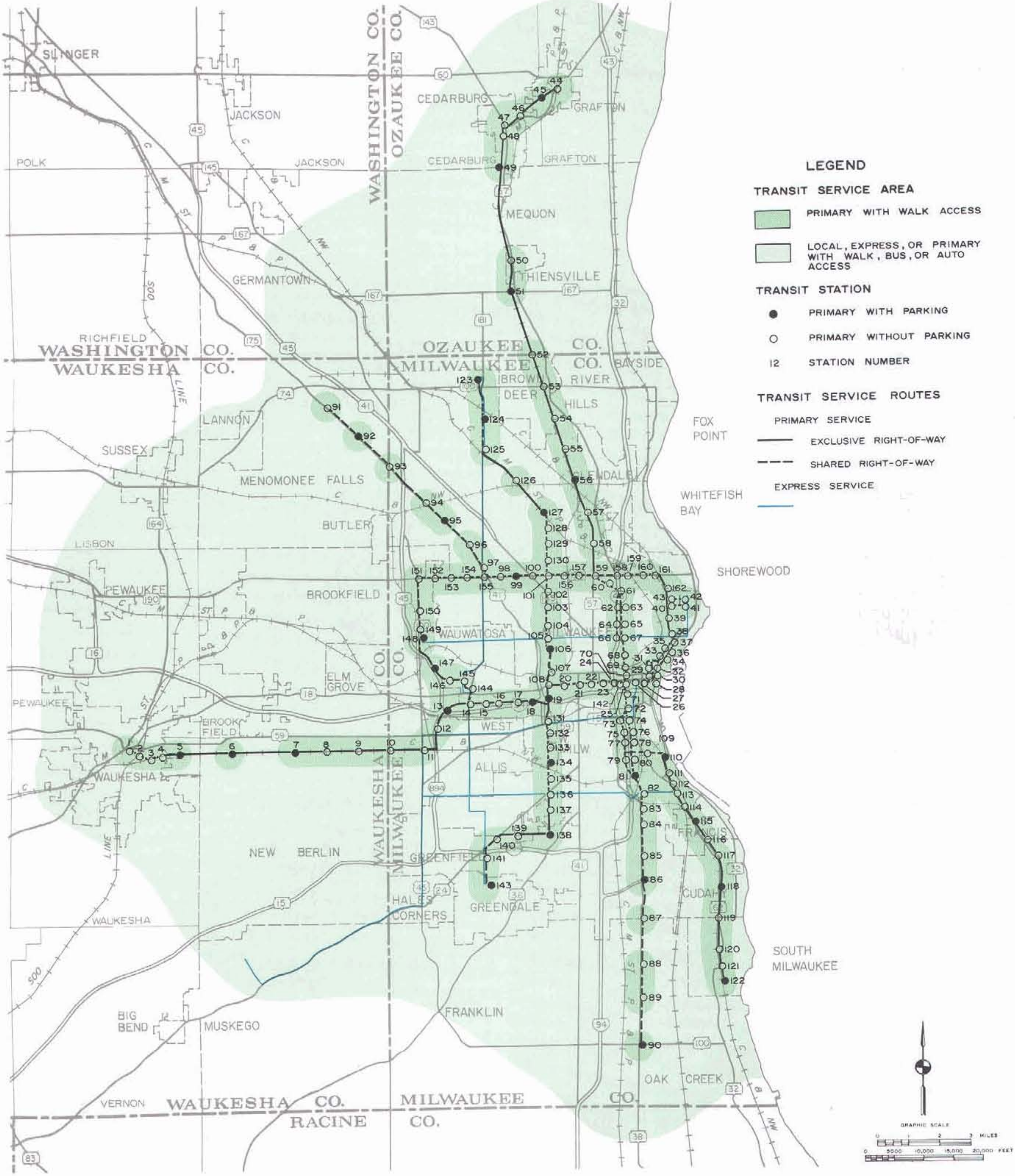
The bus-on-freeway maximum extent system plan would provide for a significant expansion of the existing primary transit service in the Milwaukee area. Under this plan, bus-on-freeway service would be increased within Milwaukee County, and would be extended well beyond existing and future limits of the Milwaukee urbanized area. Also, all bus-on-freeway service under the maximum extent plan would be provided throughout the day, including midday and evening time periods, and would be operated at headways of no more than 30 minutes in the peak direction during peak periods and 60 minutes otherwise. Altogether, 31 bus-on-freeway routes, totaling 1,218 miles in length and using 61 primary transit stations, would be operated under this maximum extent plan. This compares with the 11 bus-on-freeway routes operated in 1980 during peak periods from only 19 primary transit stations. The 31 bus-on-freeway routes would be operated using high-capacity, articulated buses over existing and proposed freeways between outlying park-ride lots and the Milwaukee central business district (CBD). Most of these routes would have a limited number of intermediate stops which would connect with feeder/distributor express and local bus service in order to permit access to major travel generators other than the Milwaukee CBD.

The maximum extent bus-on-freeway system plan also provides for complementary expansion and improvement of the Milwaukee area express and local transit system. Nine additional express or limited stop routes would be provided, and the local transit system would be extended into all contiguous areas of urban development, including all of northern and most of southern Milwaukee County, southern Ozaukee County, southeastern Washington County, and eastern Waukesha County.

Source: SEWRPC.

Map 21

MAXIMUM EXTENT LIGHT RAIL TRANSIT AND BUSWAY SYSTEM PLANS

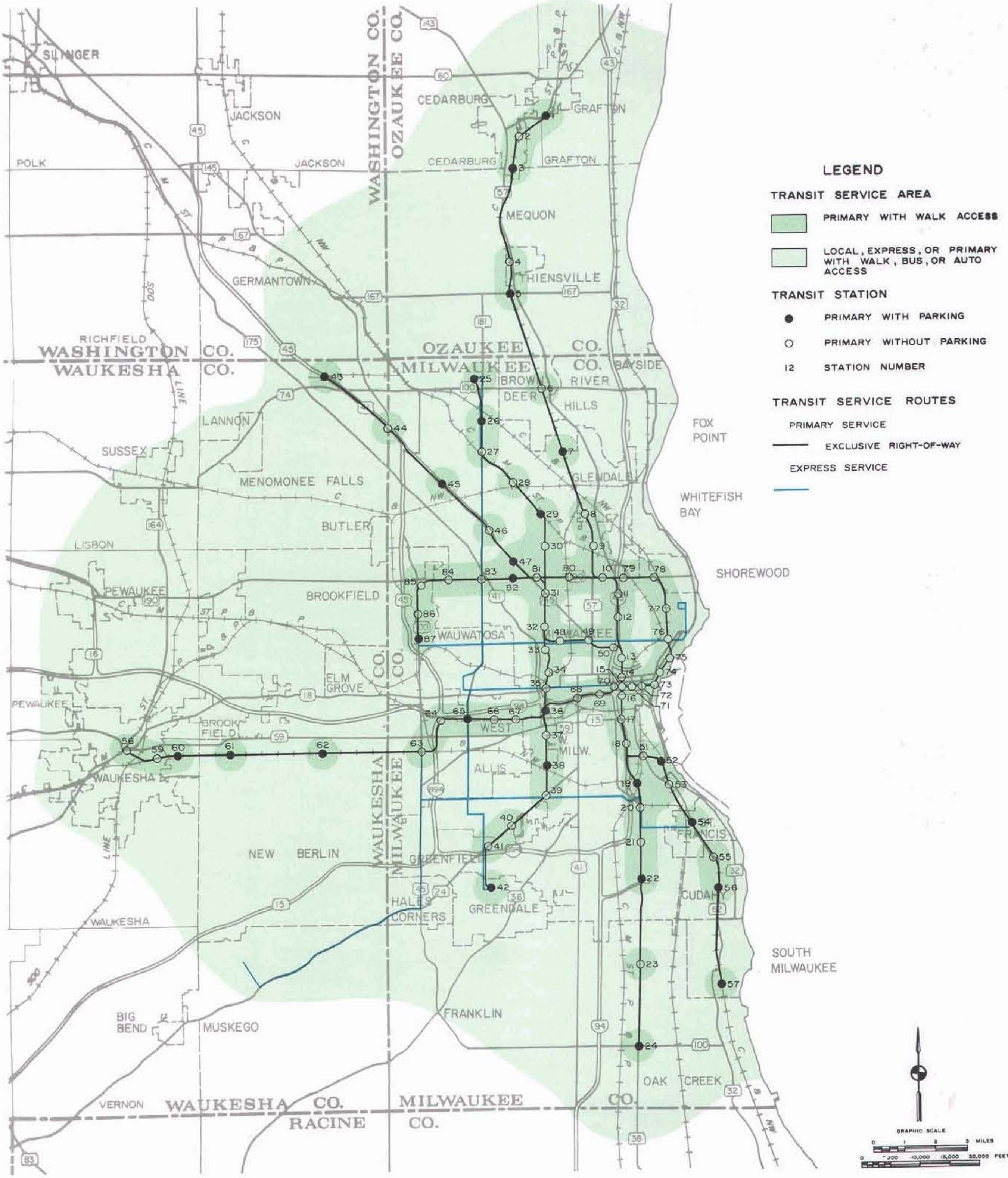


The maximum extent light rail transit system plan would significantly improve and expand primary transit service in the Milwaukee area. Under this plan, primary transit service would be improved within Milwaukee County, and would be extended outside Milwaukee County within the future limits of the Milwaukee urbanized area. All light rail transit service under the maximum extent plan would be provided throughout the day, including midday and evening time periods, and would be operated at headways of from 7 to 20 minutes during peak periods and from 10 to 20 minutes during off-peak periods. In all, five light rail transit routes totaling 255 miles in length and serving 162 primary transit stops or stations would be operated under this maximum extent plan. This compares with the 11 bus-on-freeway routes which operated in 1980 during peak periods only between 19 outlying primary transit stations and the Milwaukee central business district. The five light rail transit routes would be operated using electrically propelled, bidirectional, articulated light rail vehicles. The maximum extent light rail transit system plan also provides for complementary expansion and improvement of the Milwaukee area express and local transit system. Five express or limited stop routes would be provided, and the local transit system would be extended into all contiguous areas of urban development, including all of northern and most of southern Milwaukee County, southern Ozaukee County, southeastern Washington County, and eastern Waukesha County.

Source: SEWRPC.

Map 22

MAXIMUM EXTENT HEAVY RAIL RAPID TRANSIT SYSTEM PLAN



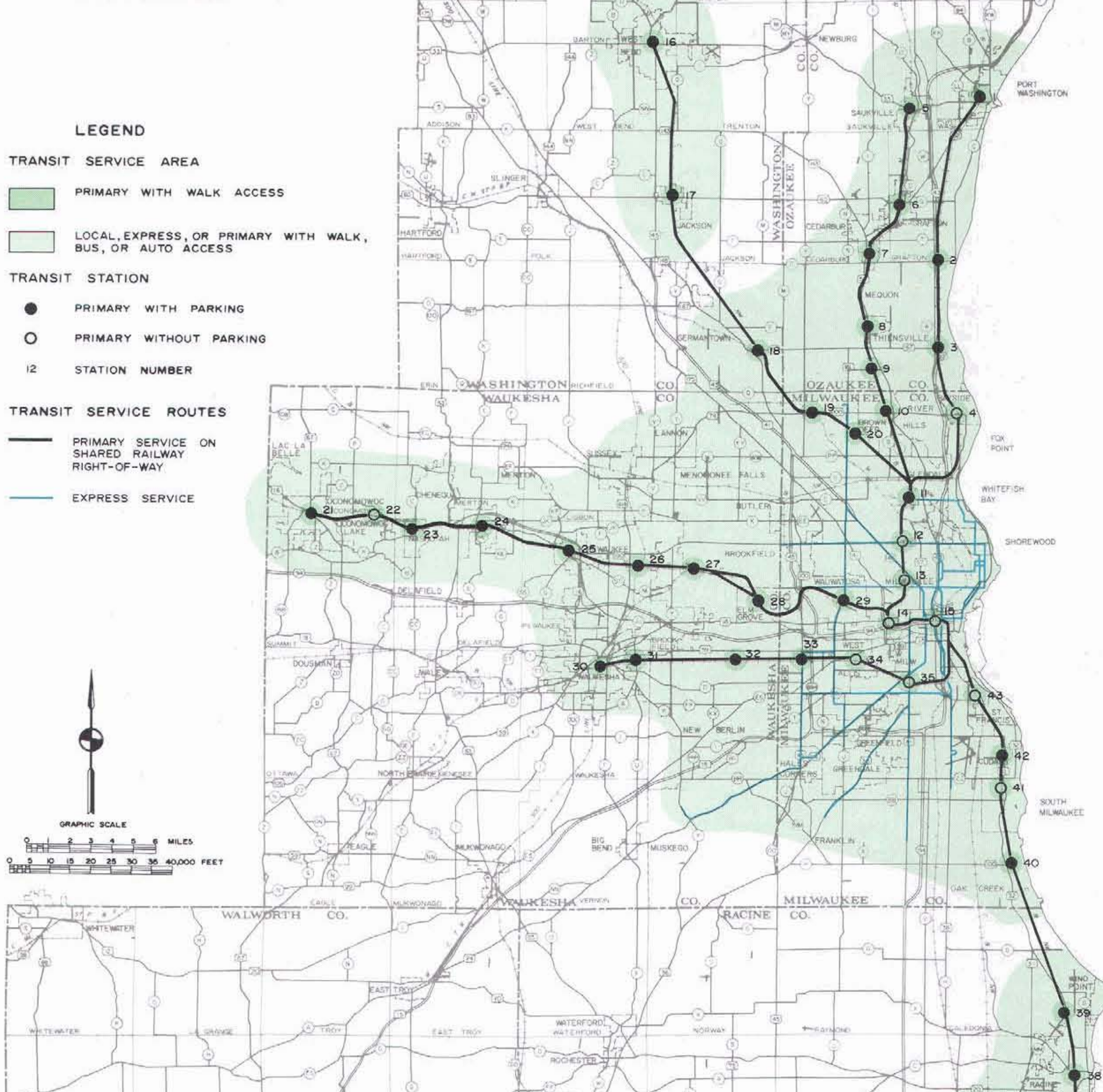
The maximum extent heavy rail rapid transit system plan would provide a significant improvement in and expansion of primary transit service in the Milwaukee area. Under this plan, primary transit service would be improved within Milwaukee County, and would be extended outside Milwaukee County within the future limits of the Milwaukee urbanized area. All heavy rail rapid transit service under the maximum extent plan would be provided throughout the day, including midday and evening time periods, and would be operated at headways of from 10 to 30 minutes during peak periods and from 30 to 45 minutes during off-peak periods. In all, four heavy rail rapid transit routes totaling 215 miles in length and serving 87 primary transit stops or stations would be operated under the maximum extent plan. This compares with the 11 bus-on-freeway routes which operated in 1980 during peak periods only between 19 outlying primary transit stations and the Milwaukee central business district. The four heavy rail rapid transit routes would be operated using electrically propelled vehicles semi-permanently coupled into two-car units.

The maximum extent heavy rail rapid transit system plan also provides for complementary expansion and improvement of the Milwaukee area express and local transit system. Five express or limited-stop routes would be provided, and the local transit system would be extended into all contiguous areas of urban development, including all of northern and most of southern Milwaukee County, southern Ozaukee County, southeastern Washington County, and western Waukesha County.

Source: SEWRPC.

Map 23

MAXIMUM EXTENT COMMUTER RAIL SYSTEM PLAN



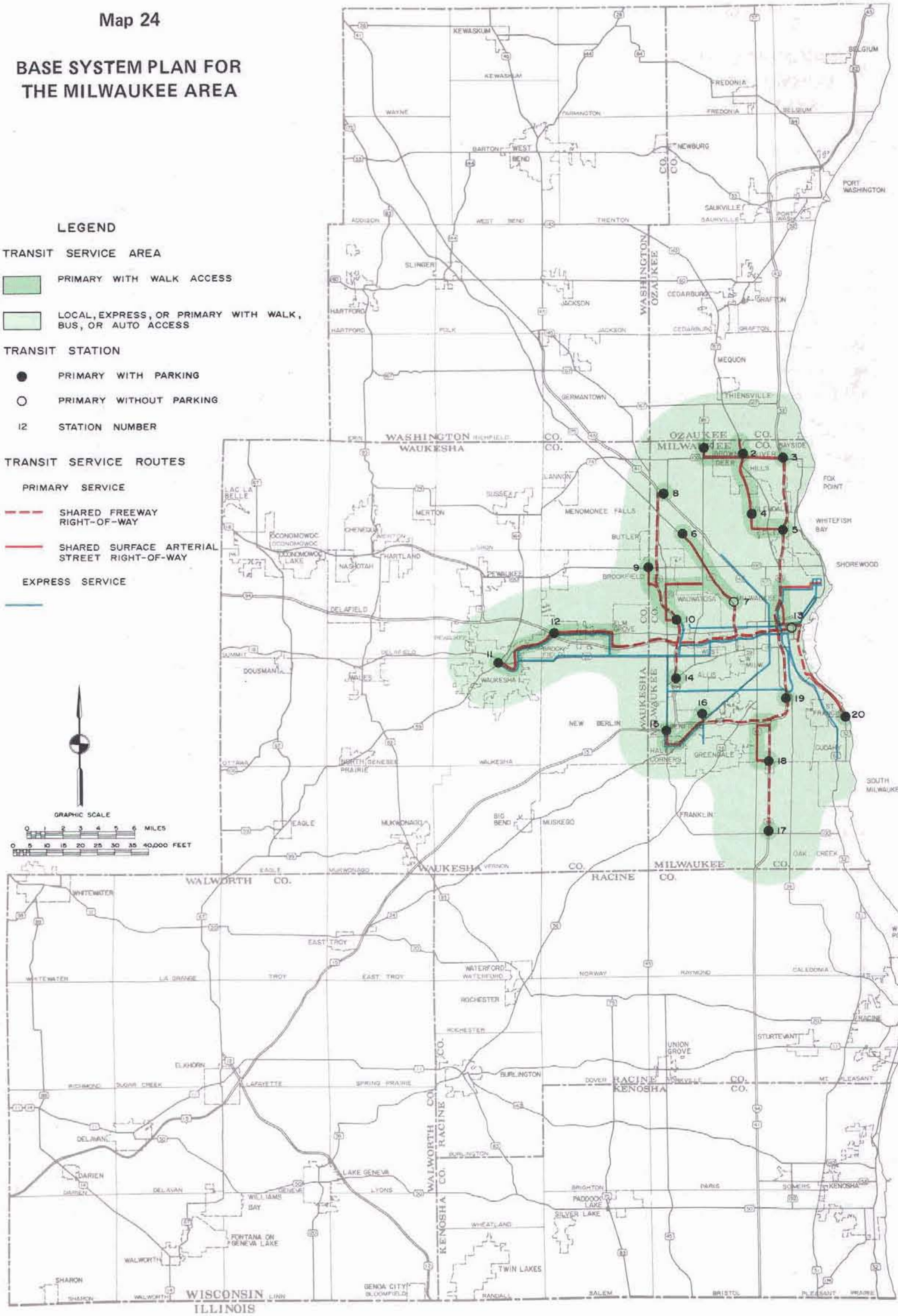
The maximum extent commuter rail system plan would provide a significant expansion of primary transit service outside Milwaukee County, but not within Milwaukee County. Under the maximum extent commuter rail plan, primary transit service would be provided by passenger trains on six railway routes emanating from the Milwaukee central business district which have largely double-track mainline railway trackage, and which extend to other major travel generators. The commuter rail service would operate throughout the day. Headways would not exceed 30 minutes during the peak periods in the peak direction and 60 minutes otherwise under the maximum extent plan.

The maximum extent commuter rail system plan also provides for complementary expansion and improvement of the Milwaukee area express and local transit system. Nine additional express bus routes would be provided over the three routes which were actually in operation in 1980. The local transit system under the plan would be extended into all contiguous areas of urban development, including all of northern and most of southern Milwaukee County, southern Ozaukee County, southeastern Washington County, and eastern Waukesha County.

Source: SEWRPC.

Map 24

BASE SYSTEM PLAN FOR THE MILWAUKEE AREA



The base system plan envisions no long-range primary transit improvements in the Milwaukee area, and is composed of the existing Milwaukee area transit system and those short-range improvements recommended in the adopted Milwaukee County five-year transit improvement plan. The base system plan is intended to provide benchmark information against which the maximum extent plans can be evaluated. The base plan provides for 16 bus-on-freeway routes totaling 449 miles in length, of which 11 routes existed in 1980. The base plan provides for seven express bus routes—four more than existed in 1980—and envisions little expansion of local service beyond that existing in 1980 within central Milwaukee County.

Source: SEWRPC.

County and into outlying counties, including routes to the City of Waukesha and the Village of Menomonee Falls in Waukesha County, and to the City of Cedarburg and Village of Grafton in Ozaukee County. Under the maximum extent busway and light rail transit system plans, five routes totaling 253 route miles in length and having 162 stations or stops would operate over 104 miles of guideway. Stops on the guideway would typically be spaced approximately one-quarter mile apart in the central business district, one-half mile apart in areas of high-density urban development, and one mile apart in areas of medium-density urban development. Nearly all the guideway facilities, 97 miles, or 92 percent, would be located on surface alignments, with the remaining 7 miles, or 8 percent, located on elevated structure. The rights-of-way for most of the light rail and bus guideway facilities—about 51.7 miles, or 49 percent—would be located in medians, reserved lanes, and malls within public street rights-of-way. Another 31.4 miles, or 30 percent, would be located along former electric interurban railway rights-of-way presently owned by the Wisconsin Electric Power Company; 11.9 miles, or 11 percent, would be located along active railway rights-of-way; 1.6 miles, or 2 percent, would be located along cleared freeway rights-of-way of the Stadium Freeway-South and Park Freeway-East corridors; and 0.5 mile, or less than 1 percent, would be located along abandoned railway rights-of-way. The remaining 7 percent, or 7.4 miles of guideway, would be located on other publicly owned lands over a distance of 3.6 miles, and on privately owned lands over a distance of 3.8 miles. Nearly all this light rail and motor bus guideway would, as a result, be exclusive, as only transit vehicles would operate over the newly constructed facilities and rights-of-way except for a distance of 2.2 miles, where operation in mixed traffic would be necessary. Very little of the guideway would be grade-separated, however, as intersections with public streets would be provided along the entire length of the bus and light rail guideway. The transit vehicles would, however, be provided with preferential treatment at all such intersections through traffic signalization.

The light rail transit vehicles used on the five routes would be electrically propelled, bi-directional, and articulated, and would have average speeds of about 20 mph. Headways during the peak periods would range from 5 to 20 minutes on each of the individual routes, with some service being provided by trains consisting of two articulated vehicles. During the off-peak periods, headways would range from 10 to 60 minutes in the midday, and 15 to 60 minutes during the evening, with all routes operating with single articulated vehicles. Under the range of future conditions tested, the maximum extent light rail transit plan would entail the provision of between 72,200 and 105,300 vehicle miles of transit service, with a fleet ranging from 97 light rail vehicles and 481 buses to 182 light rail vehicles and 634 buses.

Under the maximum extent light rail transit plan and all the other maximum extent plans, the current fares are assumed to increase with general price inflation. The fare under these plans would thus remain at $0.50 per ride, expressed in constant 1979 dollars, for local and express bus service. Similarly, the primary service fare would remain at $0.60 within Milwaukee County, and would increase with distance from Milwaukee County. These fares would range between $1.00 and $1.40 at the outer limits of the future urbanized area, and between $1.80 and $2.20 at the extreme limits of service on the maximum extent bus-on-freeway and commuter rail plan routes.

On the five busway routes that would use articulated high-capacity buses, average speeds would be about 18.5 mph. During the peak periods headways would range from 3 to 8 minutes, and during the off-peak periods would range from 10 to 60 minutes in the midday and 20 to 60 minutes during the evening. Under the range of future conditions tested, the maximum extent busway plan would entail the provision of between 77,300 and 111,900 bus miles of transit service, requiring a fleet of between 646 and 880 buses.

The maximum extent light rail and busway transit system plans, and all the other maximum extent system plans, also envision complementary expansion and improvement of the local and express transit system elements. Local transit service would be extended into all contiguous areas of urban development, including all of northern and most of southern Milwaukee County, southern Ozaukee County, southeastern Washington County, and eastern Waukesha County. Also, local transit service would be expanded in the off-peak travel periods, particularly in the evening. Express transit service would be expanded to complement the primary elements of the maximum extent system plans, serving those high-density areas not directly served by the primary transit elements of the maximum extent transit system plans.

The maximum extent heavy rail rapid transit system plan would consist of about 104 miles of guideway, over which five routes, totaling 215 miles in length and having 87 stations or stops, would operate. Stops would typically be spaced one-half mile apart in the central business district, one mile apart in areas of high-density urban development, and two miles apart in areas of medium-density urban development. Most of the heavy rail guideway, 55.5 miles, or 54 percent, would be on elevated structure. Another 41.5 miles, or 40 percent, would be on fully grade-separated surface alignments, and the remaining 6.7 miles, or 6 percent, would be in subways. About 39.2 miles, or 39 percent of the heavy rail guideway, would be located within public street rights-of-way; about 21.6 miles, or 20 percent, would be located along active mainline railway rights-of-way; about 20.2 miles, or 19 percent, would be located along former electric interurban railway rights-of-way presently owned by the Wisconsin Electric Power Company; about 13.6 miles, or 13 percent, would be located along active and cleared freeway rights-of-way; and about 1.9 miles, or 2 percent, would be located along abandoned mainline railway rights-of-way. The remaining 7 percent, or 7.2 miles of guideway, would be located on other publicly owned lands for a distance of 3.9 miles, and on privately owned lands for a distance of 3.3 miles.

Average speeds on the five heavy rail rapid transit routes would be about 32 mph, with all service being provided by trains of two electrically propelled vehicles permanently coupled together. Headways during the peak periods would range from 10 to 30 minutes. During the off-peak periods, headways would range from 30 to 45 minutes in the midday, and 30 to 45 minutes during the evening. The maximum extent heavy rail rapid transit plan would entail the provision of 95,500 vehicle miles of transit service, requiring a fleet of 66 heavy rail vehicles and 656 buses.

Maximum Extent Bus-on-Freeway and Commuter Rail Plans

The maximum extent bus-on-freeway and maximum extent commuter rail plans would provide a greater areal extent of primary transit service than the maximum extent bus-on-busway, light rail transit, and heavy rail rapid transit plans because the bus-on-freeway and commuter rail transit technologies would be able to utilize existing facilities to extend primary transit service throughout the Region. Under both plans, service would be extended to the south to the City of Kenosha in Kenosha County, to the west to the Cities of Waukesha and Oconomowoc in Waukesha County, to the northwest to the City of West Bend in Washington County, and to the north to the Cities of Port Washington and Cedarburg and Village of Grafton in Ozaukee County. In addition, service would be extended to the southwest to the Village of East Troy in Walworth County under the bus-on-freeway plan.

The maximum extent bus-on-freeway plan would consist of 31 routes totaling 1,218 route miles in length and having a total of 61 stations or stops. Under the plan, articulated, high-capacity buses would operate in primary transit service primarily over existing and proposed freeways between outlying park-ride lots and the Milwaukee central business district. Bus routes from park-ride lots in Milwaukee County to the central business district would be operated with a limited number of intermediate stops, as necessary, to connect and coordinate with feeder express and local bus service, thus providing access to major travel generators other than the Milwaukee central business district. Primary transit bus routes originating at locations outside Milwaukee County but within the existing or future Milwaukee urbanized area would generally serve two outlying park-ride lots prior to proceeding in an essentially nonstop mode of operation to the Milwaukee central business district. Primary transit bus routes originating at locations outside the Milwaukee urbanized area would have stops at two to five outlying park-ride lots prior to proceeding in an essentially nonstop mode of operation to the central business district. The park-ride lots would be located, to the extent practicable, within or near freeway interchanges to minimize travel times. Within the Milwaukee central business district, all primary transit bus routes would operate as such routes do today—that is, over E. and W. Wisconsin Avenue for a distance of about two miles with stops approximately every one-quarter mile.

The Milwaukee area freeways over which buses would operate in primary transit service under the maximum extent bus-on-freeway plan would be operationally controlled during peak travel periods.[2]

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[2] *The preparation of plans for bus-on-freeway alternatives which would operate over reserved lanes on freeways or in mixed traffic on uncontrolled*

(Footnote continued on next page)

All freeway on-ramps in the Milwaukee urbanized area would be ramp-metered to restrain automobile and truck access to the freeways during peak travel periods. The ramp meters would be operated through a central control system which would continuously measure traffic volumes on those portions of the freeway system needed for transit service through an interconnected series of traffic-sensing devices. As traffic volumes approached the levels beyond which operating speeds may be expected to deteriorate, fewer automobiles and trucks would be permitted to enter the freeway system. Sufficient constraint would be exercised to ensure uninterrupted traffic flow and operating speeds of at least 40 mph on otherwise congested freeways. Therefore, average speeds on the bus-on-freeway routes, including all stops, would range between 24 and 28 mph. Headways during peak periods would range from 6 to 30 minutes. During the off-peak periods, headways would range from 15 to 60 minutes in both the midday and evening travel periods. Under the range of future conditions tested, the maximum extent bus-on-freeway plan would entail the provision of between 110,100 and 153,100 bus-miles of transit service, requiring a fleet of between 738 and 1,096 buses.

(Footnote 2 continued)

freeways was also considered under the study, but was dismissed. Plans for reserved lane bus-on-freeway systems were not prepared because it was determined through inventories of freeway facilities and rights-of-way that buses operating over operationally controlled freeways in the Milwaukee area could provide the same preferential-freeway-treatment benefits systemwide at a lower cost and with less disruption of automobile and truck traffic, and with greater safety. Also considered in this determination to consider only a bus-on-freeway system with operational control of freeways was that a freeway operational control system was already partially in place in the Milwaukee area, and its improvement and expansion—principally for its automobile and truck travel benefits—had been programmed for implementation by the Wisconsin Department of Transportation, and was recommended under the Commission's adopted long-range and short-range regional transportation system plans.

The maximum extent commuter rail plan would consist of six routes between outlying areas of the Region and the Milwaukee central business district. The routes would total 354 miles in length and would operate over 157 miles of railway. The six routes would include all mainline railway trackage in the Region connecting the Milwaukee central business district with concentrations of residential development and other travel generators. A total of 43 stops would be made on the routes, and the average speed on the routes would be about 31 mph. Service headways in the peak period would be every one-half hour in the peak direction and every hour in the nonpeak direction, and would be every hour in off-peak periods. Trains would generally consist of a locomotive and one or two coaches except on the route to the Racine and Kenosha areas, where trains of up to six coaches would be used during the peak periods. The maximum extent commuter rail plan would entail the provision of between 82,150 and 134,600 vehicle miles of transit service, and a fleet ranging from 42 commuter rail coaches and 645 buses to 90 coaches and 1,023 buses.

TEST AND EVALUATION OF MAXIMUM EXTENT PRIMARY TRANSIT SYSTEM PLANS

The test and evaluation of these initially designed maximum extent system plans was limited to selected measures of transit ridership, cost, and cost-effectiveness, because the maximum extent plans, by design, included transit facilities and services and transit technologies which were unlikely to be fully warranted. Consideration was given particularly to the average total cost per passenger carried by each maximum extent plan and the proportion of maximum extent plan design year costs met by farebox revenues, as shown in Table 44. The maximum extent plans were considered cost-effective if their total cost per passenger approximated that of the base plan, and if the individual primary transit routes of the plans—and the plans as a system, including local and express elements—recovered at least one-half of estimated design year operating and maintenance costs from farebox revenues. A total of 21 maximum extent plans were tested and evaluated for cost-effectiveness, including the base plan and each alternative maximum extent plan under each alternative future except the maximum extent heavy rail rapid transit plan. The maximum extent heavy rail rapid transit plan was tested only under the most optimistic future for transit needs and use.

Table 44

SUMMARY OF EVALUATION OF THE BASE SYSTEM PLAN AND ALTERNATIVE MAXIMUM EXTENT PRIMARY TRANSIT SYSTEM PLANS UNDER EACH SCENARIO-LAND USE PLAN

Scenario	Alternative					
	Base Plan	Bus-on-Freeway Plan	Commuter Rail Plan	Light Rail Transit Plan	Busway Plan	Heavy Rail Rapid Transit Plan
Moderate Growth Scenario-Centralized Land Use Plan						
Public Transit Ridership						
Passenger Trips per Average Weekday	326,800	387,900	372,100	357,800	353,500	346,600
Cost						
Total Cost						
Total Cost to Design Year	$579,742,000	$832,269,800	$868,415,300	$1,120,900,000	$938,394,490	$2,048,414,900
Capital Cost						
Total Capital Cost to Design Year	148,842,000	221,249,800	210,245,300	628,160,000	442,054,490	1,572,378,300
Total Capital Investment to Design Year	233,328,700	356,443,700	401,852,100	1,231,138,000	771,162,200	2,930,538,000
Net Operating and Maintenance Cost (deficit)						
Total Deficit in Design Year	23,198,300	45,713,000	51,607,600	30,928,100	31,378,700	28,840,500
Total Deficit to Design Year	430,900,000	611,020,000	658,170,000	492,740,000	496,340,000	476,036,600
Cost-Effectiveness						
Cost to Design Year per Passenger						
Total Cost to Design Year per Passenger	0.39	0.52	0.54	0.73	0.62	1.35
Capital Cost to Design Year per Passenger	0.10	0.14	0.13	0.41	0.29	1.04
Operating Deficit to Design Year per Passenger	0.29	0.38	0.41	0.32	0.33	0.31
Percent of Operating and Maintenance Cost Met by Farebox Revenue in the Design Year						
Total Transit System	62	53	49	59	58	60
Primary Element	56	54	41	88	86	74
Moderate Growth Scenario-Decentralized Land Use Plan						
Public Transit Ridership						
Passenger Trips per Average Weekday	217,400	256,700	245,100	234,700	231,600	- -
Cost						
Total Cost						
Total Cost to Design Year	$542,926,370	$770,816,100	$785,265,880	$1,040,607,700	$ 900,128,990	- -
Capital Cost						
Total Capital Cost to Design Year	124,606,570	180,135,500	182,522,880	583,822,300	407,051,590	- -
Total Capital Investment to Design Year	186,198,500	286,385,500	334,665,700	1,127,632,600	733,648,700	- -
Net Operating and Maintenance Cost (deficit)						
Total Deficit in Design Year	21,625,900	43,171,000	44,678,800	26,434,100	30,970,600	- -
Total Deficit to Design Year	418,319,800	590,680,600	602,743,000	456,785,400	493,077,400	- -
Cost-Effectiveness						
Cost to Design Year per Passenger						
Total Cost to Design Year per Passenger	0.44	0.59	0.60	0.84	0.73	- -
Capital Cost to Design Year per Passenger	0.10	0.14	0.14	0.47	0.33	- -
Operating Deficit to Design Year per Passenger	0.34	0.45	0.46	0.37	0.40	- -
Percent of Operating and Maintenance Cost Met by Farebox Revenue in the Design Year						
Total Transit System	53	43	42	56	48	- -
Primary Element	45	48	35	82	80	- -

Table 44 (continued)

Scenario	Alternative					
	Base Plan	Bus-on-Freeway Plan	Commuter Rail Plan	Light Rail Transit Plan	Busway Plan	Heavy Rail Rapid Transit Plan
Stable or Declining Growth						
Scenario-Centralized Land Use Plan						
Public Transit Ridership						
Passenger Trips per Average Weekday	215,900	241,700	230,500	227,200	224,800	- -
Cost						
Total Cost						
Total Cost to Design Year.	$493,042,100	$708,108,800	$777,644,100	$1,019,763,000	$ 845,224,700	- -
Capital Cost						
Total Capital Cost to Design Year	119,819,100	173,830,600	260,209,900	577,865,600	399,377,700	- -
Total Capital Investment to Design Year	180,851,300	273,722,800	305,467,100	1,106,884,700	719,773,600	- -
Net Operating and Maintenance Cost (deficit)						
Total Deficit in Design Year	15,988,800	36,120,700	34,015,200	24,573,100	25,066,800	- -
Total Deficit to Design Year	373,223,000	534,278,200	517,434,200	441,897,400	445,847,000	- -
Cost-Effectiveness						
Cost to Design Year per Passenger						
Total Cost to Design Year per Passenger	0.40	0.56	0.62	0.83	0.68	- -
Capital Cost to Design Year per Passenger	0.10	0.14	0.21	0.47	0.32	- -
Operating Deficit to Design Year per Passenger	0.30	0.42	0.41	0.36	0.36	- -
Percent of Operating and Maintenance Cost						
Met by Farebox Revenue in the Design Year						
Total Transit System	61	45	45	53	52	- -
Primary Element	49	35	22	82	77	- -
Stable or Declining Growth Scenario-						
Decentralized Land Use Plan						
Public Transit Ridership						
Passenger Trips per Average Weekday	169,400	193,100	183,200	180,000	178,300	- -
Cost						
Total Cost						
Total Cost to Design Year.	$483,703,200	$688,398,600	$679,440,000	$1,016,911,000	$ 855,484,300	- -
Capital Cost						
Total Capital Cost to Design Year	107,761,000	155,958,000	158,285,100	563,200,000	393,968,500	- -
Total Capital Investment to Design Year	161,597,700	252,706,300	284,576,100	1,080,881,200	709,158,500	- -
Net Operating and Maintenance Cost (deficit)						
Total Deficit in Design Year	16,328,700	35,891,000	34,480,300	26,049,800	27,025,400	- -
Total Deficit to Design Year	375,942,200	532,440,600	521,155,000	453,711,000	461,515,800	- -
Cost-Effectiveness						
Cost to Design Year per Passenger						
Total Cost to Design Year per Passenger	0.43	0.58	0.59	0.90	0.76	- -
Capital Cost to Design Year per Passenger	0.10	0.13	0.14	0.50	0.35	- -
Operating Deficit to Design Year per Passenger	0.33	0.45	0.45	0.40	0.41	- -
Percent of Operating and Maintenance Cost						
Met by Farebox Revenue in the Design Year						
Total Transit System	54	45	39	45	44	- -
Primary Element	49	27	19	79	67	- -

Source: SEWRPC.

Those elements of the maximum extent plans determined through this test and evaluation not to be cost-effective were eliminated from further consideration under the study. The resulting truncated plans were subsequently tested and comparatively evaluated to provide the basis for formulating the study recommendations.

Maximum Extent Bus-on-Metered Freeway Plan

The test and evaluation of the maximum extent bus-on-metered freeway system plans established that only under the most optimistic future conditions could a maximum extent bus-on-metered freeway plan be expected to meet the key objectives. That is, only under the moderate growth scenario-centralized land use plan alternative future could the maximum extent plan as a system be expected to meet at least 50 percent of its operating and maintenance costs from farebox revenues, and could the capital, net operating and maintenance, and total costs per passenger be expected not to differ significantly from those of the base plan. Under the other three more pessimistic alternative futures, it was determined that between 16 and 24 of the bus-on-metered freeway routes would not meet about one-half of their design year operating and maintenance costs from farebox revenues, and that these routes should therefore not be considered for inclusion in the final plan. However, even with the removal of the inefficient routes from the maximum extent system plans, the bus-on-metered freeway plans still constituted a system under all futures, as the remaining routes under each future provided service in most major travel corridors of the Milwaukee area. Map 25 shows the extent of the truncation of the maximum extent bus-on-metered freeway plans determined necessary under each alternative future to result in a more cost-effective set of bus-on-freeway plans, and Maps 26, 27, 28, and 29 show the resulting truncated system plans under each alternative future.

Maximum Extent Light Rail Transit and Busway Plans

It was found that the maximum extent light rail transit and busway plans could be expected to perform well in terms of operating and maintenance cost-effectiveness, meeting no less than 64 percent of operating and maintenance cost from farebox revenues in the design year on any route under even the most pessimistic future. However, the combined capital and operating and maintenance costs of the maximum extent plans, expressed both in total and on per-passenger basis, were determined to be significantly higher than those of the base plan under all four futures, principally because of the significantly higher capital cost per passenger of the light rail transit and busway plans. Accordingly, the maximum extent light rail and busway system plans were truncated with the objective of reducing system capital costs and bringing the total cost per passenger closer to that of the base plan. In truncating the maximum extent system plans under each alternative future, the segments deleted were those which the plan test indicated would, if deleted, provide the largest reductions in system capital costs and operating deficits and the smallest reductions in system ridership. As shown on Map 30 for the moderate growth scenario-centralized land use plan alternative future, and on Map 31 for the other three alternative futures, the light rail transit and busway facilities that were initially proposed under the maximum extent plans were significantly truncated, with the remaining facilities serving only Milwaukee County under all four futures.

The truncated light rail transit and busway system plans were modified prior to final testing and evaluation so that the geographic extent of the primary transit service provided under each of these alternatives was comparable to that provided under the more extensive bus-on-metered freeway plan under each alternative future. The modifications consisted of adding primary transit bus-on-metered freeway routes to the truncated light rail transit and busway plans in those travel corridors wherein light rail transit or busway facilities were not proposed but where the bus-on-metered freeway plan could provide service. Without these modifications, the comparison of the alternative truncated plans would have been more difficult, as the alternatives would not have provided similar areal coverage. The composite system plans for the light rail transit and busway modes are shown on Maps 32, 33, 34, and 35 for each of the alternative futures.

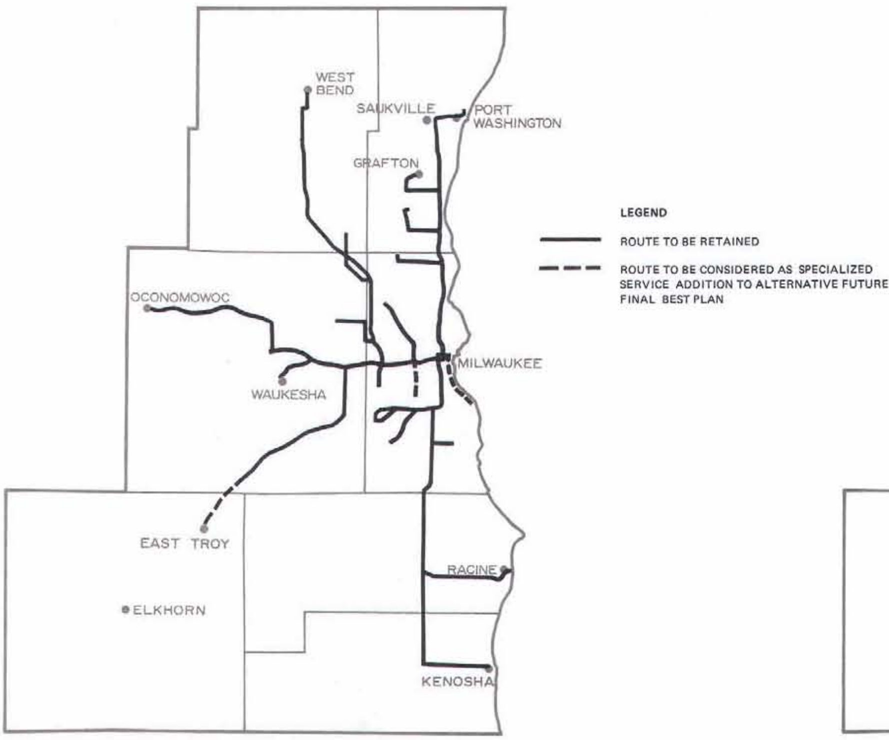
Maximum Extent Commuter Rail Plans

The test and evaluation of the maximum extent commuter rail plans under each alternative future demonstrated that commuter rail would not be viable as a primary transit mode under all of the alternative futures. Indeed, only under the most optimistic future for transit use in the Milwaukee area was it found that commuter rail could provide viable, all-day service on any route other than the route to the Racine and Kenosha areas, as shown on Map 36. Under the most optimistic future, the routes to Grafton and to Oconomowoc, as well as the route to Racine and Kenosha, were found to have the potential to meet 50 percent of the annual operating and maintenance costs from farebox

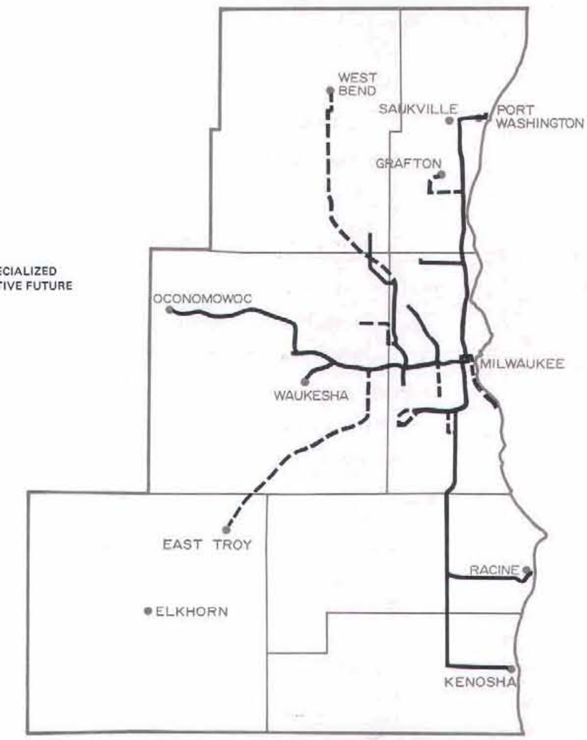
Map 25

TRUNCATED BUS-ON-FREEWAY SYSTEMS UNDER EACH OF THE ALTERNATIVE FUTURES

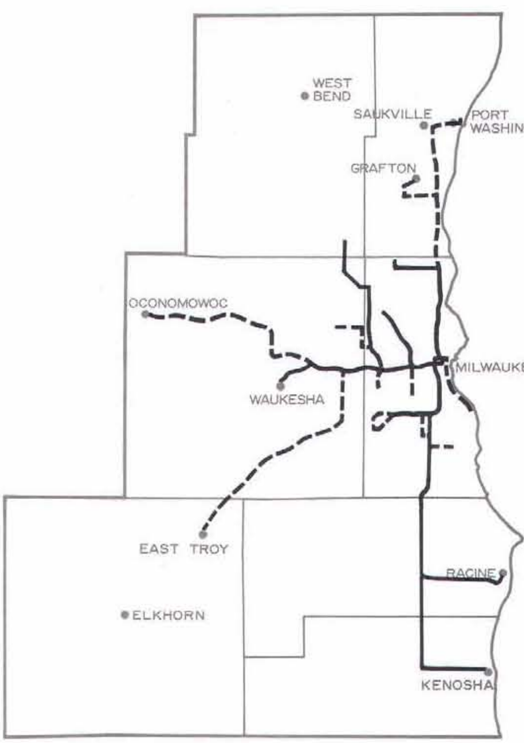
MODERATE GROWTH-CENTRALIZED
LAND USE PLAN ALTERNATIVE FUTURE



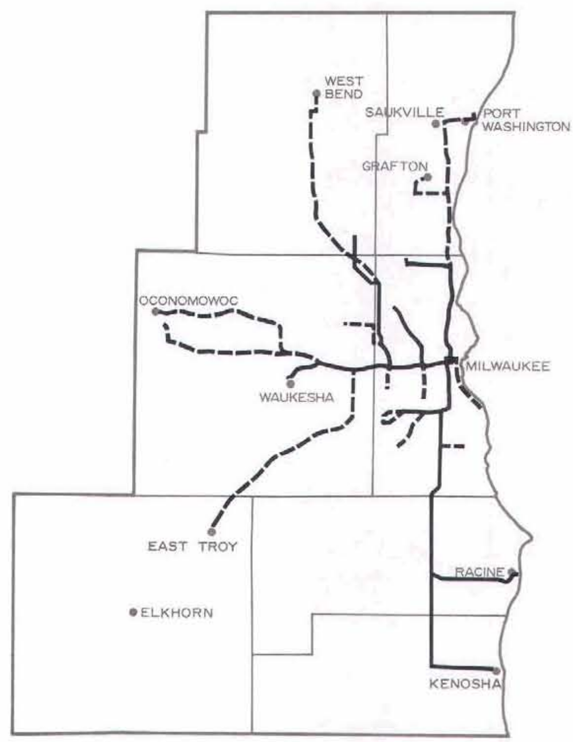
MODERATE GROWTH-DECENTRALIZED
LAND USE PLAN ALTERNATIVE FUTURE



STABLE OR DECLINING GROWTH-CENTRALIZED
LAND USE PLAN ALTERNATIVE FUTURE



STABLE OR DECLINING GROWTH-DECENTRALIZED
LAND USE PLAN ALTERNATIVE FUTURE

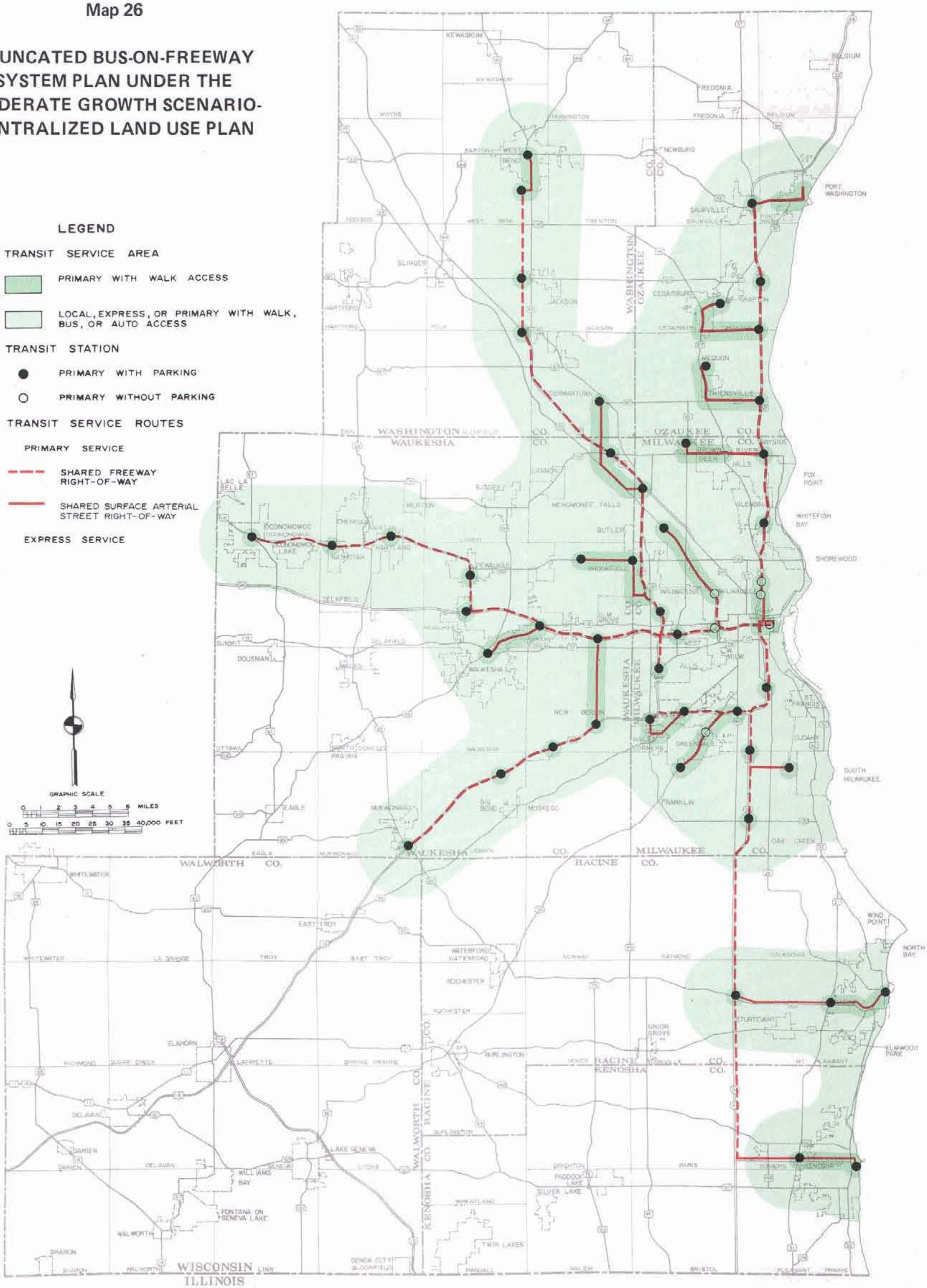


The test and evaluation of the maximum extent bus-on-freeway system plans demonstrated that this mode could be viable under each of the four alternative futures, although somewhat different sets of service cutbacks would be required under each future. Depending upon future conditions, it was found that between 7 and 24 of the bus-on-freeway routes could be expected to recover at least one-half of their operating costs from farebox revenues. Certain routes were identified as being appropriate for future consideration in any final plan as "specialized" routes, providing only limited weekday peak-period service.

Source: SEWRPC.

Map 26

TRUNCATED BUS-ON-FREEWAY SYSTEM PLAN UNDER THE MODERATE GROWTH SCENARIO-CENTRALIZED LAND USE PLAN

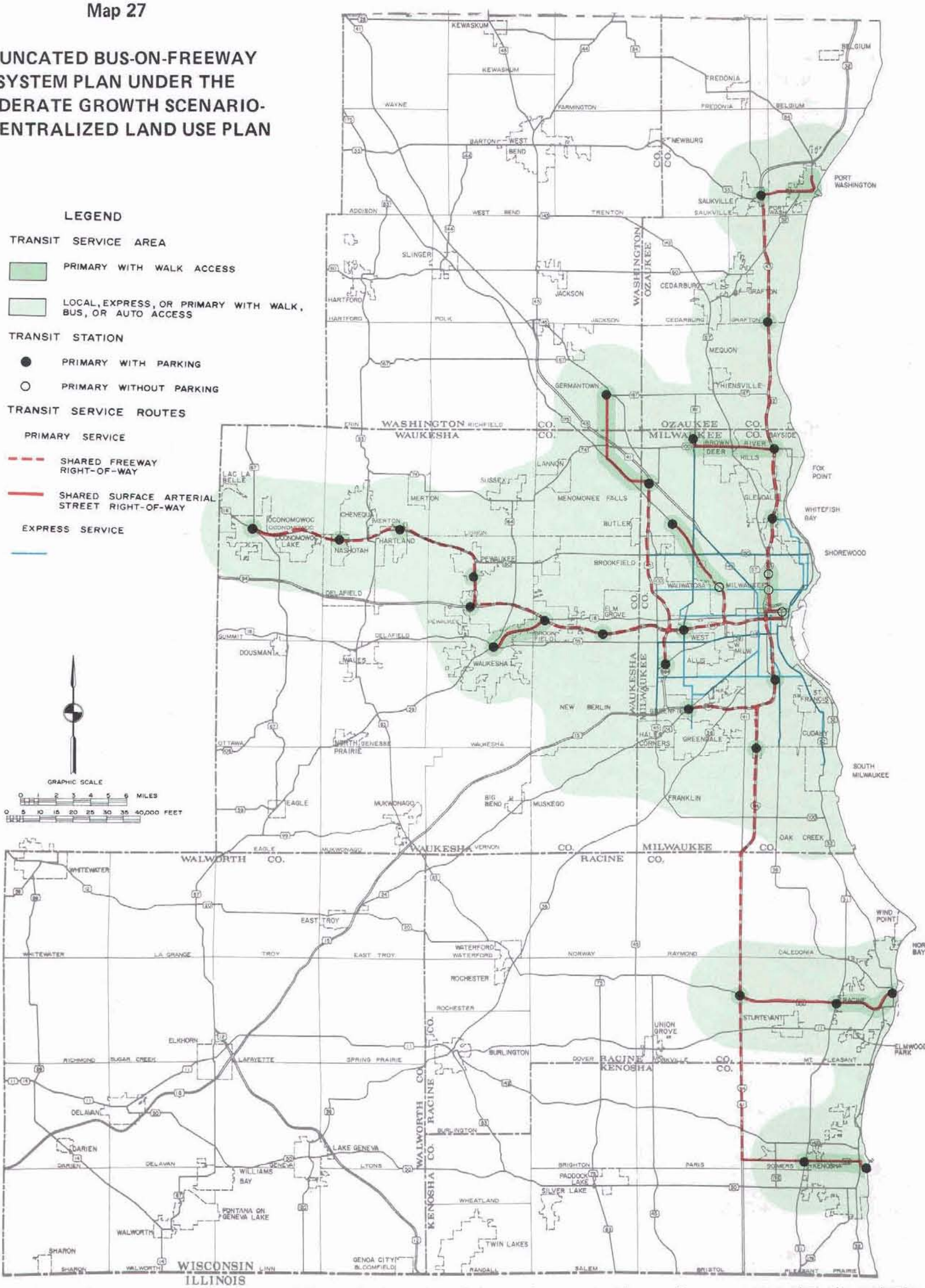


The truncated bus-on-freeway system plan is a carefully cut back version of the maximum extent bus-on-freeway system plan, the cutbacks being made with the objective of creating a more cost-effective system serving a large part of the Milwaukee area. Under the truncated plan, 24 of the 31 routes, totaling 225 miles of line over which 955 round-trip route miles of service would be provided, or about 92 percent of the 246 miles of line and 80 percent of the 1,218 route miles of service provided under the maximum extent plan, were retained. Headways were assumed to remain about the same as under the maximum extent plan, ranging from 7 to 30 minutes during the peak travel periods, and 15 to 60 minutes during the off-peak periods. Under the truncated plan, a total of 52 primary transit stations or stops would be served outside the Milwaukee central business district, 47 of which would have park-ride lots. There would be 22 stations within Milwaukee County, 17 of which would have park-ride lots.

Source: SEWRPC.

Map 27

TRUNCATED BUS-ON-FREEWAY SYSTEM PLAN UNDER THE MODERATE GROWTH SCENARIO-DECENTRALIZED LAND USE PLAN

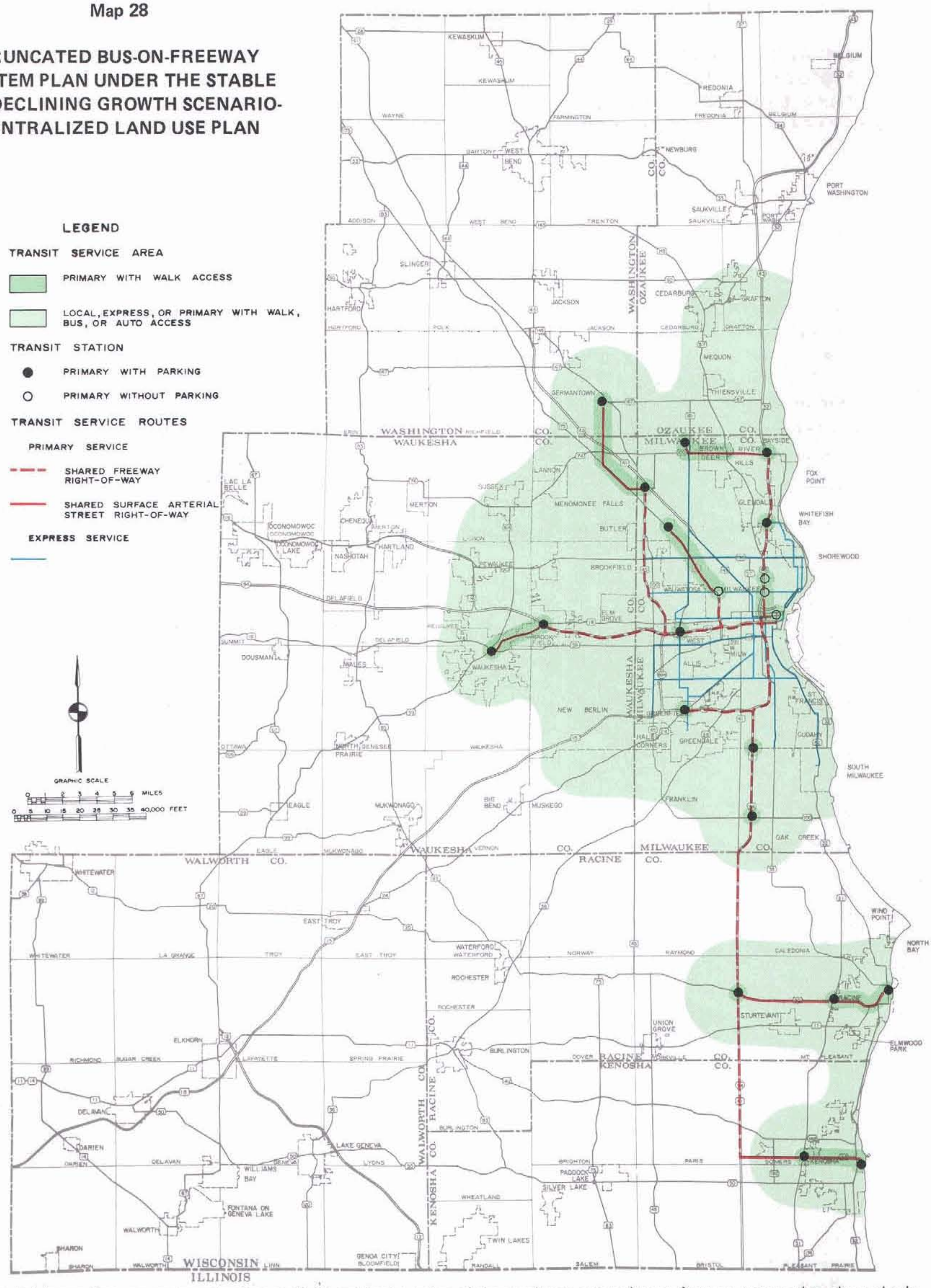


The truncated bus-on-freeway system plan is a carefully cut back version of the maximum extent bus-on-freeway system plan, the cutbacks being made with the objective of creating a more cost-effective system serving a large part of the Milwaukee area. Under the truncated plan, 15 of the 31 routes, totaling 113 miles of line over which 569 round-trip route miles of service would be provided, or about 46 percent of the 246 miles of line and 47 percent of the 1,218 route miles of service provided under the maximum extent plan, were retained. Headways were assumed to remain about the same as under the maximum extent plan, ranging from 8 to 30 minutes during the peak travel periods and 20 to 60 minutes during the off-peak periods. Under the truncated plan, a total of 29 primary transit stations or stops would be served outside the Milwaukee central business district, 26 of which would have park-ride lots. There would be 13 stations within Milwaukee County, 10 of which would have park-ride lots.

Source: SEWRPC.

Map 28

TRUNCATED BUS-ON-FREEWAY SYSTEM PLAN UNDER THE STABLE OR DECLINING GROWTH SCENARIO-CENTRALIZED LAND USE PLAN

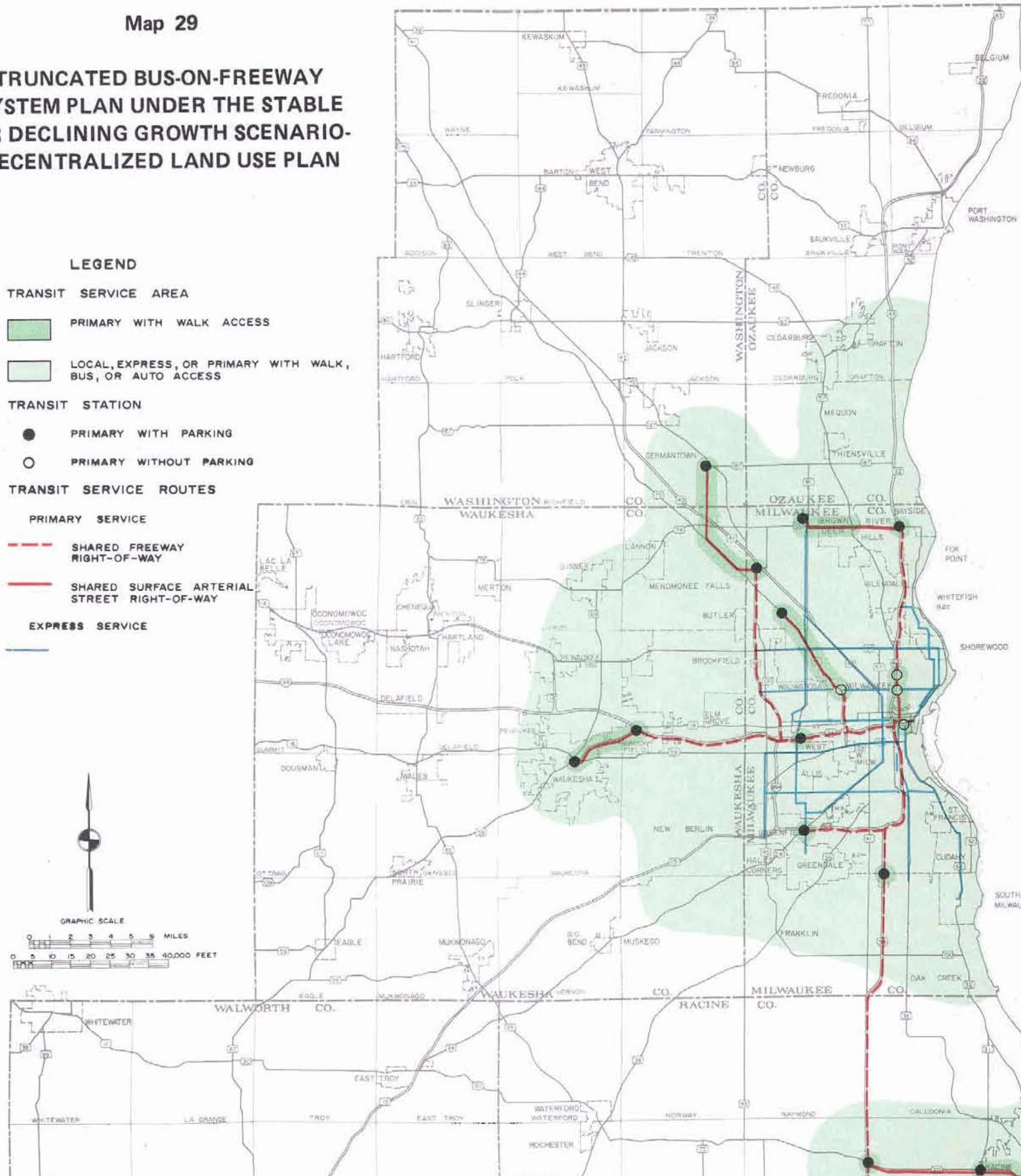


The truncated bus-on-freeway system plan is a carefully cut back version of the maximum extent bus-on-freeway system plan, the cutbacks being made with the objective of creating a more cost-effective system serving a large part of the Milwaukee area. Under the truncated plan, 9 of the 31 routes, totaling 113 miles of line over which 365 round-trip route miles of service would be provided, or about 46 percent of the 246 miles of line and 30 percent of the 1,218 route miles of service provided under the maximum extent plan, were retained. Headways were assumed to remain about the same as under the maximum extent plan, ranging from 10 to 30 minutes during the peak travel periods and 30 to 60 minutes during the off-peak periods. Under the truncated plan, a total of 20 primary transit stations or stops would be served outside the Milwaukee central business district, 17 of which would have park-ride lots. There would be 12 stations within Milwaukee County, 9 of which would have park-ride lots.

Source: SEWRPC.

Map 29

TRUNCATED BUS-ON-FREEWAY SYSTEM PLAN UNDER THE STABLE OR DECLINING GROWTH SCENARIO-DECENTRALIZED LAND USE PLAN



The truncated bus-on-freeway system plan is a carefully cut back version of the maximum extent bus-on-freeway system plan, the cutbacks being made with the objective of creating a more cost-effective system serving a large part of the Milwaukee area. Under the truncated plan, 7 of the 31 routes, totaling 113 miles of line over which 322 round-trip route miles of service would be provided, or about 46 percent of the 246 miles of line and less than 30 percent of the 1,218 route miles of service provided under the maximum extent plan, were retained. Headways were assumed to remain about the same as under the maximum extent plan, ranging from 12 to 30 minutes during the peak travel periods and 40 to 60 minutes during the off-peak periods. Under the truncated plan, a total of 18 primary transit stations or stops would be served outside the Milwaukee central business district, 15 of which would have park-ride lots. There would be 10 stations within Milwaukee County, 7 of which would have park-ride lots.

Source: SEWRPC.

revenues. Under the two futures considered to be intermediate with respect to potential transit need and use—the stable or declining growth scenario-centralized land use plan alternative future and the moderate growth scenario-decentralized land use plan alternative future—only the commuter rail route to the Racine and Kenosha areas was expected to meet the cost-effectiveness standard. Under the least optimistic future for transit use, no commuter rail route was expected to be able to meet at least one-half of its operating costs from farebox revenues and, therefore, no further consideration was given to the commuter rail mode under the most pessimistic alternative future.

A composite system plan for the truncated commuter rail plan was, therefore, designed only under the moderate growth scenario-centralized land use plan alternative future, as shown on Map 37. This composite plan was designed by modifying the truncated commuter rail plan to include certain bus-on-metered freeway routes which could serve areas not served by the truncated commuter rail plan, so that this alternative would be comparable in geographic extent to the more extensive bus-on-metered freeway alternative. Composite plans were not prepared for the commuter rail mode under any other alternative future. Under the two intermediate futures, the truncated system plan for commuter rail consisted of only one route in a single corridor radiating south from the Milwaukee central business district to the Racine and Kenosha areas. Therefore, primary transit commuter rail service in this corridor was compared directly with service under the truncated bus-on-metered freeway system plan on a corridor basis.

Maximum Extent Heavy Rail Rapid Transit Plan

Through test and evaluation of the maximum extent heavy rail rapid transit plan under the most optimistic future for transit need and use, it was determined that heavy rail would entail substantially greater capital costs than any of the other primary transit alternatives, and that its high speed and high capacity could not be efficiently utilized in the Milwaukee area for at least the next two decades. The analyses clearly established that the transit travel demand in all of the major travel corridors of the Milwaukee area, even under the most optimistic future for transit use, would be insufficient to permit cost-effective heavy rail service headways—headways that are short enough to promote high utilization. The analyses indicated that the inconvenience of the necessarily longer headways would outweigh the vehicle operating speed advantages of heavy rail in attracting transit ridership, the heavy rail plan being found to carry between 7,000 and 11,000, or 2 to 3 percent, fewer passenger trips on an average weekday than the light rail and busway alternatives. In addition, because of its need for a fully grade-separated exclusive right-of-way, the capital cost of the heavy rail alternative was more than two-and-one-half times that of the comparable light rail plan, and three-and-one-half times that of the comparable busway plan. It was accordingly determined that heavy rail should not be tested under the more pessimistic alternative future, and that it should be eliminated from further consideration as a possible mode for the provision of primary transit service in the Milwaukee area under this study.

Implications of the Test and Evaluation of the Maximum Extent Plans

The test and evaluation of the maximum extent system plans provided information vital to the sound development of study recommendations by identifying those elements of the maximum extent plans which would not be viable under the alternative futures postulated. Based on this test and evaluation, heavy rail rapid transit was eliminated from further consideration under the study as it was shown to be not viable under even the most optimistic future for transit need and use considered in the study.

Commuter rail was shown to be a viable alternative as a system only under the most optimistic of futures considered in the study. While the route to the Racine and Kenosha areas was found to be viable under two of the intermediate futures, no commuter rail route was found to be viable under the most pessimistic future.

The bus-on-freeway, light rail transit, and busway alternatives were shown to be viable under the full range of alternative futures considered. Moreover, nearly the same extent of light rail transit and busway facilities and services—a truncated, five-corridor system of between 97 and 103 route miles in extent with service confined to Milwaukee County—was determined to be feasible under both the most optimistic and most pessimistic futures.

The evaluation indicated that nearly all the maximum extent system routes for the bus-on-metered freeway mode would be viable under the most optimistic future. Only under the other three futures were some bus-on-metered freeway routes shown not to be cost-effective and thus recommended for elimination.

Those elements of the maximum extent system plans for each primary transit mode thus identified as being viable were combined into truncated system plans of reasonable, cost-effective facilities and services under each alternative future. These truncated system plans were subsequently further tested, evaluated, and compared under each alternative future to provide a basis for the study recommendations. A total of 13 truncated system plans were tested, evaluated, and compared, including bus-on-metered freeway, busway, and light rail transit plans under all the alternative futures and a commuter rail plan under only the most optimistic future.

TEST AND EVALUATION OF TRUNCATED AND COMPOSITE PRIMARY TRANSIT SYSTEM PLANS

The truncated and composite alternative primary transit system plans were subject to further test and comparative evaluation under each alternative future. Objectives considered in those evaluations included transit system cost and ridership, accessibility, level of service, energy consumption, and environmental impacts, including air pollution and community disruption. In addition, to the extent possible the evaluation considered certain intangible implications of the alternative plans which could not be quantitatively measured with any reasonable degree of certainty.

The evaluation of the three primary transit alternatives which the analyses indicated could perform as systems under all four alternative futures—bus on metered freeway, bus on busway, and light rail transit—indicated that these three alternatives could, in addition, be expected to work well in the Milwaukee area under each of the alternative futures, as indicated in Tables 45, 46, 47, and 48. Under the wide range of future conditions considered, these three alternatives were determined to have the potential to provide essentially identical levels of service, to attract similar levels of ridership, to result in similar annual operating and maintenance cost subsidy requirements, and to have similar systemwide energy consumption and environmental impacts.

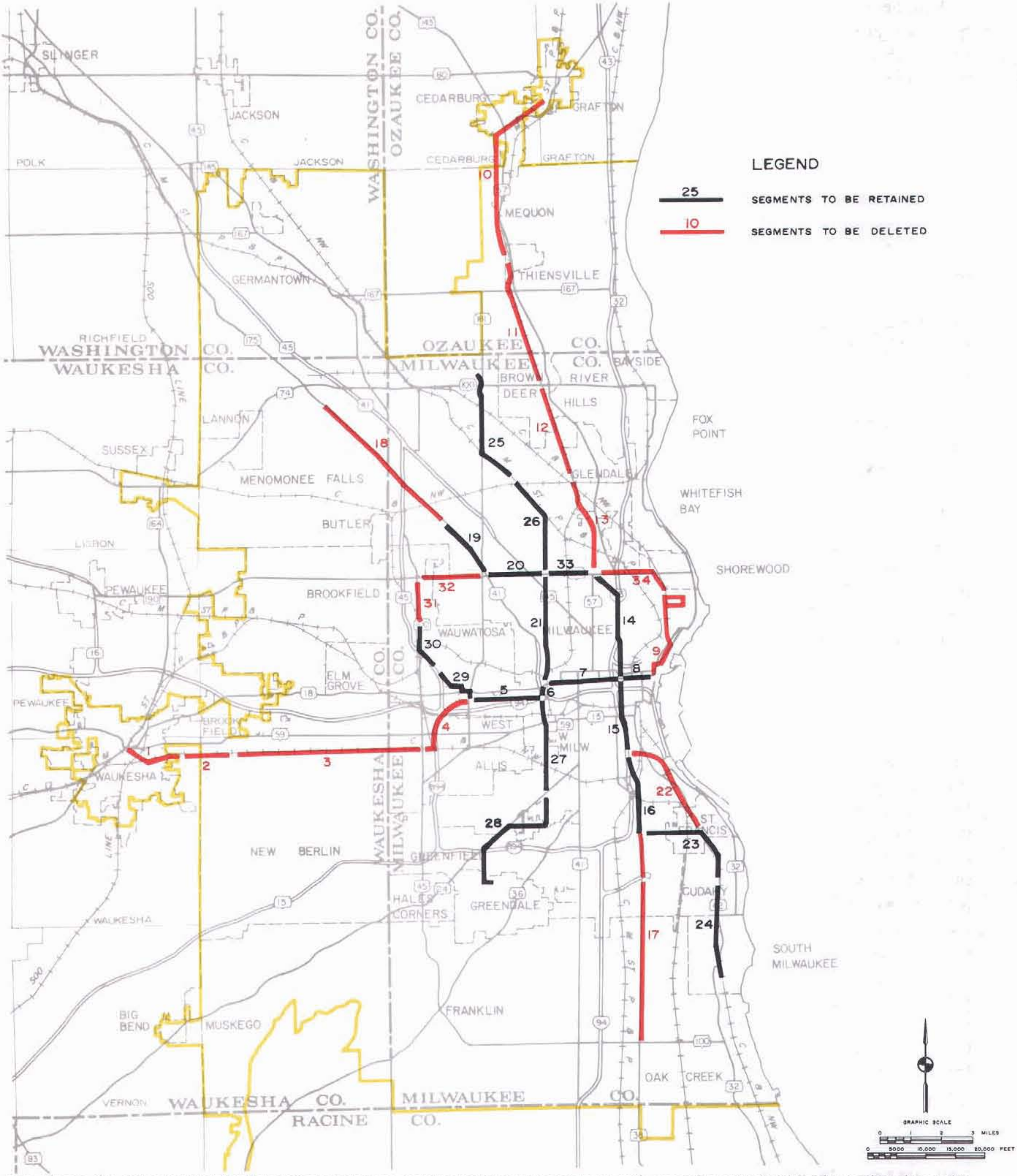
Under the moderate growth scenario-centralized land use plan alternative future, the expected level of transit use in the Milwaukee area under the bus-on-metered freeway, bus-on-busway, and light rail transit plans in the plan design year was found to range from about 373,000 to about 379,000 trips per average weekday, with the largest number of transit trips being made under the bus-on-metered freeway plan and the smallest number made under the bus-on-busway plan. Operating and maintenance costs under this future were determined to require a subsidy ranging from about $35 million to about $38 million per year in the design year under the three plans, with the light rail plan incurring the smallest operating deficit and the bus-on-freeway plan incurring the largest deficit. Each of the three plans was also shown to be expected to recover nearly the same proportion of operating and maintenance costs from farebox revenues, between 56 and 59 percent, with the light rail plan being the most efficient and the bus-on-freeway plan being the least efficient of the plans.

The differences in the design year performance of these three alternative plans under each of the more pessimistic futures were found to be even smaller. Under the most pessimistic alternative future, the stable or declining growth scenario-decentralized land use plan future, the level of transit use under the three plans is expected to differ by less than 2 percent, ranging from about 177,000 passenger trips per average weekday in the plan design year under the busway plan to about 180,000 passenger trips under the bus-on-freeway plan. Under the moderate growth scenario-decentralized land use plan intermediate future, the level of transit use of the three plans is expected to range from about 238,000 to about 242,000 passenger trips per average weekday; and under the stable or declining growth scenario-centralized land use plan intermediate future, the level of transit use under the three plans is expected to range from about 224,000 to about 228,000 average weekday passenger trips.

The public subsidy required for transit operating and maintenance costs in the design year was also found to differ little between these three plans under the three more pessimistic alternative futures. The necessary public subsidies were found to range from a high of between $32 and $34 million under the moderate growth scenario-decentralized land use plan alternative future, to a low of between $22 and $26 million under the other two pessimistic futures. The proportion of operating and maintenance costs met by farebox revenues under the three plans was also found to be similar under the three more pessimistic futures, ranging from 53 to 54 percent under the moderate growth scenario-decentralized land use plan intermediate future, and from 46 to 49 percent under the other two more pessimistic futures.

Map 30

RECOMMENDED TRUNCATED LIGHT RAIL TRANSIT AND BUSWAY SYSTEMS UNDER THE MODERATE GROWTH SCENARIO-CENTRALIZED LAND USE PLAN

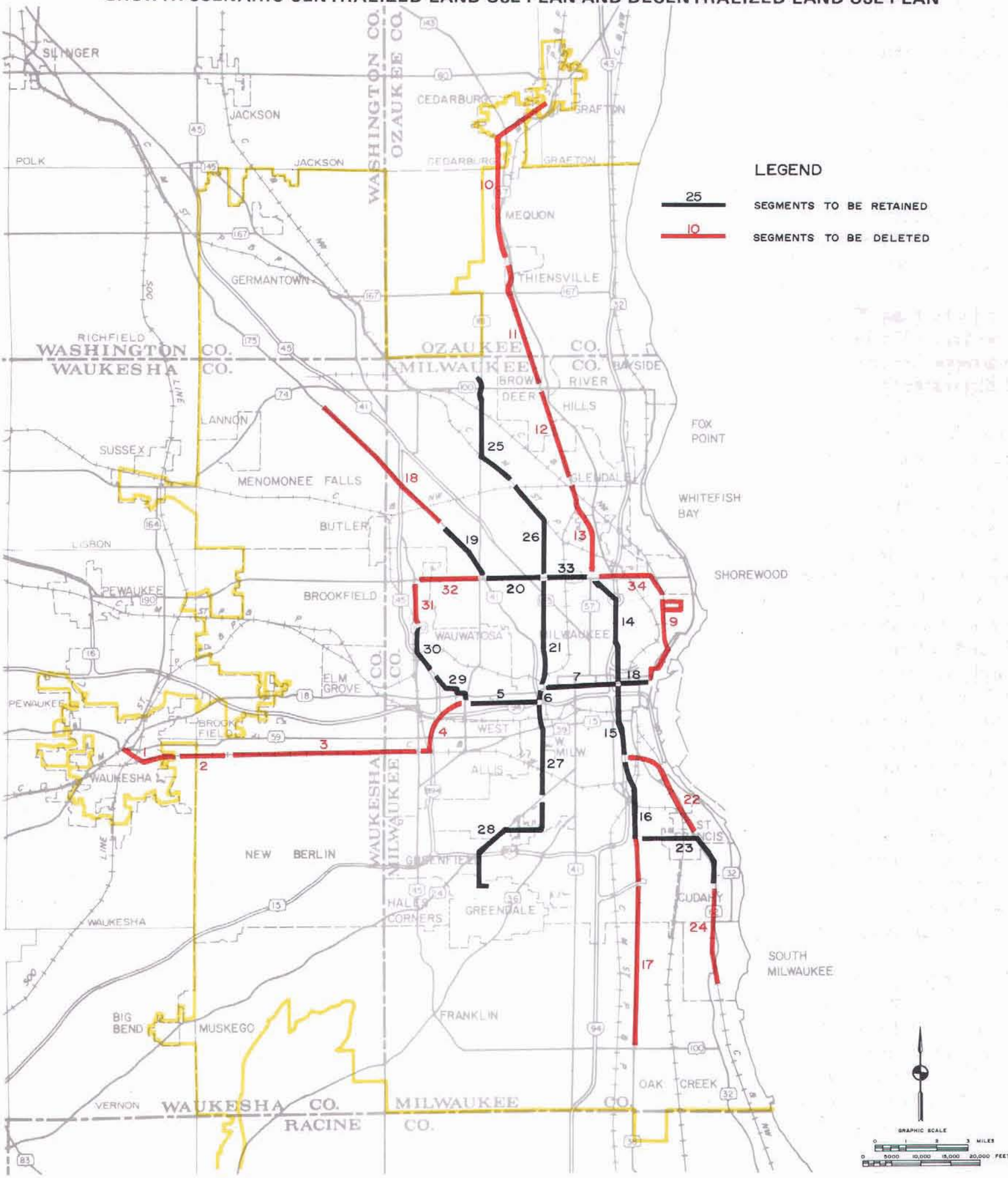


This map shows the truncated light rail transit and busway system under the moderate growth scenario-centralized land use plan alternative future, the result of certain modifications being made in the maximum extent light rail transit and busway system plan. Such modifications included the deletion of 16 segments which were judged to contribute, in their entirety, insufficient operating revenues and ridership to the system in comparison with the operating expenses and capital investment necessary to construct and support those segments. In addition, portions of two other segments were deleted and a new segment was added to provide a more cost-effective alignment between the City of Milwaukee's south side and the suburban communities of Cudahy and South Milwaukee. These modifications were made with the objective of reducing capital cost requirements and operating deficits while bringing the total cost per passenger for a light rail transit and busway system plan under this future closer to that of the base plan, while retaining an integrated primary transit system which serves a large part of the Milwaukee area.

Source: SEWRPC.

Map 31

RECOMMENDED TRUNCATED LIGHT RAIL TRANSIT AND BUSWAY SYSTEMS UNDER THE MODERATE GROWTH SCENARIO-DECENTRALIZED LAND USE PLAN AND THE STABLE OR DECLINING GROWTH SCENARIO-CENTRALIZED LAND USE PLAN AND DECENTRALIZED LAND USE PLAN



This map shows the truncated light rail transit and busway system under the three least optimistic alternative futures for public transit use and need, the result of certain modifications being made in the maximum extent light rail transit (and busway) system plan. Such modifications included the deletion of 16 segments which were judged in their entirety to contribute insufficient operating revenues and ridership to the system in comparison with the operating expenses and capital investment necessary to construct and support those segments. In addition, portions of two other segments were deleted and a new segment was added to provide a more cost-effective alignment between the City of Milwaukee's south side and the suburban communities of Cudahy and South Milwaukee. These modifications were made with the objective of reducing capital cost requirements and operating deficits while bringing the total cost per passenger for a light rail transit and busway system plan under these futures closer to that of the base plan, while retaining an integrated primary transit system which serves a large part of the Milwaukee area.

Source: SEWRPC.

Other aspects of the performance of these three alternative truncated and composite plans may also be expected to be similar, including air pollutant emissions, community disruption, and energy consumption. Considering all energy consumption attendant to implementation of the truncated bus-on-metered freeway, bus-on-busway, and light rail transit system plans, including energy required for construction as well as operation and maintenance over the 21-year design period, the bus-on-metered freeway plan was determined to require the least total energy consumption—from about 17 trillion British Thermal Units (BTU's) under the most pessimistic future to about 25 trillion BTU's under the most optimistic future.[3] The total energy consumption under the bus-on-busway and light rail transit plans was determined to be not more than 10 percent greater, ranging from about 18 trillion BTU's to about 27 trillion BTU's. The light rail transit plan, however, would require the least petroleum-based motor fuel—between 5 and 8 percent less than required by the bus-on-busway plan, and 8 and 11 percent less than required by the bus-on-metered freeway plan—as between 21 and 27 percent of the transit trips under the light rail plan may be expected to be made on electrically propelled vehicles. This savings in petroleum-based motor fuel, however—which would range between 5 and 18 million gallons over the 20-year plan implementation period—would represent less than a 1 percent savings in petroleum-based motor fuel use by the total transportation system in the Milwaukee area. This is because levels of automobile tripmaking and travel are expected to be about the same under all three alternative transit plans, and to be at least 12 times greater than levels of transit tripmaking and travel in the Milwaukee area. Therefore, any savings in petroleum-based motor fuel through the use of electrically propelled transit vehicles will be dominated by petroleum-based fuel use for automobile travel.[4]

The only significant measurable difference found between the bus-on-metered freeway, bus-on-busway, and light rail transit alternative plans was the capital investment and capital costs attendant to their implementation.[5] The bus-on-metered freeway plan was determined to require the least capital investment over the plan design period of the three plans, ranging from $203 million under the most pessimistic future, the stable or declining growth scenario-decentralized land use plan future, to $341 million under the most optimistic future, the moderate growth scenario-centralized land use plan alternative future. The greater capital investment was required under the most optimistic future for the purchase of transit vehicles to serve the larger demand for transit service under this future. The busway and light rail transit alternatives were found to require substantially more capital investment, primarily because they would require extensive new guideway construction. The capital investment required for implementation of the bus-on-busway plan was estimated to range from $453 million under the most pessimistic alternative future to $627 million under the most optimistic alternative future, and the capital investment required for the light rail transit plan was estimated to range from $607 million under the most pessimistic future to $834 million under the most optimistic future.

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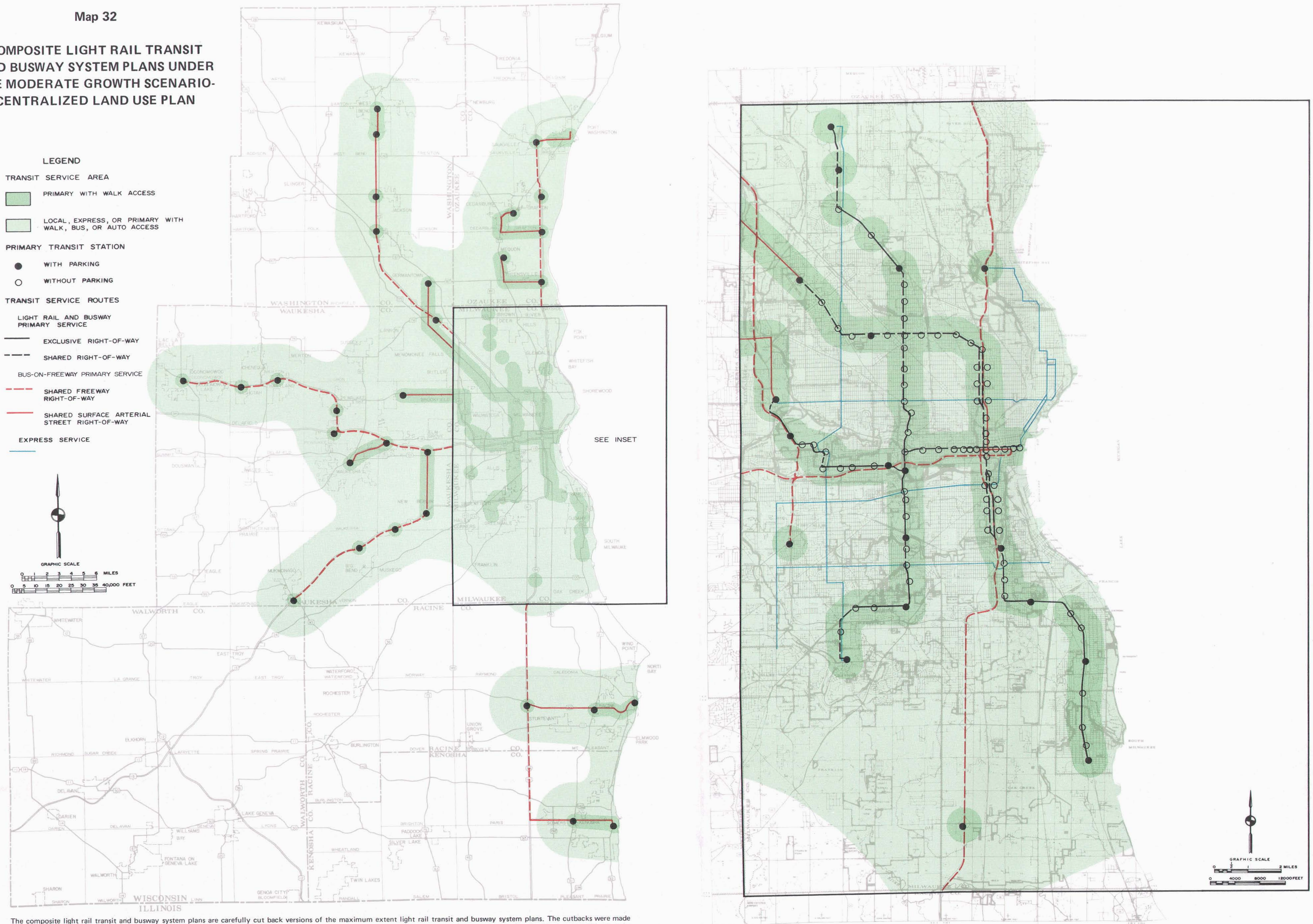
[3] *The equivalent energy use of the bus-on-freeway system plan over the 21-year plan design period is estimated to be 182 million gallons of diesel fuel, or about one million tons of coal.*

[4] *It should be noted that implementation of the composite light rail transit system plan in the Milwaukee area would result in the consumption of between 35 and 87 million kilowatt-hours of electricity in the plan design year, and would place a peak power demand of between 25 and 60 megawatts on the electric power generating system in the plan design year 2000. Based upon the electric power generating system demands in the year 2000 forecast by the Wisconsin Electric Power Company (WEPCo), these light rail system power requirements would represent less than 2 percent of the forecast year 2000 peak power demands in the WEPCo service area, and less than 1 percent of the forecast year 2000 total electric power consumption in the WEPCo service area.*

[5] *Capital investment is defined as the total outlay of funds for guideway, station, and support facility construction and vehicle acquisition necessary to implement a plan over the plan design period, and indicates total capital resources required for plan implementation. Capital cost is defined as the capital investment less the value of the remaining life of facilities and vehicles beyond the plan design period, and indicates the true capital expenditures required for plan implementation over the plan design period.*

Map 32

COMPOSITE LIGHT RAIL TRANSIT AND BUSWAY SYSTEM PLANS UNDER THE MODERATE GROWTH SCENARIO-CENTRALIZED LAND USE PLAN



The composite light rail transit and busway system plans are carefully cut back versions of the maximum extent light rail transit and busway system plans. The cutbacks were made with the objective of creating more cost-effective systems which could still serve a large part of the Milwaukee area. Under the composite plans, fixed guideways would be limited to Milwaukee County. A total of 49.3 miles of line over which 103 round-trip route miles of service would be provided were retained on three routes, or about 47 percent of the 104.5 miles of line and about 40 percent of the 253 round-trip route miles of service provided under the maximum extent plan. To make this plan comparable to the bus-on-freeway plan, a total of 14 bus-on-freeway routes, operating over 201 miles of line and providing an additional 743 round-trip route miles of primary service, were added to serve portions of the Milwaukee area that would not be served by the three light rail transit or busway primary transit routes. Headways on the light rail transit system would range from 5 to 10 minutes during the peak travel periods, and 8 to 20 minutes in the off-peak periods. Bus-on-freeway service would be provided with headways ranging from 7 to 30 minutes during the peak travel periods, and 15 to 60 minutes in the off-peak periods. A total of 126 primary transit stations or stops would be provided, of which 93 stations would serve the light rail transit system, and 33 stations would serve the bus-on-freeway service. Of the 126 stations, 16 would have park-ride lots for light rail transit, and 33 would have park-ride lots for bus-on-freeway. A total of 96 stations would be located within Milwaukee County, of which 19 would have park-ride lots.

Source: SEWRPC.

Because of the expected 30-year life of the guideways to be constructed under the bus-on-busway and light rail transit plans, and the relatively longer life of rail vehicles, the differences in capital costs between the bus-on-freeway plan and the busway and light rail transit plans over the design period, while substantial, were found to be considerably less than the differences in capital investment. The bus-on-metered freeway plan was found to have the lowest capital costs under each alternative future, ranging from $144 million to $223 million. The capital costs of the busway and light rail transit plans were estimated to range from $268 million to $347 million and from $336 million to $436 million, respectively. For each plan, the lowest capital cost was attendant to the most pessimistic future, and the highest capital cost was attendant to the most optimistic future.

The bus-on-metered freeway plan was also found to have the lowest total public cost, including both capital and net operating and maintenance costs, under each of the four alternative futures, ranging from $594 million to $774 million.[6] The bus-on-busway plan was found to have the next highest total public cost, ranging from $709 to $883 million. The highest total public cost could be expected to be incurred under the light rail transit plans—from $771 million to $964 million. Again, the lowest total cost for each plan may be expected to be incurred under the most pessimistic future for transit use, and the highest cost under the most optimistic future. On a per-passenger-trip basis, the bus-on-metered freeway plan had the lowest total public cost, including capital costs and net operating and maintenance costs, of the three plans, approximating between $0.47 and $0.52 over the 21-year plan design period, compared with between $0.57 and $0.62 for the bus-on-busway plan and between $0.62 and $0.68 for the light rail transit plan. It should be noted that for each plan, the lowest total average cost per passenger over the plan design period was incurred under the most optimistic future for transit use, and the highest cost was incurred under the most pessimistic future.

The results of the test and evaluation of the maximum extent plans revealed the fourth primary transit alternative, commuter rail, to be viable as a system only under the most optimistic future conditions. Furthermore, the test and evaluation indicated that commuter rail would not be a viable alternative at all under the most pessimistic future conditions, and that it would be viable under the intermediate future conditions only in a single route that extends south from the Milwaukee central business district to the Racine and Kenosha areas. The test and evaluation of commuter rail as a truncated system under the most optimistic future and as a single route under the two intermediate futures indicated that commuter rail would entail slightly lower capital costs than comparable bus-on-metered freeway facilities and service, but would result in somewhat lower transit ridership and somewhat higher annual public subsidies of operating and maintenance costs. Consequently, commuter rail would be a less cost-effective alternative. As shown in Table 45, under the moderate growth scenario-centralized land use plan future, the commuter rail system plan would entail nearly 4 percent less capital cost than the bus-on-metered freeway plan, or $215 million compared with $223 million. Under this commuter rail plan, however, about 12,500, or 3 percent, fewer transit trips would be carried on an average weekday than under the bus-on-freeway plan, and about $1.9 million, or 5 percent, more public subsidy would be required for operating and maintenance costs in the design year. Therefore, the commuter rail plan would cost about $7 million more than the bus-on-freeway plan under this alternative future, and would cost about $0.03 more per passenger trip. Both of these figures, however, represent differences of less than 1 percent.

The extent of the differences between the bus-on-metered freeway plan and the commuter rail plan is shown in Table 49 for all three corridors in the commuter rail plan under the moderate growth scenario-centralized land use plan future, and for the Racine-Kenosha corridor under the two intermediate futures, the moderate growth scenario-decentralized land use plan future and the stable or declining growth scenario-centralized land use plan future. While the differences between

[6] *Estimates of total public cost for each plan were based first on the assumption that each plan would be implemented incrementally over the plan design period, and that an equal capital expenditure would thus be made during each year over the 21-year design period, and second on the assumption that the annual operating and maintenance cost subsidy would increase linearly from the current level of about $19 million to the plan design year level.*

the plans under the moderate growth scenario-centralized land use plan alternative future are not large in absolute terms in any of the three corridors, they are large in proportionate terms, particularly in the Port Washington and Oconomowoc-to-Milwaukee corridors, and indicate that the bus-on-freeway plan is the most cost-effective plan of the two. Similarly, comparison of the bus-on-freeway and commuter rail services in the Milwaukee-to-Racine and Kenosha corridor under the moderate growth scenario-decentralized land use plan and stable or declining growth scenario-centralized land use plan alternative futures indicates relatively small differences between the bus-on-freeway and commuter rail alternatives except with respect to cost-effectiveness, or the capital costs and operating and maintenance costs per passenger trip.

Assessment of Intangible Benefits of Alternative Primary Transit System Plans

Also considered in the evaluation of the alternative truncated and composite primary transit system plans were any intangible, or uncertain and unquantifiable, differences between the plans. All of these differences would support public investment in the light rail transit plan, but some would support public investment in the fixed guideway transit plans for busways or commuter rail as well. The intangible benefits considered included the potential for public transit to influence land development and redevelopment; the potential for continued and expanded public transit operation during a severe petroleum energy shortage; the potential for public transit to reduce the localized environmental impacts of public transit; the potential for public transit to increase the reliability and safety of public transit operations; and rider preference for rail transit service over motor bus transit service.

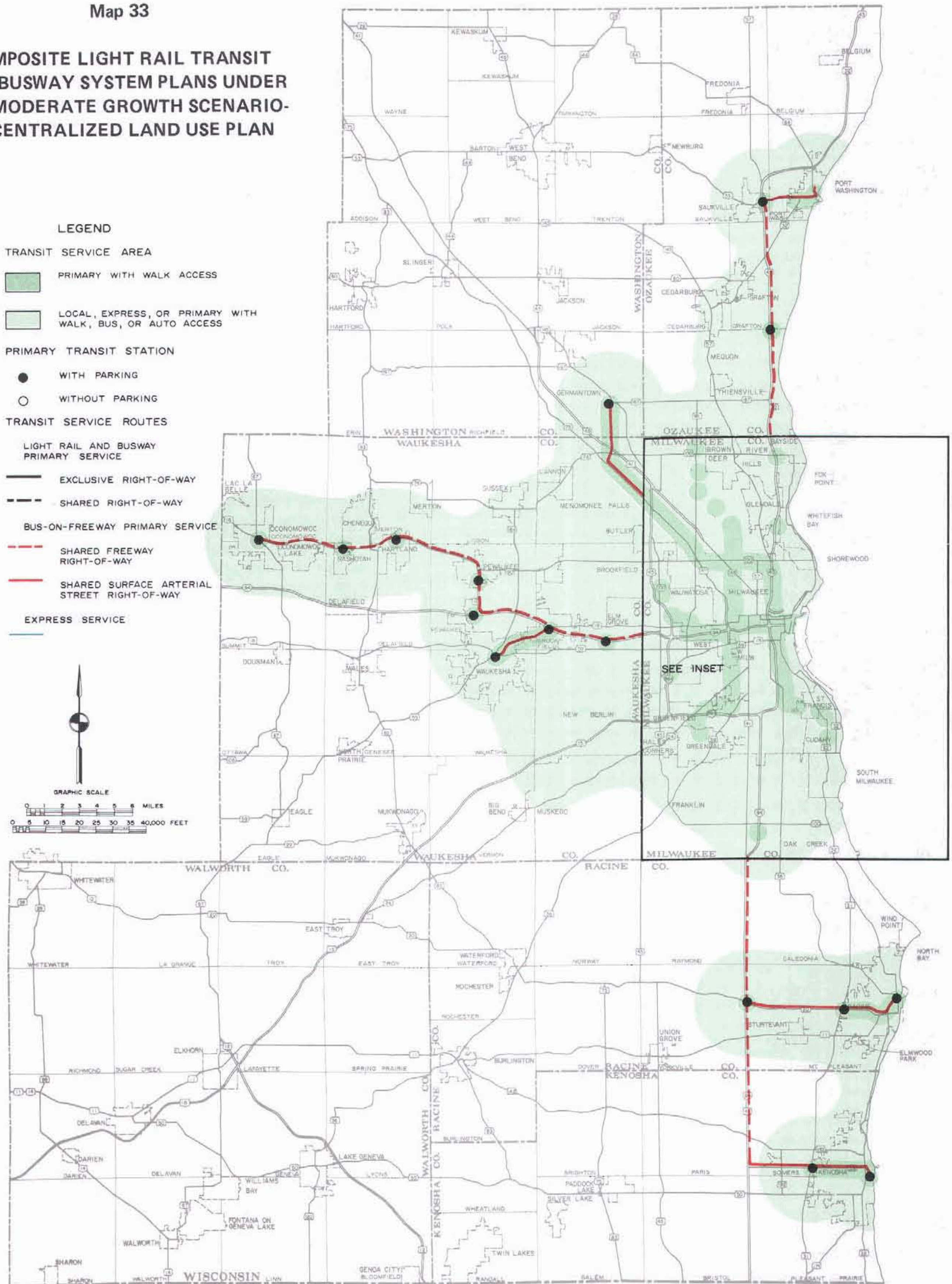
Perhaps the most important of these intangible benefits considered is the potential for public transit to influence urban land development and redevelopment. All transit alternatives which have a fixed guideway and fixed station facilities provide visible evidence of a long-term public commitment to the continued provision of high-quality transit service. Moreover, by providing relatively high-speed service on the fixed guideways, such alternatives generally provide improved accessibility to the land uses adjacent to the guideways. Such alternatives are, therefore, generally considered to have the potential to attract, and thereby guide and shape, urban land use development and redevelopment. Such potential is of great importance, as it would permit public transit to be used to meet land use development objectives, as well as transportation development objectives, through the promotion of sound land use development and the inducement of urban development in desired locations.

Light rail transit is considered by some to have a greater potential to influence land development than bus-on-freeway, bus-on-busway, and commuter rail alternatives for four reasons. First, light rail transit is considered to represent a greater public commitment to the continued provision of a high level of transit service, as it requires the greatest public investment for implementation of these four modes. Second, light rail is considered to represent the most permanent public commitment to a high level of transit service among these four modes because the investment in its guideway cannot be as readily adapted for other uses. Third, light rail transit is considered to be the least objectionable alternative with respect to local environmental impacts. And fourth, light rail transit exclusive guideways and electrically propelled vehicles are considered to provide the greatest increase in the level of transit service over the levels provided by the other alternatives.

It must be noted in this respect, however, that the analyses made under this study indicated that a light rail system in the Milwaukee area would provide about the same level of service and accessibility as a bus-on-metered freeway or bus-on-busway system. Moreover, studies of the land development impacts of fixed guideway transit have indicated that there are a number of other factors which affect urban land development and redevelopment, and that the presence of any one of these other factors is at least as important to whether a transit facility will, in fact, influence land development as the particular transit technology concerned. These other factors include the presence of economic forces which support substantial land use development and redevelopment; the existence of a strong demand for such development and redevelopment in the urban area; the attractiveness of sites surrounding transit stations in terms of ease of access, utilities, and other urban facilities and services, physical features, and social characteristics; the existence of a public land use policy which encourages such development and redevelopment through coordinated tax policies, infrastructure supply, and appropriate land use controls, as well as local neighborhood and community acceptance and approval; and the presence of land near the

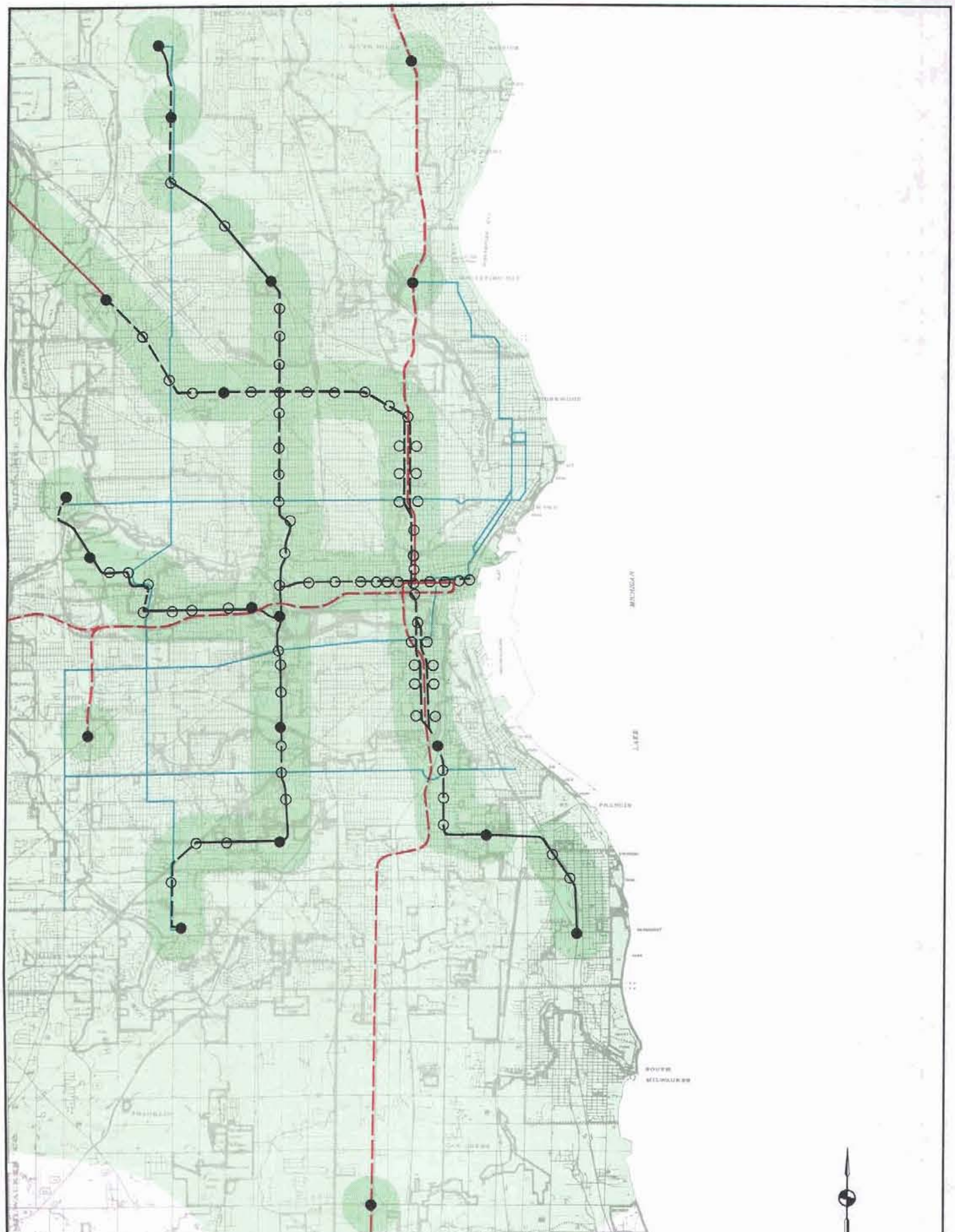
Map 33

COMPOSITE LIGHT RAIL TRANSIT AND BUSWAY SYSTEM PLANS UNDER THE MODERATE GROWTH SCENARIO-DECENTRALIZED LAND USE PLAN



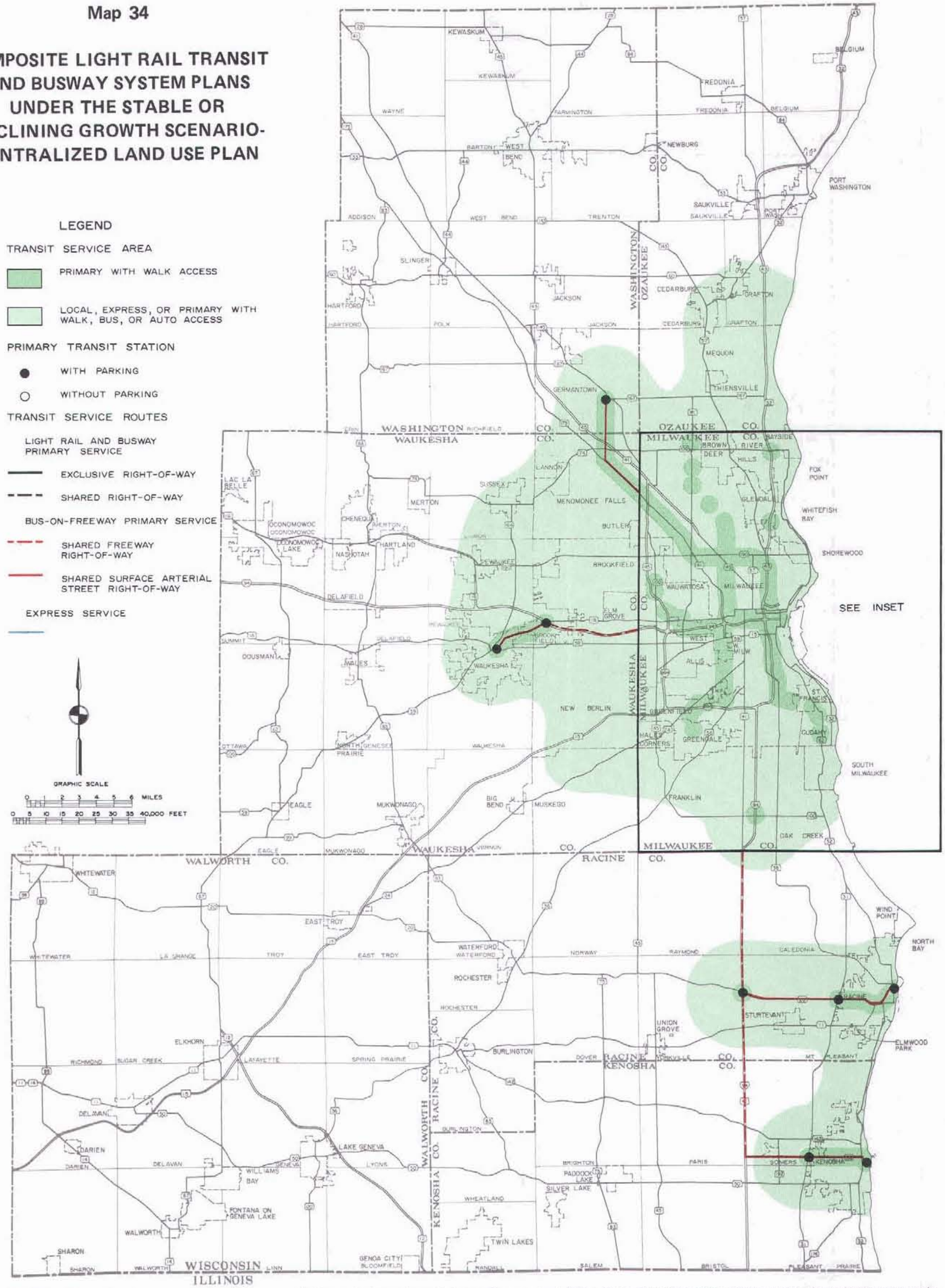
The composite light rail transit and busway system plans are carefully cut back versions of the maximum extent light rail transit and busway system plans. The cutbacks were made with the objective of creating more cost-effective systems which could still serve a large part of the Milwaukee area. Under the composite plans, fixed guideways would be limited to Milwaukee County. A total of 46 miles of line over which 97 round-trip route miles of service would be provided were retained on three routes, or about 44 percent of the 105 miles of line and about 40 percent of the 253 route miles of service provided under the maximum extent plan. To make this plan comparable to the bus-on-freeway plan, a total of seven bus-on-freeway routes operating over 80 miles of line, and providing an additional 432 route miles of primary service, were added to serve portions of the Milwaukee area that would not be served by the three light rail transit or busway primary transit routes. Headways on the light rail transit system would range from 4 to 10 minutes during the peak travel periods, and from 30 to 60 minutes in the off-peak periods. Bus-on-freeway service would be provided with headways ranging from 9 to 30 minutes during the peak travel periods, and 15 to 30 minutes in the off-peak periods. A total of 108 primary transit stations or stops would be provided, of which 89 stations would serve the light rail transit system and 19 stations would serve the bus-on-freeway service. Of the 108 stations, 15 would have park-ride lots for light rail transit and 18 would have park-ride lots for bus on freeway. A total of 92 stations would be located within Milwaukee County, of which 18 would have park-ride lots.

Source: SEWRPC.


GRAPHIC SCALE
0 1/2 1 2 MILES
0 4000 8000 12000 FEET
LAKE MICHIGAN
SOUTH MILWAUKEE

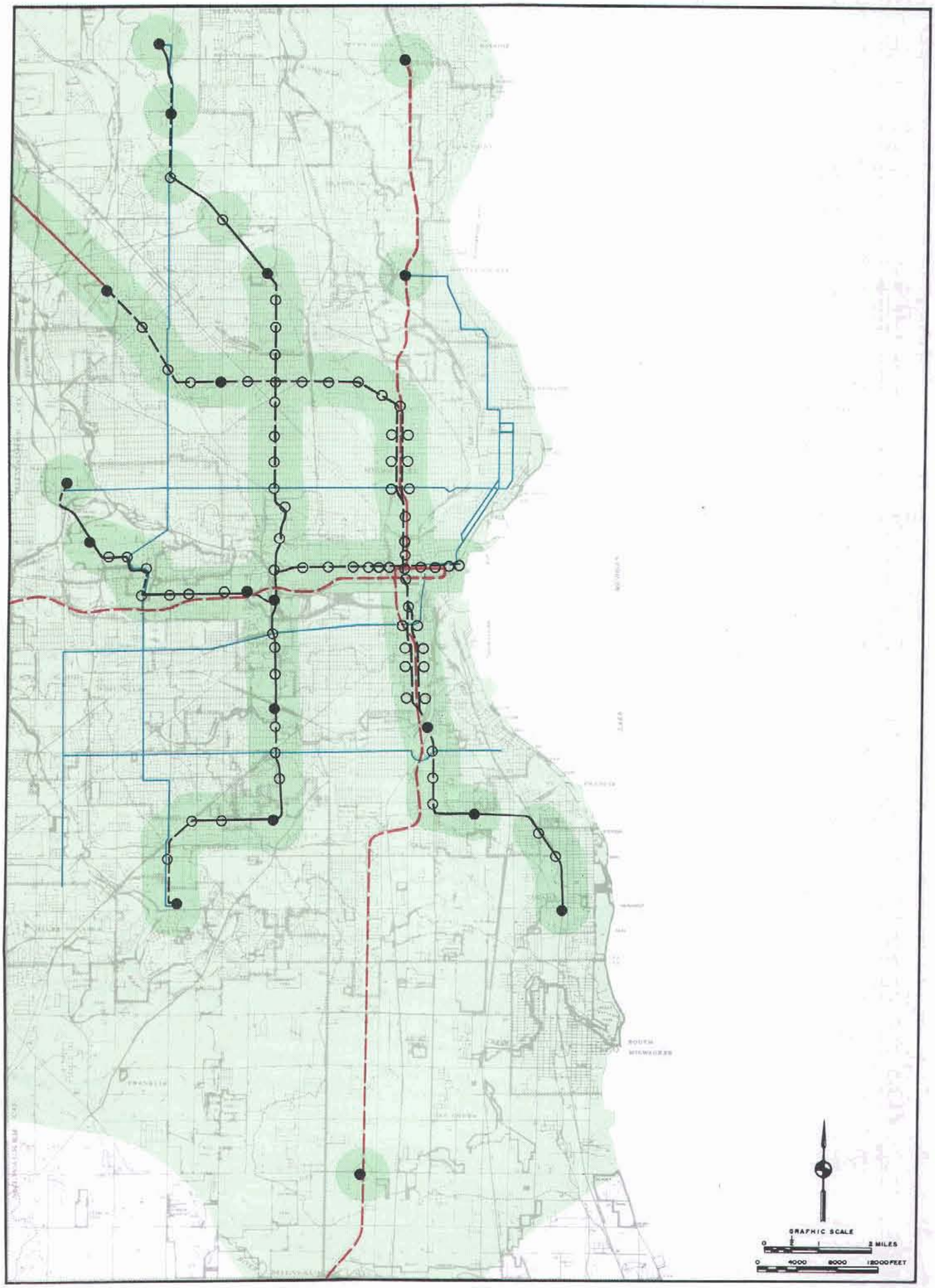
Map 34

COMPOSITE LIGHT RAIL TRANSIT AND BUSWAY SYSTEM PLANS UNDER THE STABLE OR DECLINING GROWTH SCENARIO-CENTRALIZED LAND USE PLAN



The composite light rail transit and busway system plans are carefully cut back versions of the maximum extent light rail transit and busway system plans. The cutbacks were made with the objective of creating more cost-effective systems which could still serve a large part of the Milwaukee area. Under the composite plans, fixed guideways would be limited to Milwaukee County. A total of 46 miles of line over which 97 round-trip route miles of service would be provided were retained on three routes, or about 44 percent of the 105 miles of line and about 38 percent of the 253 route miles of service provided under the maximum extent plan. To make this plan comparable to the bus-on-freeway plan, a total of 6 bus-on-freeway routes operating over 80 miles of line, and providing an additional 276 route miles of primary service, were added to serve portions of the Milwaukee area that would not be served by the three light rail transit or busway primary transit routes. Headways on the light rail transit system would range from 4 to 10 minutes during the peak travel periods, and from 30 to 60 minutes in the off-peak periods. Bus-on-freeway service would be provided with headways ranging from 10 to 30 minutes during the peak travel periods, and 40 to 60 minutes in the off-peak periods. A total of 100 primary transit stations or stops would be provided, of which 89 stations would serve the light rail transit system and 11 stations would serve the bus-on-freeway service. Of the 100 stations, 15 would have park-ride lots for light rail transit and 11 would have park-ride lots for bus on freeway. A total of 92 stations would be located within Milwaukee County, of which 18 would have park-ride lots.

Source: SEWRPC.


GRAPHIC SCALE
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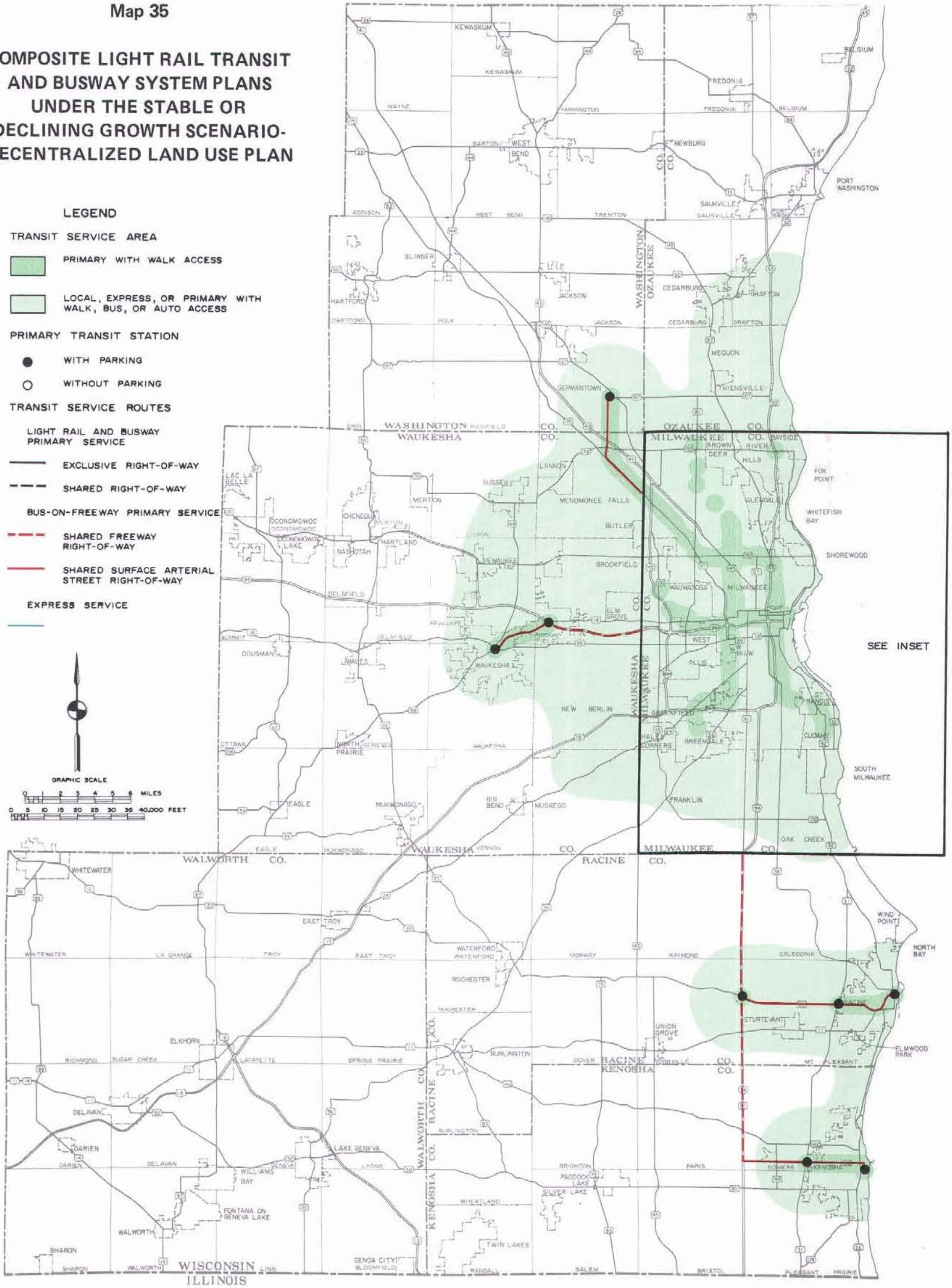
0 4000 8000 12000 FEET

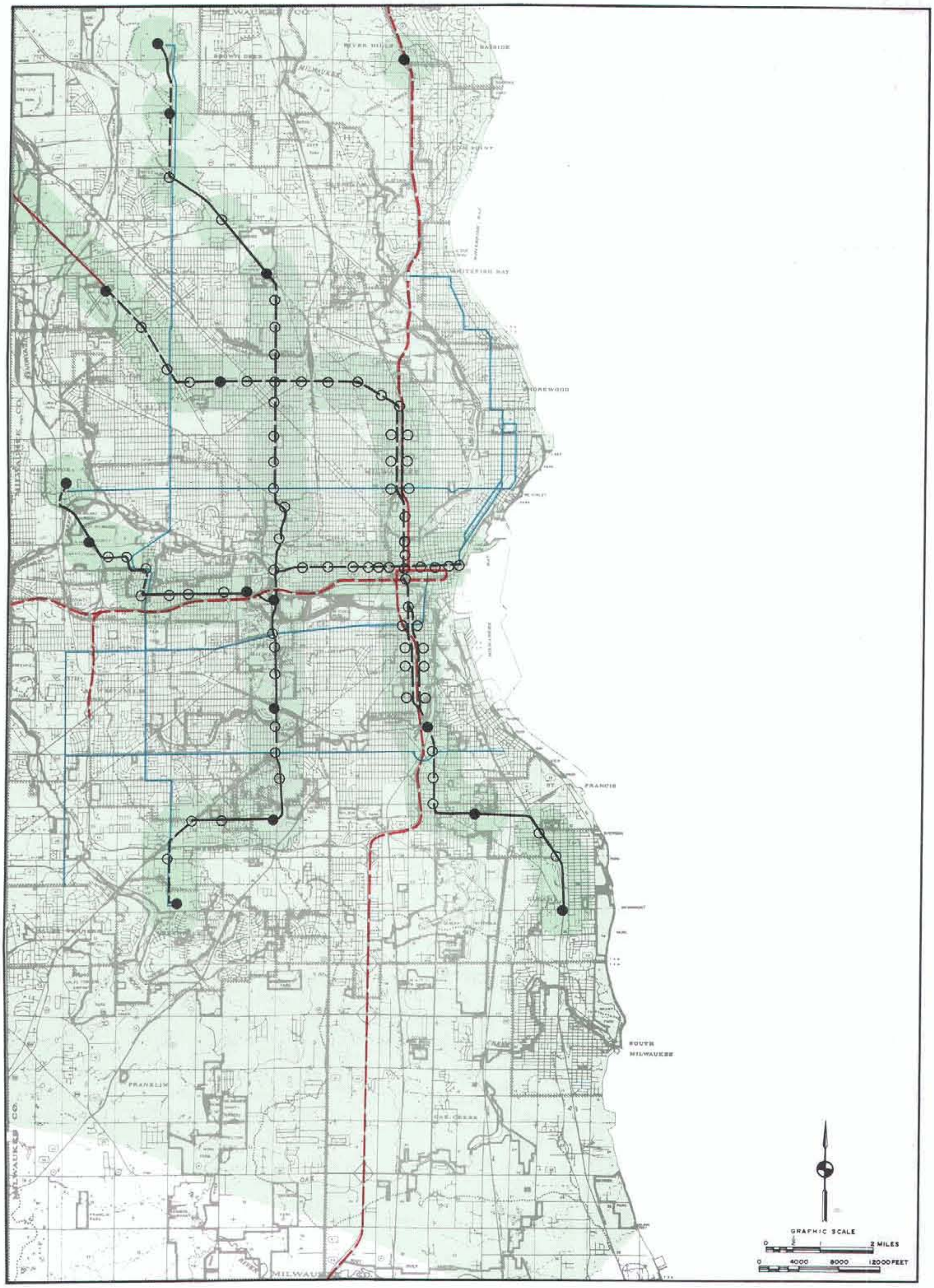
Map 35

COMPOSITE LIGHT RAIL TRANSIT AND BUSWAY SYSTEM PLANS UNDER THE STABLE OR DECLINING GROWTH SCENARIO-DECENTRALIZED LAND USE PLAN



The composite light rail transit and busway system plans are carefully cut back versions of the maximum extent light rail transit and busway system plans. The cutbacks were made with the objective of creating more cost-effective systems which could still serve a large part of the Milwaukee area. Under the composite plans, fixed guideways would be limited to Milwaukee County. A total of 46 miles of line over which 97 round-trip route miles of service would be provided were retained on three routes, or about 44 percent of the 105 miles of line, and about 40 percent of the 253 route miles of service provided under the maximum extent plan. To make this plan comparable to the bus-on-freeway plan, a total of five bus-on-freeway routes operating over 80 miles of line and providing an additional 234 route miles of primary service were added to serve portions of the Milwaukee area that would not be served by the three light rail transit or busway primary transit routes. Headways on the light rail transit system would range from 6 to 12 minutes during the peak travel periods, and would be 60 minutes in the off-peak periods. Bus-on-freeway service would be provided with headways ranging from 22 to 30 minutes during the peak travel periods, and 40 to 60 minutes in the off-peak periods. A total of 98 primary transit stations or stops would be provided, of which 89 stations would serve the light rail transit system and 9 stations would serve the bus-on-freeway service. Of the 98 stations, 15 would have park-ride lots for light rail transit and 9 would have park-ride lots for bus-on-freeway. A total of 90 stations would be located within Milwaukee county, of which 16 would have park-ride lots.

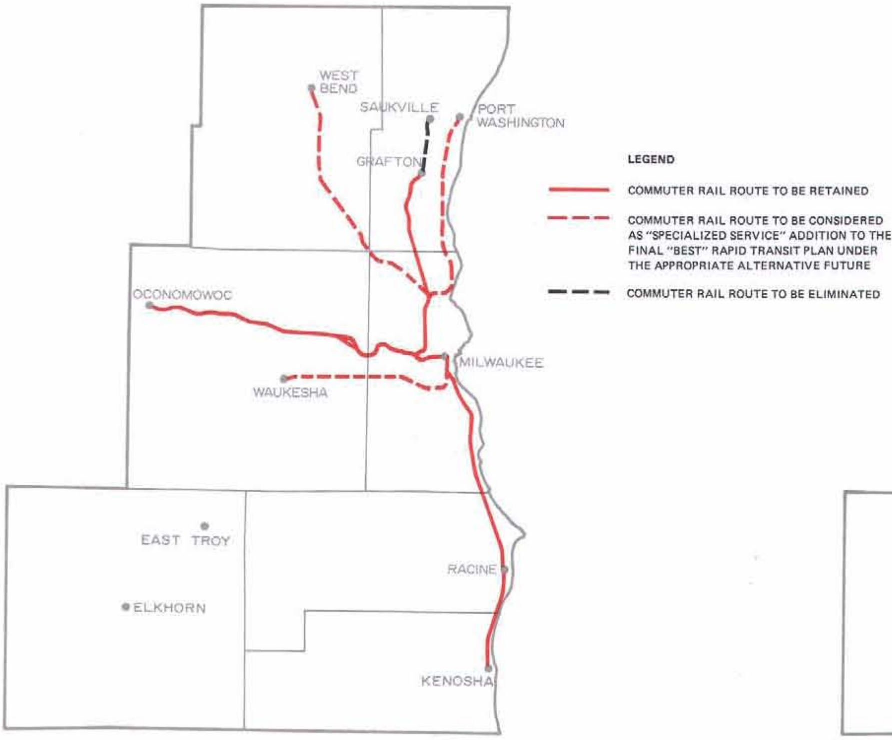
Source: SEWRPC.


RIVER HILLS
BAYSIDE
BROWN DEER
WHITEFISH BAY
SHOREWOOD
ST. FRANCIS
SOUTH
MILWAUKEE
FRANKLIN
OAK CREEK
GRAPHIC SCALE
0
2 MILES
0
4000
8000
12000 FEET

Map 36

TRUNCATED COMMUTER RAIL SYSTEMS UNDER EACH OF THE ALTERNATIVE FUTURES

MODERATE GROWTH-CENTRALIZED
LAND USE PLAN ALTERNATIVE FUTURE



MODERATE GROWTH-DECENTRALIZED
LAND USE PLAN ALTERNATIVE FUTURE

STABLE OR DECLINING GROWTH-CENTRALIZED
LAND USE PLAN ALTERNATIVE FUTURE

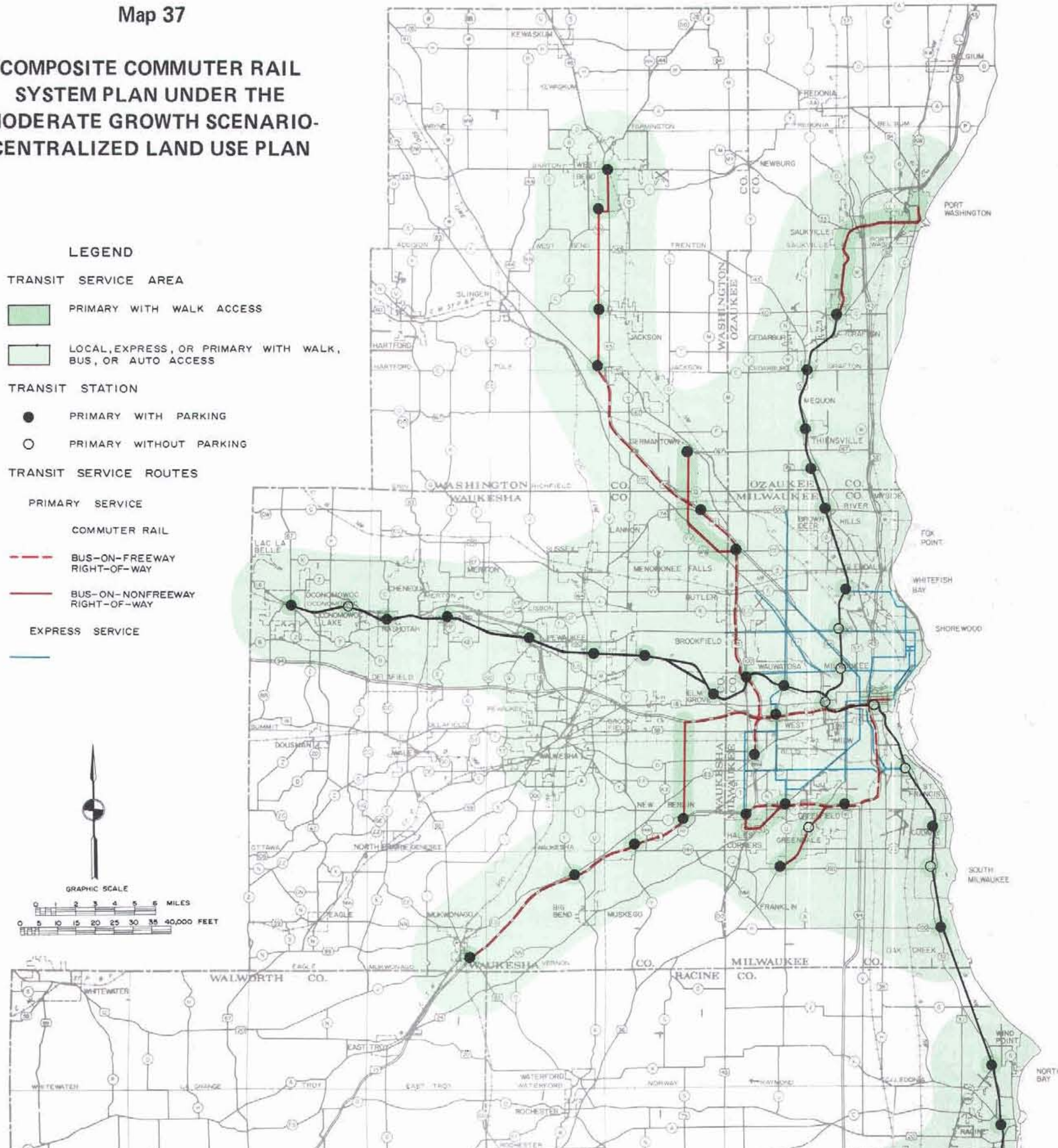
STABLE OR DECLINING GROWTH-DECENTRALIZED
LAND USE PLAN ALTERNATIVE FUTURE

The test and evaluation of the maximum extent commuter rail systems under each alternative future demonstrated that commuter rail would not be viable as a primary transit mode under the complete range of alternative futures. Only under the most optimistic future for transit use in the Milwaukee area was it found that commuter rail could provide viable, all-day service on any route other than that between Milwaukee, Racine, and Kenosha, and thus operate as a true system. Under the least optimistic future for transit use, no commuter rail route could be expected to recover at least one-half of its operating costs from farebox revenues.

Source: SEWRPC.

Map 37

COMPOSITE COMMUTER RAIL SYSTEM PLAN UNDER THE MODERATE GROWTH SCENARIO-CENTRALIZED LAND USE PLAN



The composite commuter rail system plan is a carefully cut back version of the maximum extent commuter rail system plan, the cutbacks being made with the objective of creating a more cost-effective system serving a large part of the Milwaukee area. Under the composite plan, three of the six commuter rail lines totaling 86.2 miles in length and over which a total of 177 round-trip route miles of service would be provided—or about one-half of the 154.5 miles of line and 354 route miles of service provided under the maximum extent plan—were retained. To make this plan comparable to the truncated bus-on-freeway plan, a total of nine bus-on-freeway routes, representing an additional 344 round-trip route miles of primary service, were added to serve portions of the Milwaukee area that would not be served by the three commuter rail primary transit routes. Headways for the commuter rail system would remain the same as under the maximum extent plan, and headways for the bus-on-freeway service would range from 6 to 30 minutes during the peak travel periods and 40 to 60 minutes during the off-peak periods. A total of 46 primary transit stations or stops would be provided, of which 28 stations would serve the commuter rail system and 18 stations would serve the bus-on-freeway service. Of the 46 stations, 38 would have park-ride lots. There would be 20 stations within Milwaukee County, of which 13 would have park-ride lots.

Source: SEWRPC.

Table 45

SUMMARY OF EVALUATION OF THE BASE SYSTEM PLAN AND TRUNCATED AND COMPOSITE PRIMARY TRANSIT SYSTEM PLANS UNDER THE MODERATE GROWTH SCENARIO-CENTRALIZED LAND USE PLAN

Evaluative Measure	Alternative				
	Base Plan	Truncated Bus-on-Freeway Plan	Composite Commuter Rail Plan	Composite Light Rail Transit Plan	Composite Busway Plan
Objective No. 1—Serve Land Use					
Accessibility					
Average Overall Travel Time of Transit Trips to the Milwaukee Central Business District (minutes)	35	34	36	35	37
Objective No. 2—Minimize Cost and Energy Use					
Cost					
Total Public Cost to Design Year (capital cost and operating and maintenance cost deficit)	$579,742,000	$774,474,000	$781,156,400	$964,264,000	$883,375,000
Average Annual Total Public Cost	27,606,600	36,879,700	37,197,900	45,917,000	42,066,200
Capital Cost[a] and Investment					
Capital Cost to Design Year	148,840,000	222,980,000	214,551,000	435,845,000	347,468,000
Average Annual Capital Cost	7,087,600	10,618,100	10,216,700	20,754,500	16,546,100
Capital Investment to Design Year	233,328,700	341,200,000	374,573,200	833,951,200	626,992,700
Average Annual Capital Investment	11,110,900	16,333,700	17,836,800	39,711,900	29,856,800
Operating and Maintenance Cost Deficit (net cost)					
Deficit in Design Year	23,198,300	38,272,600	40,161,600	35,388,300	36,324,300
Deficit to Design Year	430,900,000	551,494,000	566,605,400	528,419,000	535,907,000
Average Annual Deficit	20,519,000	26,261,600	26,981,200	25,162,800	25,519,400
Cost-Effectiveness					
Total Cost to Design Year per Passenger	0.39	0.47	0.50	0.62	0.57
Capital Cost to Design Year per Passenger	0.10	0.14	0.14	0.28	0.22
Operating Deficit to Design Year per Passenger	0.29	0.34	0.36	0.34	0.35
Percent of Operating and Maintenance Cost Met by Farebox Revenue in the Design Year[b]					
Total Transit System	62	56	54	59	59
Primary Element	56	60	52	76	76
Energy					
Total Transit System Energy Use to Design Year (million (BTU's)	20,278,020	24,749,880	24,560,460	26,987,880	25,364,600
Total Transit Construction Energy Use to Design Year (million (BTU's)	1,498,400	1,914,560	2,414,100	3,940,730	3,321,680
Total Transit Operating and Maintenance Energy Use to Design Year (million BTU's)	18,779,620	22,835,320	22,146,360	23,047,150	22,042,920
Total Transit Energy Use per Passenger Mile to Design Year (BTU's)	3,329	3,007	3,229	3,376	3,172
Total Transit Passenger Miles per Gallon of Diesel Fuel to Design Year (BTU's)	40.9	45.2	42.1	40.2	42.9
Dependence on Petroleum-Based Fuel	All trips dependent	All trips dependent	All trips dependent	27 percent of transit trips not dependent	All trips dependent
Petroleum-Based Fuel Use by Transit to Design Year (gallons of diesel fuel)	134,355,000	161,649,000	158,861,000	143,383,000	155,551,000
Automobile Propulsion Energy Use in Design Year (gallons of gasoline)	404,800,000	388,800,000	397,600,000	395,200,000	396,000,000
Objective Nos. 3 and 5—Provide Appropriate Service and Quick Travel					
Average Weekday Transit Trips					
Total Transit System	326,800	378,600	366,100	374,600	372,900
Primary Element	15,000	75,100	46,300	145,100	134,900
Percent of Transit Trips Using Primary Element	4	20	13	39	36
Service Coverage					
Population Served Within a One-Half-Mile Walking Distance of Primary Transit Service	257,100	373,500	190,500	550,900	550,900
Population Served Within a Three-Mile Driving Distance of Primary Transit Service	1,012,400	1,620,700	1,428,200	1,685,600	1,685,600
Jobs Served Within a One-Half-Mile Walking Distance of Primary Transit Service	237,000	293,600	221,300	441,200	441,200
Average Speed of Transit Vehicle (mph)					
Primary Element	19	29	29	26	25
Total System	14	18	16	18	18
Average Speed of Passenger Travel on Vehicle (mph)					
Primary Element	25	34	30	27	26
Total System	15	21	18	20	20

Table 45 (continued)

Evaluative Measure	Alternative: Base Plan	Truncated Bus-on-Freeway Plan	Composite Commuter Rail Plan	Composite Light Rail Transit Plan	Composite Busway Plan
Objective No. 4—Minimize Environmental Impacts					
Community Disruption					
Homes, Businesses, or Industries Taken	None	None	None	None	None
Land Required (acres)	12	70	90	210	200
Air Pollutant Emissions—Total Transportation System (Highway and Transit) in Design Year (tons per year)					
Carbon Monoxide	171,193	167,368	168,440	167,055	167,508
Hydrocarbons	17,361	16,887	17,025	16,853	16,905
Nitrogen Oxides	30,693	29,988	30,371	30,000	30,015
Sulfur Oxides	2,514	2,502	2,533	2,754	2,499
Particulates	4,086	4,018	4,046	4,032	4,019
Objective No. 6—Maximize Safety					
Proportion of Total Person Trips Made on Transit	0.074	0.086	0.083	0.085	0.084

[a] *The capital cost of a composite plan is equal to the plan's required capital investment, or total capital outlays necessary over the plan design period, less the value of that investment beyond the plan design period.*

[b] *Transit revenues were assigned entirely to the primary transit element for primary transit trips which used, through transfers, local or express transit as a feeder or distributor to the primary transit element. The proportion of trips using primary transit which transfers to or from local and express services was found to be highest under the commuter rail plan—1.2 transfers per primary trip—and lowest under the light rail transit and busway plans—0.4 transfer per primary trip. Under the bus-on-freeway plan, 0.7 transfer was made per primary trip. Consequently, to some extent a disproportionate share of transit revenues was assigned to each plans's primary element, this disproportionate share being the highest under the commuter rail plan and the lowest under the light rail transit and busway plans.*

Source: SEWRPC.

stations which is available, or which can be readily assembled, for development. Consequently, it may be concluded that any increased land development potential of light rail transit over other transit alternatives must be considered uncertain at best. And yet, it can also be concluded that the potential benefits are large; the evolution of a more desirable land use pattern in southeastern Wisconsin, such as that postulated in the adopted regional land use plan—which seeks to centralize land use development to the greatest extent practicable—could serve to protect the environment and natural resources of the Region; preserve and revitalize the City of Milwaukee; and reduce the public and private costs of land development and supporting facilities and services, including public transit.

Another significant, though intangible, advantage of electrically propelled light rail transit which was considered was its potential not to be directly and adversely affected by a serious petroleum shortage and, in fact, to be readily expanded to limits imposed by safe minimum headways and vehicle fleet size. The limitations of this advantage were also recognized. First, it was recognized that any substantial expansion of light rail transit operation during a petroleum energy emergency situation would be difficult because of the lengthy lead time necessary for the manufacture of new vehicles and vehicle components. Second, it was recognized that the composite light rail transit system plans considered for the Milwaukee area could accommodate only about one-fourth of the transit trips in the Milwaukee area, with the remaining trips having to be made on diesel motor buses in travel corridors where light rail facilities were not provided. Under the composite light rail transit plan, petroleum-based fuels would be expected to account for about 80 percent of the energy used by the transit operations on an average weekday in the design year. Finally, it was determined that the operation of transit alternatives which are not electrically propelled need not be severely curtailed during a petroleum shortage, as motor fuels could be expected to be rationed under such a shortage, with priority given to public transit.

Another intangible advantage of light rail transit which was considered was its potential to minimize the localized environmental impacts of transit operations. Light rail transit vehicles emit no air pollutants along the routes of operation, as such associated emissions are released at remotely located central electric power generating stations.

Table 46

SUMMARY OF EVALUATION OF THE BASE SYSTEM PLAN AND TRUNCATED AND COMPOSITE PRIMARY TRANSIT SYSTEM PLANS UNDER THE MODERATE GROWTH SCENARIO-DECENTRALIZED LAND USE PLAN

Evaluative Measure	Base Plan	Alternative: Truncated Bus-on-Freeway Plan	Alternative: *Composite Light Rail Transit Plan*	Alternative: Composite Busway Plan
Objective No. 1—Serve Land Use				
Accessibility				
Average Overall Travel Time of Transit Trips to the Milwaukee Central Business District (minutes)	35	35	34	35
Objective No. 2—Minimize Cost and Energy Use				
Cost				
Total Public Cost to Design Year (capital cost and operating and maintenance deficit)	$542,926,400	$691,313,400	$862,822,200	$798,761,400
Average Annual Total Public Cost	25,853,600	32,919,700	41,086,800	38,036,200
Capital Cost[a] and Investment				
Capital Cost to Design Year	124,606,600	172,448,000	358,740,800	280,747,400
Average Annual Capital Cost	5,933,620	8,211,800	17,082,900	13,368,900
Capital Investment to Design Year	186,198,500	263,877,500	686,968,300	506,478,100
Average Annual Capital Investment	8,866,600	12,565,600	32,712,800	24,118,000
Operating and Maintenance Cost Deficit (net cost)				
Deficit in Design Year	21,625,900	34,194,100	32,346,100	34,088,300
Deficit to Design Year	418,319,800	518,865,400	504,081,400	518,014,000
Average Annual Deficit	19,919,950	24,707,900	24,003,900	24,667,300
Cost-Effectiveness				
Total Cost to Design Year per Passenger	0.44	0.54	0.68	0.63
Capital Cost to Design Year per Passenger	0.10	0.13	0.28	0.22
Operating Deficit to Design Year per Passenger	0.30	0.35	0.34	0.36
Percent of Operating and Maintenance Cost Met by Farebox Revenue in the Design Year				
Total Transit System	53	48	49	47
Primary Element	45	54	73	66
Energy				
Total Transit System Energy Use to Design Year (million BTU's)	16,407,170	19,368,060	21,435,230	20,788,590
Total Transit Construction Energy Use to Design Year (million BTU's)	1,220,540	1,527,960	3,432,030	3,173,490
Total Transit Operating and Maintenance Energy Use to Design Year (million BTU's)	15,186,630	17,840,100	18,003,200	17,615,100
Total Transit System Energy Use per Passenger Mile Traveled to Design Year (BTU's)	3,250	3,140	3,530	3,440
Total Transit Passenger Miles per Gallon of Diesel Fuel to Design Year (BTU's)	40.9	43.4	38.5	39.6
Dependence on Petroleum-Based Fuel	All trips dependent	All trips dependent	22 percent of transit trips not dependent	All trips dependent
Petroleum-Based Fuel Use by Transit to Design Year (gallons of diesel fuel)	108,687,720	126,769,340	115,355,000	124,767,210
Automobile Propulsion Energy Use in Design Year (gallons of gasoline)	449,600,000	440,800,000	440,800,000	440,800,000

Table 46 (continued)

Evaluative Measure	Alternative: Base Plan	Truncated Bus-on-Freeway Plan	Composite Light Rail Transit Plan	Composite Busway Plan
Objective Nos. 3 and 5—Provide Appropriate Service and Quick Travel				
Average Weekday Transit Trips				
Total Transit System	217,400	242,100	239,600	238,300
Primary Element	10,300	37,300	83,200	75,500
Proportion of Transit Trips Using Primary Element	0.047	0.154	0.347	0.317
Service Coverage				
Population Served Within a One-Half-Mile Walking Distance of Primary Transit Service	234,200	228,400	394,700	394,700
Population Served Within a Three-Mile Driving Distance of Primary Transit Service	930,400	1,343,400	1,424,700	1,424,700
Jobs Served Within a One-Half-Mile Walking Distance of Primary Transit Service	190,500	206,400	329,000	329,000
Average Speed of Transit Vehicle (mph)				
Primary Element	23	29	25	24
Total System	15	17	17	17
Average Speed of Passenger Travel on Vehicle (mph)				
Primary Element	25	35	26	26
Total System	15	20	19	19
Objective No. 4—Minimize Environmental Impacts				
Community Disruption				
Homes, Businesses, or Industries Taken	None	None	None	None
Land Required (acres)	9	40	145	142
Air Pollutant Emissions—Total Transportation System (Highway and Transit) in Design Year (tons per year)				
Carbon Monoxide	189,027	185,602	185,523	185,732
Hydrocarbons	19,654	19,163	19,156	19,180
Nitrogen Oxides	34,294	33,615	33,646	33,641
Sulfur Oxides	2,656	2,688	2,844	2,688
Particulates	4,480	4,412	4,425	4,416
Objective No. 6—Maximize Safety				
Proportion of Total Person Trips Made on Transit	0.050	0.055	0.055	0.054

[a] *The capital cost of a composite plan is equal to the plan's required capital investment, or total capital outlays necessary over the plan design period, less the value of that investment beyond the plan design period.*

Source: SEWRPC.

Diesel motor buses, on the other hand, release about one-half the carbon monoxide and hydrocarbons, six times the nitrogen oxides, and about three times the particulate matter released by an automobile along the routes of operation. In addition, a diesel motor bus may be expected to generate about 20 percent more noise than a light rail transit vehicle, and about 5 to 15 percent more noise than an automobile.

The potential air and noise reduction benefits, however, would be very localized, since the air pollutant emission levels and noise levels of automobiles and trucks dominate those of transit vehicles on a systemwide basis. Such air pollutant emission levels and noise levels would, therefore, be nearly the same under all alternative transit plans. Moreover, even within specific corridors, the differences between diesel motor buses and light

Table 47

SUMMARY OF EVALUATION OF THE BASE SYSTEM PLAN AND TRUNCATED AND COMPOSITE PRIMARY TRANSIT SYSTEM PLANS UNDER THE STABLE OR DECLINING GROWTH SCENARIO-CENTRALIZED LAND USE PLAN

Evaluative Measure	Alternative			
	Base Plan	Truncated Bus-on-Freeway Plan	Composite Light Rail Transit Plan	Composite Busway Plan
Objective No. 1—Serve Land Use				
Accessibility				
Average Overall Travel Time of Transit Trips to the Milwaukee Central Business District (minutes)	34	34	33	33
Objective No. 2—Minimize Cost and Energy Use				
Cost				
Total Public Cost to Design Year (capital cost and operating and maintenance deficit)	$493,042,100	$603,060,000	$775,703,000	$727,150,000
Average Annual Total Public Cost	23,478,200	28,717,150	36,938,300	34,626,200
Capital Cost[a] and Investment				
Capital Cost to Design Year	119,819,100	158,150,000	351,363,900	283,220,900
Average Annual Capital Cost	5,705,700	7,530,950	16,731,600	13,486,700
Capital Investment to Design Year	180,851,300	225,928,500	634,755,700	478,082,100
Average Annual Capital Investment	8,611,950	10,758,500	30,226,400	22,765,800
Operating and Maintenance Cost Deficit (net cost)				
Deficit in Design Year	15,988,800	24,949,200	22,378,600	24,826,600
Deficit to Design Year	373,223,000	444,910,000	424,340,000	443,930,000
Average Annual Deficit	17,772,500	21,186,200	20,206,700	21,139,500
Cost-Effectiveness				
Total Cost to Design Year per Passenger	0.40	0.48	0.62	0.58
Capital Cost to Design Year per Passenger	0.10	0.12	0.28	0.23
Operating Deficit to Design Year per Passenger	0.30	0.35	0.34	0.36
Percent of Operating and Maintenance Cost Met by Farebox Revenue in the Design Year				
Total Transit System	61	53	55	53
Primary Element	49	48	78	71
Energy				
Total Transit System Energy Use to Design Year (million BTU's)	15,901,220	17,851,980	19,531,520	19,329,100
Total Transit Construction Energy Use to Design Year (million BTU's)	1,163,820	1,329,060	3,181,920	3,034,260
Total Transit Operating and Maintenance Energy Use to Design Year (million BTU's)	14,737,400	16,522,920	16,349,600	16,294,840
Total Transit System Energy Use per Passenger Mile Traveled to the Design Year (BTU's)	3,420	3,490	3,940	3,890
Total Transit Passenger Miles per Gallon of Diesel Fuel to Design Year (BTU's)	39.8	39.0	34.5	34.9
Dependence on Petroleum-Based Fuel	All trips dependent	All trips dependent	21 percent of transit trips not dependent	All trips dependent
Petroleum-Based Fuel Use by Transit to Design Year (gallons of diesel fuel)	106,105,800	118,551,250	107,739,200	116,971,470
Automobile Propulsion Energy Use in Design Year (gallons of gasoline)	314,400,000	309,600,000	309,600,000	310,400,000

Table 47 (continued)

Evaluative Measure	Alternative: Base Plan	Truncated Bus-on-Freeway Plan	Composite Light Rail Transit Plan	Composite Busway Plan
Objective Nos. 3 and 5—Provide Appropriate Service and Quick Travel				
Average Weekday Transit Trips				
Total Transit System	215,900	228,500	224,800	223,700
Primary Element	10,000	22,500	57,300	50,300
Proportion of Transit Trips Using Primary Element	0.05	0.10	0.25	0.22
Service Coverage				
Population Served Within a One-Half-Mile Walking Distance of Primary Transit Service	203,000	163,200	319,400	319,400
Population Served Within a Three-Mile Driving Distance of Primary Transit Service	775,100	881,700	1,047,200	1,047,200
Jobs Served Within a One-Half-Mile Walking Distance of Primary Transit Service	205,700	194,000	337,600	337,600
Average Speed of Transit Vehicle (mph)				
Primary Element	23	28	24	23
Total System	15	16	16	16
Average Speed of Passenger Travel on Vehicle (mph)				
Primary Element	25	33	24	23
Total System	15	18	17	17
Objective No. 4—Minimize Environmental Impacts				
Community Disruption				
Homes, Businesses, or Industries Taken	None	None	None	None
Land Required (acres)	12	20	113	110
Air Pollutant Emissions—Total Transportation System (Highway and Transit) in Design Year (tons per year)				
Carbon Monoxide	154,784	152,507	152,484	152,677
Hydrocarbons	153,333	15,046	15,047	15,068
Nitrogen Oxides	27,488	27,034	27,065	27,071
Sulfur Oxides	2,306	2,292	2,406	2,294
Particulates	3,717	3,673	3,680	3,675
Objective No. 6—Maximize Safety				
Proportion of Total Person Trips Made on Transit	0.059	0.063	0.062	0.062

[a] *The capital cost of a composite plan is equal to the plan's required capital investment, or total capital outlays necessary over the plan design period, less the value of that investment beyond the plan design period.*

Source: SEWRPC.

rail transit vehicles were considered to be relatively insignificant, given that the primary transit vehicles would be operated at 3- to 60-minute headways, and given the presence of other urban noise, such as motor vehicle traffic surrounding primary transit facilities provided over medians or reserved lanes on surface streets. It was therefore concluded that only in the central business district of Milwaukee could any significant differences in transit noise and air pollution be expected between the alternative transit plans. In the central business district, transit traffic volumes would be significant compared to automobile and truck traffic volumes. On the proposed Wisconsin Avenue transit mall only transit vehicle traffic would be permitted, and transit vehicle traffic volumes would be substantial. Under the most optimistic alternative future, the composite light rail transit system plan would

Table 48

SUMMARY OF EVALUATION OF THE BASE SYSTEM PLAN AND TRUNCATED AND COMPOSITE PRIMARY TRANSIT SYSTEM PLANS UNDER THE STABLE OR DECLINING GROWTH SCENARIO-DECENTRALIZED LAND USE PLAN

Evaluative Measure	Alternative			
	Base Plan	Truncated Bus-on-Freeway Plan	Composite Light Rail Transit Plan	Composite Busway Plan
Objective No. 1—Serve Land Use				
Accessibility				
Average Overall Travel Time of Transit Trips to the Milwaukee Central Business District (minutes)	34	34	35	36
Objective No. 2—Minimize Cost and Energy Use				
Cost				
Total Public Cost to Design Year (capital cost and operating and maintenance deficit)	$483,703,200	$593,539,800	$771,032,400	$709,009,800
Average Annual Total Public Cost	23,033,500	28,263,800	36,715,850	33,762,400
Capital Cost[a] and Investment				
Capital Cost to Design Year	107,761,000	143,648,000	336,039,000	268,270,000
Average Annual Capital Cost	5,131,500	6,840,400	16,001,900	12,774,800
Capital Investment to Design Year	161,597,700	203,037,300	606,946,100	452,763,300
Average Annual Capital Investment	7,695,100	9,668,400	28,902,200	21,560,100
Operating and Maintenance Cost Deficit (net cost)				
Deficit in Design Year	16,328,700	25,572,400	23,710,100	23,828,400
Deficit to Design Year	375,942,200	449,891,800	434,993,400	440,739,800
Average Annual Deficit	17,902,000	21,423,400	20,713,450	20,987,600
Cost-Effectiveness				
Total Cost to Design Year per Passenger	0.43	0.52	0.68	0.62
Capital Cost to Design Year per Passenger	0.10	0.12	0.30	0.24
Operating Deficit to Design Year per Passenger	0.33	0.39	0.38	0.39
Percent of Operating and Maintenance Cost Met by Farebox Revenue in the Design Year				
Total Transit System	53	46	48	47
Primary Element	49	42	72	64
Energy				
Total Transit System Energy Use to Design Year (million BTU's)	15,037,280	16,809,400	18,676,480	18,075,450
Total Transit Construction Energy Use to Design Year (million BTU's)	1,044,480	1,193,400	3,038,580	2,906,250
Total Transit Operating and Maintenance Energy Use to Design Year (million BTU's)	13,992,800	15,616,000	15,637,900	15,169,200
Total Transit Energy Use per Passenger Mile to Design Year (BTU's)	3,530	3,650	4,150	4,020
Total Transit Passenger Miles per Gallon of Diesel Fuel to Design Year (BTU's)	38.5	37.3	32.8	33.8
Dependence on Petroleum-Based Fuel	All trips dependent	All trips dependent	21 percent of transit trips not dependent	All trips dependent
Petroleum-Based Fuel Use by Transit to Design Year (gallons of diesel fuel)	100,744,850	112,045,440	103,587,210	108,893,900
Automobile Propulsion Energy Use in Design Year (gallons of gasoline)	338,400,000	332,800,000	332,800,000	333,600,000

Table 48 (continued)

Evaluative Measure	Alternative: Base Plan	Truncated Bus-on-Freeway Plan	Composite Light Rail Transit Plan	Composite Busway Plan
Objective Nos. 3 and 5—Provide Appropriate Service and Quick Travel				
Average Weekday Transit Trips				
Total Transit System	169,400	180,200	178,100	177,200
Primary Element	9,500	15,300	43,500	37,600
Proportion of Transit Trips Using Primary Element	0.06	0.08	0.24	0.21
Service Coverage				
Population Served Within a One-Half Mile Walking Distance of Primary Transit Service	181,500	163,700	294,800	294,800
Population Served Within a Three-Mile Driving Distance of Primary Transit Service	698,800	741,700	917,300	917,300
Jobs Served Within a One-Half-Mile Walking Distance of Primary Transit Service	194,600	186,900	315,500	315,500
Average Speed of Transit Vehicle (mph)				
Primary Element	24	28	24	23
Total System	15	16	16	16
Average Speed of Passenger Travel on Vehicle (mph)				
Primary Element	25	32	25	23
Total System	15	18	17	17
Objective No. 4—Minimize Environmental Impacts				
Community Disruption				
Homes, Businesses, or Industries Taken	None	None	None	None
Land Required (acres)	10	14	103	100
Air Pollutant Emissions—Total Transportation System (Highway and Transit) in Design Year (tons per year)				
Carbon Monoxide	165,764	163,309	163,283	163,395
Hydrocarbons	16,702	16,392	16,392	16,405
Nitrogen Oxides	30,073	29,183	29,206	29,201
Sulfur Oxides	2,426	2,410	2,540	2,400
Particulates	3,959	3,909	3,917	3,910
Objective No. 6—Maximize Safety				
Proportion of Total Person Trips Made on Transit	0.047	0.050	0.049	0.049

[a] The capital cost of a composite plan is equal to the plan's required capital investment, or total capital outlays necessary over the plan design period, less the value of that investment beyond the plan design period.

Source: SEWRPC.

replace the 150 to 200 buses called for by the busway, bus-on-freeway, and commuter rail alternatives during peak travel periods with 33 two-car trains of light rail vehicles. Under the most pessimistic alternative future, between 75 and 100 diesel motor buses would be replaced with 36 one-car trains of light rail vehicles.

An intangible advantage attributed to all fixed guideway—light rail transit, bus-on-freeway, and commuter rail—public transit was that it is generally considered to be more reliable than public transit provided over arterial streets in mixed traffic. This is because fixed guideway public transit should not be as readily affected by traffic congestion, traffic accidents, or street and utility repairs. Also, operational problems caused by inclement weather—especially snow and ice—may be expected to be less severe than such problems for buses operated on public streets. It was noted, however, that any motor bus or light rail fixed guideways located within arterial street medians or

Table 49

CORRIDOR COMPARISON OF EVALUATIVE MEASURES FOR THE BUS-ON-FREEWAY AND COMMUTER RAIL ALTERNATIVES

	Moderate Growth Scenario-Centralized Land Use Plan									Moderate Growth Scenario-Decentralized Land Use Plan			Stable or Declining Growth Scenario-Centralized Land Use Plan		
	Port Washington Corridor			Oconomowoc Corridor			Racine-Kenosha Corridor			Racine-Kenosha Corridor			Racine-Kenosha Corridor		
		Commuter Rail			Commuter Rail			Commuter Rail			Commuter Rail			Commuter Rail	
Evaluative Measure	Bus on Freeway	Primary Element	Total Transit Service	Bus on Freeway	Primary Element	Total Transit Service	Bus on Freeway	Primary Element	Total Transit Service	Bus on Freeway	Primary Element	Total Transit Service	Bus on Freeway	Primary Element	Total Transit Service
Ridership															
Average Weekday Passengers	16,000	5,700	11,500	10,500	4,400	7,800	21,700	13,200	18,000	13,900	9,800	12,100	8,300	4,500	6,670
Design Year Passengers	4,088,000	1,457,000	2,689,000	2,689,000	1,117,000	2,103,000	5,532,000	3,376,000	4,768,000	3,544,500	2,499,000	3,166,000	2,116,500	1,147,500	1,776,800
Capital Cost and Investment															
Total Capital Cost to Design Year	$13,637,400	$11,257,700	$13,927,800	$ 9,362,100	$ 8,402,600	$ 9,967,800	$17,070,200	$16,000,000	$18,118,500	$17,158,600	$15,315,800	$16,449,600	$10,210,400	$11,243,600	$12,311,100
Total Capital Investment to Design Year	24,657,200	28,348,000	32,486,700	17,019,000	21,878,000	24,304,100	30,270,600	40,900,000	44,751,800	30,103,800	37,136,000	39,236,000	17,859,400	26,425,400	28,366,400
Operating Cost															
Operating Cost in Design Year	$ 4,119,600	$ 2,473,200	$ 3,720,000	$ 3,356,000	$ 2,503,200	$ 3,234,100	$ 8,175,000	$ 6,617,400	$ 7,781,200	$ 5,253,000	$ 4,772,600	$ 5,345,900	$ 3,534,800	$ 2,677,500	$ 3,197,500
Percent of Operating Cost Met by Farebox Revenue in the Design Year	66	48	50	61	42	45	63	60	59	69	64	62	46	44	45
Net Operating Cost (deficit) in the Design Year	1,384,200	1,287,000	1,848,800	1,323,400	1,440,400	1,769,700	3,000,500	2,663,100	3,189,500	1,628,400	1,662,600	2,012,900	1,895,150	1,491,750	1,756,950
Cost-Effectiveness															
Net Operating Cost per Passenger in the Design Year	$0.33	$0.88	$0.59	$0.49	$1.29	$0.84	$0.54	$0.78	$0.67	$0.46	$0.67	$0.64	$0.90	$1.30	$0.99
Capital Cost to Design Year per Passenger in the Design Year	3.30	7.70	4.40	3.50	7.50	4.70	3.10	4.70	3.80	4.84	6.12	5.19	4.82	9.80	6.93

Source: SEWRPC.

reserved lanes have some potential to be affected by traffic problems, and that all the fixed guideway transit alternatives could be affected by vehicle traffic at at-grade intersections. In addition, all rail transit modes were noted as having the potential for an entire guideway segment to lose service should a single vehicle or train break down or become involved in an accident since, unlike rubber-tired motor vehicles, rail vehicles cannot be steered around obstructions. Light rail transit service disruptions were noted as also having the potential to occur from power outages and breakdowns in the overhead power distribution system.

The potentially greater safety of the three composite system plans requiring fixed guideways was also identified as an intangible advantage over the truncated bus-on-freeway system plan. This safety advantage stems from the extensive use of dedicated rights-of-way under these plans, in addition to the preferential treatment granted these systems at at-grade intersections. Boarding and deboarding accidents, which are among the most common types of accidents in current-day transit operations, would be significantly reduced under the composite light rail transit plan if high-level boarding platforms were used at stations. Light rail transit and commuter rail vehicles also offer greater protection to passengers in the event of vehicle-to-vehicle and vehicle-to-fixed object collisions than do motor buses because of the overall larger size and stronger structural design of the frame and body of the rail vehicles.

Another intangible advantage attributed to all fixed guideway public transit was the belief of proponents of light rail transit and commuter rail that transit passengers prefer rail transit services to equivalent motor bus transit services. The basis of this argument is that there is something about rail transit which makes it intrinsically more attractive than the diesel motor bus transit modes, even if the levels of service provided are the same. This attraction is usually described in terms of ride quality, comfort, or image.

All these intangible benefits for fixed guideway primary transit, but particularly for light rail transit, were thoughtfully considered by the Advisory Committee in comparing the alternative plans, even though these benefits could not be precisely quantified and, in some cases, the degree to which any benefit could actually be attained was regarded as uncertain and controversial. These intangible benefits were discussed at the Advisory Committee meetings, and members of the Committee raised a number of other subjective considerations as well. Whether these additional subjective considerations would have a significant impact on the operations, efficiency, and practicality of any one of the alternative primary transit system plans was also unknown, thus making their potential impacts speculative. These considerations included the effect of labor disruptions, the impact of the potential deterioration of the highway system through deferred maintenance, the effect of widespread emergency situations, the effect of Milwaukee area climatic conditions, the long-range usefulness of the transit alternatives in view of advances in technology, the effect of current land use decentralization trends, and the probability of implementation of the alternatives.

It was concluded that insofar as the operation of transit vehicles is concerned, service under all of the alternative plans would be equally prone to labor disruptions as all transit vehicle operators can be expected to be represented by labor agreements. Should supervisory personnel be required to continue operations during a strike, then light rail transit or commuter rail, which have a higher level of productivity in terms of passengers per operator and can be assembled into trains, may have an advantage.

With regard to the consideration of the future deterioration of the existing arterial street and highway system, in recent years revenues for highway operation and maintenance have declined as highway operation and maintenance costs have increased. If highway maintenance continued to be deferred, and if highway activities such as winter snow and ice control operations were reduced, the level of primary transit service which could be provided by the bus-on-metered freeway plan, which is dependent upon the arterial street and highway system, would be reduced significantly relative to that which could be provided by the fixed guideway primary transit alternatives.

With regard to the potential for the primary transit alternatives to respond to a widespread emergency situation resulting from either a natural or manmade catastrophe, it was recognized that under such extreme conditions, the most versatile vehicle would be the diesel motor bus, as it would be equipped with an on-board propulsion unit and would not require a fixed guideway. Public transit systems without on-board propulsion units, such as light rail transit, would be susceptible to a single malfunction, or to a failure in, or interruption of, their power generation or distribution systems. Also, all rail primary transit modes would be restricted to providing service over fixed guideway facilities, and would be susceptible to failure of such guideways. Self-propelled motor vehicles would thus have a distinct advantage in terms of versatility, as they could operate between virtually any origin and destination over any roadway surface—either paved or unpaved—as well as maneuver around obstructions or unpassable roadway segments. However, under the most extreme conditions the rail primary transit modes and the bus-on-busway mode would have the advantage of being able to move large numbers of people quickly over their guideway without interference from motor vehicle traffic.

Climatic conditions were also suggested as having some differential effects on the primary transit alternatives. Extreme summer and winter temperatures—both of which occur in the Milwaukee area—can be expected to increase the tendency for mechanical, pneumatic, and hydraulically operated transit components and subsystems to perform erratically or not at all. For example, very hot summer temperatures may overtax the capabilities of air-conditioning units on transit vehicles, while very cold winter temperatures may cause fuel line and coolant system problems. For the Milwaukee area, winter weather conditions present greater potential problems than do summer weather conditions. Of the primary transit alternatives, any that use electrically propelled vehicles have an advantage with respect to winter weather conditions. Because such vehicles use electric traction motors instead of internal combustion engines for propulsion—and therefore don't require engine coolant systems and pneumatic braking systems as do diesel motor buses—vehicle start-up, interior heating, and overall operation is smoother; there is less chance for component failure; and indoor storage of vehicles is not mandatory. Also, electric propulsion requires fewer mechanical assemblies which incorporate moving parts.

Rail transit systems also have an advantage over other systems with respect to winter conditions in that they tend to function better during periods of severe snow and ice storms because of the positive vehicle guidance and better vehicle traction of such systems. Also, any transit alternatives that would use exclusive guideways, including buses on busways, would not be subject to interference from traffic congestion resulting from adverse winter weather conditions. It must be noted, however, that all the primary transit alternatives can be expected to perform well under the climatic conditions common to the Milwaukee area. The advantages cited for light rail transit and other fixed guideway transit during severe winter weather conditions can be expected to increase their relative reliability only slightly.

The Advisory Committee's concern over the long-term usefulness of the different primary transit alternatives—their usefulness over many decades rather than simply the 21-year plan design period—was determined to be valid, because the amortization or "useful life" periods of major components of the fixed guideway primary transit alternatives are 30 to 50 years. A major factor in any consideration of the useful life of components is the potential for technological improvements. Only those primary transit alternatives determined to be proven and readily available for implementation as a system in the Milwaukee area during the next two decades were considered applicable to this study. Transit technologies conceptually having potential advantages over proven technologies, but not expected to become practically available for the provision of primary transit service within the next two decades, were dismissed from further consideration. Should these exotic technologies become practicable in the future, certain elements of the proven primary transit technologies could be adapted to the new technologies. As reported in SEWRPC Technical Report No. 24, State-of-the-Art of Primary Transit System Technology, the light rail transit and busway system plans would have the greatest potential to be readily adapted to unproven, future technologies because most of these technologies would require guideways on exclusive rights-of-way. However, even though some new primary transit technology may become available in the future, it cannot be concluded at this time that any futuristic primary transit technology will be significantly more efficient or economical than any proven primary transit technology during and well beyond the plan design period for this study.

Improvements in automotive technology over the next several decades may also be expected to have some impact on the long-range usefulness of the primary transit alternatives, either by increasing or decreasing demand for public transit. The effect on demand will be dependent upon future technological change, as it may affect the cost of automobile ownership and operation, the safety of automobile travel, and other factors.

The energy source used by the primary transit alternatives should also be considered as a factor in their long-range usefulness. The use of petroleum represents a withdrawal from a fixed and limited supply which is projected to decline in availability in the 21st century. At that time, public transit may require an energy source other than petroleum-based fuels, and thus conversion to electric propulsion or some other technology may be necessary. A system based on electric propulsion would require a greater capital cost than petroleum-based transit. Selection of a light rail transit plan at this time, then, could be seen as the selection of the inevitable system at the inevitable higher cost—that is, unless there is an advance in the technology of transit propulsion.

Another subjective consideration raised by the Advisory Committee was the need to consider the viability of the different primary transit alternatives should the outward movement of predominantly middle- and upper-income white families from the central parts of the transit service area continue. Some aspects of a continuation of this trend are reflected in the test and evaluation of alternative primary transit plans under the range of futures considered under this study. This test and evaluation indicated that such a future would have the same impact on each of the alternative primary transit technologies. One of the alternative futures envisions the decline of population in Milwaukee County to a level of 700,000 people and no real increase in average household income in the County. It was determined that under this future, bus-on-freeway, light rail transit, and bus-on-busway plans could all be expected to perform reasonably well, attracting similar levels of ridership, providing similar levels of service, and requiring similar levels of public subsidy of operating and maintenance costs. However, the level of ridership and the proportion of public transit operating and maintenance costs which could be met by farebox revenues under all these plans would be less under this future than under any of the other alternative futures.

A final intangible factor which must be considered in the selection of a recommended plan from among the alternative plans is the potential acceptance of the recommended plan by the concerned elected officials. Only if a considerable degree of such acceptance exists will the recommended plan be implemented, and its anticipated benefits achieved. A plan which is only marginally better than others but has a lesser chance of being implemented should perhaps be considered a less desirable plan. Indeed, in methods used in corporate and military decision-making which have in the past been adapted to regional planning by the Regional Planning Commission, such explicit consideration of the uncertainty of plan implementation occurs in the selection of a best plan. The bus-on-metered freeway plan may have a particular disadvantage in attaining the acceptance of public elected officials necessary to its implementation. The bus-on-metered freeway plan proposes that extensive preferential treatment be provided for transit vehicles principally through implementation of an areawide freeway traffic management system. This system is envisioned as exercising sufficient constraint on freeway access to ensure uninterrupted freeway traffic flow and operating speeds of at least 40 mph over the Milwaukee area freeway system during weekday peak travel periods.

The implementation of this freeway traffic management system would require significant expansion of the limited freeway traffic management system in operation today at 21 freeway entrance ramps in central Milwaukee County, as only with an areawide system of ramp meters and attendant control of freeway access would the envisioned freeway operation be practically attainable. Freeway entrance ramp meters would need to be constructed at freeway entrance ramps throughout the Milwaukee area, including all of Milwaukee County, substantial parts of Waukesha and Ozaukee Counties, and parts of Washington and Racine Counties, and these meters would have to be operated as an integrated system designed to maintain high operating speeds on the freeway system.

However, for the last two years the Regional Planning Commission's Intergovernmental Coordinating and Advisory Committee on Transportation System Planning and Programming for the Milwaukee Urbanized Area has refused to approve the inclusion of the installation of any further ramp meters in the annual transportation improvement program for southeastern Wisconsin, thereby effectively denying the use of federal funds for the expansion of the freeway traffic management system. Moreover, a preliminary engineering study recommended by that Committee to be conducted prior to its endorsement of any further implementation of such a system has not progressed beyond completion of a prospectus in 1979, as required funding for the conduct of the study has not been available to date.

Test and Evaluation of a Bus-on-Unmetered Freeway Alternative: Consequently, the study Advisory Committee requested that the implications of removing the freeway operational control system element from the bus-on-freeway alternative be determined. In direct response to this request, a quantitative test, evaluation, and comparison of metered and unmetered bus-on-freeway alternative system plans was conducted for the moderate growth scenario-centralized land use plan alternative future, because freeway operational control under this future may be expected to have the greatest effect on freeway operating speeds, transit ridership, and attendant evaluative considerations.

The results of the quantitative test, evaluation, and comparison of bus-on-freeway plans with and without freeway operational control under this future are summarized in Table 50. The table indicates that although peak-direction bus-on-freeway operating speeds during peak travel periods would be significantly affected, as would peak-travel-period bus-on-freeway ridership, peak-travel-period total transit system ridership would only be marginally affected, since the majority of public transit trips under either alternative would be made on local and express transit services which have been assumed to be largely unaffected by freeway operational control. The validity of this assumption, however, can be determined only through a preliminary engineering study of areawide freeway traffic management in the Milwaukee area. In addition, all-day, bus-on-freeway ridership would be only somewhat affected, and all-day total transit system ridership would be insignificantly affected because off-peak-travel period primary, express, and local transit operating speeds, and therefore off-peak transit ridership, would not be directly affected by the presence or absence of peak-period freeway operational control.

Specifically, this quantitative test and evaluation indicated that without the implementation of an areawide freeway traffic management system, the bus-on-freeway plan under the moderate growth scenario-centralized land use plan alternative future would entail peak-travel-period motor bus speeds of 30 mph or less on the East-West Freeway (IH 94) between the Marquette and Zoo Interchanges, and of 30 to 40 mph on two- to four-mile segments of the North-South Freeway (IH 43 and IH 94) and Zoo Freeway (USH 45) and Airport Freeways (IH 894 and USH 45) which connect to this segment of the East-West Freeway at the Marquette and Zoo Interchanges. This compares with speeds of at least 40 mph over these freeway segments if the freeway system were operationally controlled. Thus, the peak-travel-period performance of the bus-on-freeway plan may be expected to decline significantly without operational control. The average speed of primary transit in-vehicle travel for a typical peak-period trip may be expected to decline by about five mph, or 15 percent. Average weekday primary transit ridership during the peak travel period in the design year may accordingly be expected to decline by about 9 percent during each of the peak periods, or about 1,400 trips in the morning peak period and 2,700 trips in the afternoon peak period. However, because only about 21 percent of the peak-period ridership on the total transit system in the design year may be expected to be made on the primary element of the bus-on-freeway alternative, with the remainder being made on local and express elements, total transit system ridership during the peak travel periods may be expected to decline by only 2 percent. On an all-day basis, including off-peak travel periods—during which freeway operational control can be expected to have little impact—average weekday primary transit ridership may be expected to decline by only about 6 percent, and total average weekday transit system ridership may be expected to decline by about 1 percent.

It may be concluded from these analyses that neither the performance of a bus-on-freeway plan in the Milwaukee area with respect to systemwide level-of-service, ridership, operating and maintenance cost-effectiveness, and capital costs nor the plan's implications for Milwaukee area total transportation system energy use, air pollutant and noise emissions, or travel safety should be significantly affected by removal of the freeway traffic management system element from the bus-on-freeway plan. A more precise determination of the benefits of freeway traffic management will require detailed analyses in a preliminary engineering study. Conversely, these analyses indicate that implementation of an areawide freeway traffic management system may be expected to affect the level of primary transit service and ridership to the Milwaukee central business district significantly. The analyses indicated that lack of an areawide freeway traffic management system would result in 4,100 fewer trips being made on primary transit to and from the Milwaukee central business district on an average weekday, a decline of about 9 percent from the level expected under a bus-on-metered freeway plan. All these trips may be expected to continue to be made to the central business district during peak travel periods, but by automobiles instead of transit. This difference in the amount of automobile travel to the Milwaukee central business district is equivalent to the capacity of one lane of central business district surface arterial in the morning peak travel hour and two lanes of central business district surface arterial in the evening peak travel hour. The effect of this additional automobile travel on Milwaukee central business district traffic congestion can be determined only through more detailed analyses in a preliminary engineering study of freeway traffic management.

Implications of the Results of the Test and Evaluation of the Truncated and Composite Alternative Plans

Further test and evaluation of the three primary transit technologies which the test and evaluation of the maximum extent plans revealed would be feasible as truncated systems under the full range of alternative futures indicated that all three of these technologies--bus on metered freeway, bus on busway, and light rail transit—would perform equally well in the Milwaukee area over the plan design period. These three alternatives were determined to have the potential to provide equal levels of service, attract similar levels of ridership, require similar operating and maintenance cost subsidies, and result in similar total energy consumption and environmental impacts under the wide range of future conditions considered.

The only significant measurable difference between these three alternatives was determined to be the capital costs attendant to their implementation and, therefore, their total public costs. The bus-on-metered freeway plan was determined to entail substantially less capital cost over the plan design period than the bus-on-busway and light rail transit plans, ranging from $144 million under the most pessimistic future, the stable or declining growth scenario-decentralized land use plan future, to $223 million under the most optimistic future, the moderate growth scenario-centralized land use plan future. The busway and light rail transit alternatives were found to entail between 1.5 and 2.5 times as much capital cost, because they would require extensive new guideway construction. The capital costs of the bus-on-busway plan were estimated to range from $268 million under the most pessimistic future to $347 million under the most optimistic future; and the capital costs of the light rail transit plan were estimated to range from $336 million under the most pessimistic future to $436 million under the most optimistic future.

Therefore, the bus-on-metered freeway plan was also found to be the plan with the least total public cost under each of the four alternative futures, including both capital costs and operating and maintenance cost subsidies, ranging from $594 million to $774 million over the plan design period. The bus-on-busway plan was found to entail the next highest total public cost, ranging from $709 to $883 million, or between 14 and 19 percent more than the cost of the bus-on-freeway alternative. The highest total public cost may be expected to be incurred under the light rail transit plan, estimated to range from $771 million to $964 million, or between 25 and 30 percent more than the cost of the bus-on-freeway alternative.

The fourth primary transit alternative, commuter rail, was found to be viable as a system only under the most optimistic future conditions, not to be viable at all under the most pessimistic future conditions, and to be viable only for a single route extending south from the Milwaukee central business district to the Cities of Racine and Kenosha under intermediate future conditions. Further test and evaluation of commuter rail indicated that it would entail slightly lower capital costs than comparable bus-on-metered freeway facilities and service, but would result in somewhat lower transit ridership and somewhat higher annual public subsidies of operating and maintenance cost. Consequently, it would be a less cost-effective alternative, particularly with respect to operating and maintenance costs. Under the most optimistic future, the moderate growth scenario-centralized land use plan alternative future, a truncated commuter rail system plan was found to entail nearly 4 percent less capital cost than the bus-on-metered freeway plan, or $215 million compared with $223 million. This commuter rail plan, however, would carry about 12,500, or 3 percent, fewer transit passenger trips on an average weekday than the bus-on-metered freeway plan, and would require about $1.9 million, or 5 percent, more public subsidy of operating and maintenance costs in the design year. Comparison of the bus-on-metered freeway and commuter rail services in the Milwaukee-to-Racine and Kenosha corridor under the intermediate futures, the moderate growth scenario-decentralized land use plan and stable or declining growth scenario-centralized land use plan futures, similarly indicated relatively small differences between the two alternatives except with respect to capital costs and operating and maintenance cost subsidies per passenger, both of which were higher under the commuter rail alternative.

As much as the bus-on-metered freeway alternative was found to be superior to the other primary transit alternatives with respect to costs over the plan design period, the other alternatives—

Table 50

EVALUATION OF BUS-ON-METERED FREEWAY AND BUS-ON-UNMETERED FREEWAY ALTERNATIVE PRIMARY TRANSIT SYSTEM PLANS UNDER THE MODERATE GROWTH SCENARIO-CENTRALIZED LAND USE PLAN

Evaluative Measure	Truncated Bus-on-Metered Freeway Plan	Truncated Bus-on-Unmetered Freeway Plan
Objective No. 1—Serve Land Use		
Accessibility		
Average Overall Travel Time of Transit Trips to the Milwaukee Central Business District (minutes)	34	36
Objective No. 2—Minimize Cost and Energy Use		
Cost		
Total Public Cost to Design Year (capital cost and operating and maintenance deficit)	$774,474,000	$759,865,500
Average Annual Total Public Cost	36,879,700	36,184,100
Capital Cost[a]		
Capital Cost to Design Year	222,980,000	209,300,000
Average Annual Capital Cost	10,618,100	9,966,700
Capital Investment to Design Year	341,200,000	322,034,500
Average Annual Capital Investment	16,247,600	15,335,000
Operating and Maintenance Cost Deficit (net cost)		
Deficit in Design Year	38,272,600	38,148,800
Deficit to Design Year	551,494,000	550,565,500
Average Annual Deficit	26,261,600	26,217,400
Cost-Effectiveness		
Total Cost to Design Year per Passenger	0.48	0.48
Capital Cost to Design Year per Passenger	0.14	0.13
Operating Deficit to DesignYear per Passenger	0.34	0.35
Percent of Operating and Maintenance Cost Met by Farebox Revenue in the Design Year		
Total Transit System	58	57
Primary Element	60	58
Energy		
Total Transit System Energy Use to Design Year (million BTU's)	24,749,880	22,978,580
Total Transit Construction Energy Use to Design Year (million BTU's)	1,914,560	1,896,180
Total Transit Operating and Maintenance Energy Use to Design Year (million BTU's)	22,835,320	21,082,400
Total Transit Passenger Miles per Gallon of Diesel Fuel to Design Year (BTU's)	45.2	47.9
Dependence on Petroleum-Based Fuel	All trips dependent	All trips dependent
Petroleum-Based Fuel Use by Transit to Design Year (gallons of diesel fuel)	161,649,000	149,240,500
Automobile Propulsion Energy Use in Design Year (gallons of gasoline)	395,200,000	395,600,000

Table 50 (continued)

Evaluative Measure	Truncated Bus-on-Metered Freeway Plan	Truncated Bus-on-Unmetered Freeway Plan
Objective Nos. 3 and 5—Provide Appropriate Service and Quick Travel		
Average Weekday Transit Use in Design Year		
Total Transit System		
All Day	378,600	374,500
Peak Periods	206,600	202,500
Primary Element		
All Day	75,100	71,000
Peak Periods	44,900	40,800
Service Coverage		
Population Served Within a One-Half-Mile Walking Distance of Primary Transit Service	373,500	373,500
Population Served Within a Three-Mile Driving Distance of Primary Transit Service	1,620,700	1,620,700
Jobs Served Within a One-Half-Mile Walking Distance of Primary Transit Service	293,600	293,600
Average Speed of Transit Vehicle (mph)		
Primary Element		
All Day for Total System	29	27
Peak Periods and Peak Direction for Typical Trip	31	26
Total System	18	17
Average Speed of Passenger Travel on Vehicle (mph)		
Primary Element	34	31
Total System	21	20
Objective No. 4—Minimize Environmental Impacts		
Community Disruption		
Homes, Businesses, or Industries Taken	None	None
Land Required (acres)	70	70
Air Pollutant Emissions—Total Transportation System (Highway and Transit) in Design Year (tons per year)		
Carbon Monoxide	167,368	167,522
Hydrocarbons	16,887	16,901
Nitrogen Oxides	29,988	30,015
Sulfur Oxides	2,502	2,504
Particulates	4,018	4,020
Objective No. 6—Maximize Safety		
Proportion of Total Person Trips Made on Transit	0.086	0.085

[a] *The capital cost of a composite plan is equal to the plan's required capital investment, or total capital outlays necessary over the plan design period, less the value of that investment beyond the plan design period.*

Source: SEWRPC.

particularly light rail transit—were determined to be preferable to the bus-on-metered freeway alternative with respect to the intangible implications of primary transit performance. It was concluded from this assessment that light rail transit, bus on busway, and commuter rail would all probably have a greater, although uncertain and unmeasurable, potential to influence land development and redevelopment and would possibly provide a more reliable and safe public transit system and be less subject to the adverse effects of future highway system deterioration from deferred maintenance. Also, because of their potentially high passenger-carrying capacity per operator, both light rail transit and commuter rail were found to have an advantage with respect to operation during labor disruptions, and both light rail transit and bus on busways were determined to have greater long-range usefulness as they would require acquisition of rights-of-way and construction of guideways which are essential to more advanced, but still unproven, futuristic transit technologies. Light rail transit alone, because of its electric propulsion, was determined to have an advantage with respect to operation in Milwaukee's winter climate, the greatest potential to continue and expand operations during a petroleum-based fuel shortage, and perhaps the greatest long-term usefulness given the prospects for reduced domestic and world petroleum production in the 21st century. Light rail transit was also concluded to have perhaps the greatest potential to influence land development and redevelopment because it would require the most permanent, least disruptive, and greatest public commitment to high-quality transit in a corridor of all the transit alternatives.

The only intangible advantage of the bus-on-metered freeway alternative was its potential to provide the best services under widespread emergency conditions, specifically because its operations would not be restricted to fixed guideways and, like the busway and commuter rail alternatives, it would not be susceptible to a single power stoppage. One intangible disadvantage of the bus-on-metered freeway alternative was also identified: the uncertainty regarding its acceptance by elected officials prior to implementation and thereby attainment of its potential benefits. The bus-on-metered freeway plan assumes the implementation of an areawide freeway traffic management system. Expansion of the presently limited freeway traffic management system, however, has not progressed in recent years, although recommended in adopted short- and long-range regional transportation system plans. Quantitative test and evaluation indicated that without the implementation of an areawide freeway traffic management system to provide preferential treatment for buses on area freeways, design year transit passenger trips under the bus-on-metered freeway plan would decline somewhat; however, the decline may be expected to have little impact systemwide. Under the moderate growth scenario-centralized land use plan future—the future under which the greatest impact on transit use may be expected—this decline was expected to total about 4,100 trips per average weekday on the bus-on-metered freeway primary transit element, or about 9 percent of peak-period primary transit system ridership, about 6 percent of all-day primary transit system ridership, and only about 1 percent of all-day Milwaukee area transit system ridership. In conclusion, then, the analyses indicated that the level of service and use of bus-on-freeway service to the Milwaukee central business district may be expected to be significantly affected by the implementation of an areawide freeway traffic management system. A determination of the full systemwide benefits of freeway operational control will require more detailed analyses in a preliminary engineering study.

DEVELOPMENT OF A RECOMMENDED PRIMARY TRANSIT SYSTEM PLAN FOR THE MILWAUKEE AREA

The last step in the six-step planning process applied in the Milwaukee area primary transit system alternatives analysis was the formulation of a recommended primary transit system plan for adoption and implementation. The formulation of the recommended plan was based upon consideration of the performance and cost of the alternative primary transit system plans considered under each alternative future, and of the intangible benefits of each alternative plan as summarized in the previous section of this chapter.

The quantitative evaluation indicated that three of the primary transit system alternatives—bus on metered freeway, bus on busway, and light rail transit—could in general be expected to function equally well in the Milwaukee area under a wide range of alternative futures, providing essentially identical levels of service, attracting very similar levels of ridership, possessing similar design year operating and maintenance cost subsidy requirements, and having similar systemwide energy consumption and environmental impacts. The bus-on-metered freeway plan, however, was determined to entail substantially less capital cost than the bus-on-busway and light rail transit plans, the bus-on-busway plan requiring between $124 and $203 million, or between 85 and 90 percent, more cost over the plan design period, and between $192 and $213 million, or between 95 and 135 percent, more capital cost.

The commuter rail primary transit alternative was shown to be infeasible under the most pessimistic alternative future conditions for transit use in the Milwaukee area, and to be feasible only along a single route extending south from the Milwaukee central business district to the Cities of Racine and Kenosha under intermediate alternative future conditions. Only under the most optimistic alternative future conditions was commuter rail shown to be feasible as a system. Moreover, it was determined that as a system under those optimistic future conditions, and as a single route under the intermediate future conditions, commuter rail could not be expected to perform as well as the other primary transit alternatives, resulting in somewhat lower transit ridership and requiring somewhat higher design year public operating and maintenance cost subsidies. However, it was determined that the commuter rail alternative could be expected to entail the lowest capital cost of all of the primary transit alternatives considered, requiring somewhat less capital cost than the bus-on-metered freeway alternative.

The remaining primary transit alternative considered, heavy rail rapid transit, was determined to entail substantially greater capital costs and total costs than any of the other primary transit alternatives considered. Moreover, it was determined that the high speed and high capacity of this alternative could not be effectively utilized in the Milwaukee area for at least the next two decades.

Thus, based on the quantitative evaluation of the primary transit alternatives considered, the bus-on-metered freeway plan was shown to be the best alternative. It would have comparable performance to, but significant capital cost advantages over, the light rail transit and bus-on-busway alternatives. In addition, it would have a slight performance and cost-effectiveness advantage over the commuter rail alternative and would be capable of performing well under even the most pessimistic of future conditions, although it would have a slight capital cost disadvantage.

Based on the consideration of the intangible factors involved, the fixed guideway modes—especially light rail transit—were concluded to possess a number of advantages over a bus-on-metered freeway plan. Table 51 summarizes the 13 intangible benefits and subjective considerations which were carefully considered by the Advisory Committee and which are discussed earlier in this chapter with respect to the degree each benefit is associated with the development of each of the fixed guideway modes. It was concluded that implementation of the busway or commuter rail modes could be supported to some degree by nine of the intangible benefits or considerations. Implementation of the light rail transit mode, however, could be supported by all of the intangible benefits, as well as, to some degree, by all of the subjective considerations. To some extent, many of these advantages were concluded to be shared by the alternative plans which incorporate the commuter rail and busway modes. However, if a final plan is recommended which is based at least partially upon the benefits of these intangible advantages, then light rail transit technology will have been concluded to offer the greatest opportunities with respect to real, but intangible, benefits.

Commission Staff Recommendations to Study Advisory Committee for Milwaukee Area Primary Transit System Development

Based on this quantitative evaluation and assessment of intangible factors, the Commission staff determined that it could present to the study Advisory Committee two options together with the base plan for consideration as the concluding recommendations of the study. One option presented by the Commission staff to the Committee was for the Committee to conclude that the measurable and more certain advantages of the bus-on-metered freeway alternative outweighed the intangible advantages of the other alternatives, and for the Committee to recommend a bus-on-metered freeway system plan for the Milwaukee area. The other option was for the study Advisory Committee to conclude that the intangible advantages of the light rail transit alternative and of commuter rail facilities and services in the corridor between the Milwaukee and Racine and Kenosha areas sufficiently outweighed the quantifiable and more certain advantages of the bus-on-metered freeway and busway alternatives.

Under this second option, the primary transit plan recommendations would be divided into a lower and an upper tier. The lower tier of the plan recommendations would propose implementation of a basic bus-on-metered freeway system plan, but including a light rail transit facility in the northwest corridor of the Milwaukee area between the

Table 51

SUMMARY OF INTANGIBLE BENEFITS ATTENDANT TO FIXED GUIDEWAY PRIMARY TRANSIT FACILITIES

Benefit or Consideration	Primary Transit Mode		
	Light Rail Transit	Busway	Commuter Rail
Intangible Benefits			
Ability to influence land development and redevelopment	●	O	O
Continued operation during severe petroleum shortage	●		
Reduce localized adverse environmental impacts	●		
Increased public transit reliability	●	●	●
Increased public transit safety	●	O	●
Rider preference	O		O
Other Subjective Considerations			
Operation during labor disruptions	O		O
Importance in light of possible deferred highway maintenance	●	●	●
Operation during widespread emergency situations	O	●	O
Local climatic conditions	●	O	O
Usefulness with respect to long-range advances in transit technology	O	O	
Impact of current land use decentralization trends	O	O	
Probability of implementation	O	O	O

LEGEND

● Benefit or consideration appears to definitely support this transit mode.
O Benefit or consideration may support this transit mode.

Source: SEWRPC.

Milwaukee central business district and northwestern Milwaukee County. This northwest corridor was shown through light rail transit system plan test and evaluation to have the highest potential for light rail transit development in the Milwaukee area. The most heavily used local and express bus service in the Milwaukee area is presently operated within this corridor. Also, it is the major corridor in the Milwaukee area within which an existing or proposed freeway is not available to provide direct bus-on-freeway primary transit service. The remainder of the lower tier would consist of bus-on-metered freeway facilities and services. However, in each of the four corridors other than the northwest corridor indicated by the quantitative test and evaluation to be feasible for light rail transit under the wide range of alternative future conditions considered, and in the corridor between the Milwaukee and Racine and Kenosha areas shown to be feasible for commuter rail, the routing and park-ride lot locations of the bus-on-metered freeway services recommended for implementation in the lower tier of the plan would be modified as necessary to be consistent with a possible eventual conversion to light rail transit or commuter rail operation as appropriate. And, to ensure that no action would be taken to foreclose the possible future development of light rail transit and commuter rail facilities, such facilities would be included in the upper tier of the plan. However, as facilities in the upper tier of the plan, they would not be recommended for implementation. Also, the conversion of the concerned bus-on-metered freeway service to light rail transit or commuter rail operation in these corridors would be considered only after the development of an initial light rail transit line in the northwest corridor, and demonstration of the intangible benefits attendant to the implementation and operation of light rail transit in that corridor. These two options for primary transit plan selection and adoption are discussed further in the following paragraphs.

Option One—Recommendation for Development of a Bus-on-Metered Freeway System Plan: The Commission staff determined that one of the two options that could be presented to the study Advisory Committee for consideration was a bus-on-metered freeway system plan for the Milwaukee area. Selection of this option by the Committee would mean that it had concluded that the intangible—uncertain and unquantifiable—benefits attendant to development of the higher cost light rail transit and bus-on-busway plans do not outweigh the capital cost differences between these plans and the bus-on-metered freeway alternative. It would also mean that the Committee had concluded that the intangible advantages of the commuter rail alternative are also insufficient to outweigh the performance and cost-effectiveness advantages of the bus-on-metered freeway alternative—in particular, to outweigh the advantage of the bus-on-metered freeway alternative of being able to perform well under even the most pessimistic of possible future conditions for transit use in the Region.

The bus-on-metered freeway facilities and services constituting the system plan under this option are shown on Map 38. The bus-on-metered freeway routes and stations included in this plan are those that the quantitative evaluations indicated would provide cost-effective service throughout the day at maximum headways of 30 minutes during peak travel periods and 60 minutes during off-peak travel periods under the moderate growth scenario-centralized land use plan alternative future—the most optimistic of the alternatives considered. This plan would, in fact, be the truncated bus-on-metered freeway plan that was tested and evaluated under that most optimistic future, but with some adjustments in the supporting secondary (express) and tertiary (local) transit service. This extent of facilities and services can be recommended because even under the stable or declining growth scenario-decentralized land use plan future—the most pessimistic future for transit use in the Milwaukee area—all of the bus-on-metered freeway services would be viable during at least the peak travel periods, if not on an all-day basis. Also, those facilities and services included in this bus-on-metered freeway plan but found to be cost-effective under only the most optimistic future conditions would be staged to be implemented last, and then only if future conditions in the Milwaukee area were found to approximate the most optimistic conditions for transit use.

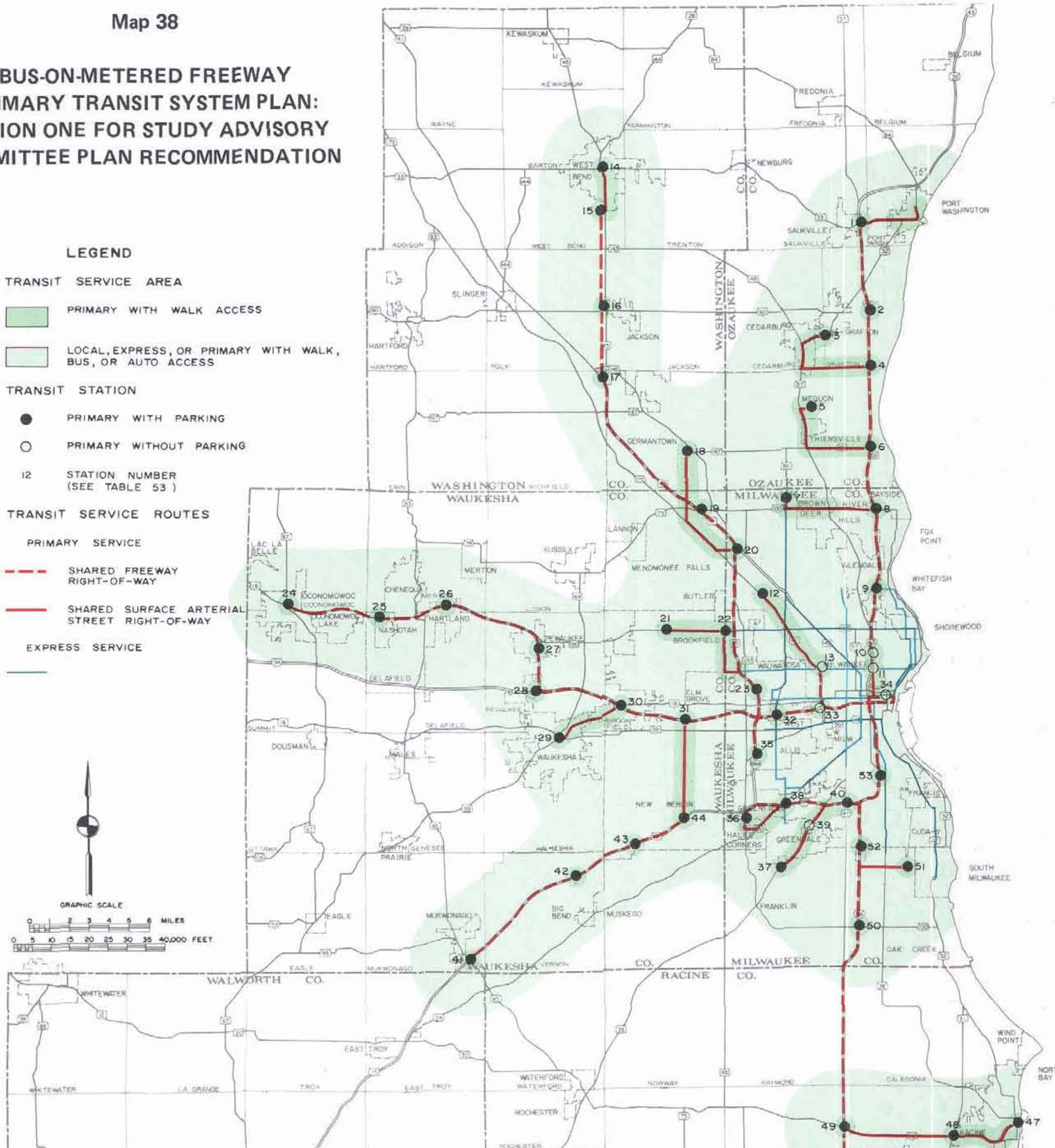
Plan Description: The recommended bus-on-metered freeway primary transit system plan calls for the expansion of the existing system of routes of buses operating over freeways, the expansion of all bus-on-freeway service to all-day weekday service at maximum headways of 30 minutes in peak travel periods and 60 minutes in off-peak travel periods, and the provision of extensive preferential treatment for buses operating in primary transit use. As shown on Map 38, the bus-on-metered freeway system plan would expand primary transit service within Milwaukee County, and extend service to the south to the Cities of Racine and Kenosha in Racine and Kenosha Counties, to the southwest to the Village of Mukwonago in Waukesha County, to the northwest to the City of West Bend in Washington County, and to the north to the City of Port Washington in Ozaukee County.

The primary transit system plan would consist of 24 bus-on-freeway routes totaling 955 route miles in length and having a total of 53 stations, 47 of which would have park-ride lots. Twenty-two of the 53 stations and 16 of the park-ride lots would be located in Milwaukee County. Under the plan, high-capacity articulated buses would operate in primary transit service primarily over existing and proposed metered freeways between outlying park-ride lots and the Milwaukee central business district. Bus routes from park-ride lots in Milwaukee County to the central business district would be operated with a limited number of intermediate stops, as necessary, to connect and coordinate with feeder express and local bus service, and to provide access to major travel generators other than the Milwaukee central business district.

Primary transit bus routes originating at locations outside Milwaukee County but within the Milwaukee urbanized area would generally serve two outlying park-ride lots prior to proceeding in an essentially nonstop mode of operation to the Milwaukee central business district. Primary transit bus routes originating at locations outside the Milwaukee urbanized area would have stops at two to five outlying park-ride lots prior to proceeding in an essentially nonstop mode of operation to the central business district. The park-ride lots would be located, to the extent practicable, within or near freeway interchanges to minimize travel times. Within the Milwaukee central business district, all primary transit bus routes would be operated over E. and W. Wisconsin Avenue for a distance of about two miles, with stops approximately every one-

Map 38

BUS-ON-METERED FREEWAY PRIMARY TRANSIT SYSTEM PLAN: OPTION ONE FOR STUDY ADVISORY COMMITTEE PLAN RECOMMENDATION



Two options were recommended by the Commission staff to the study advisory committee for possible selection as the best plan for primary transit system development in the Milwaukee area. One option was a bus-on-metered freeway system plan, all the components of which would be recommended for implementation over a 20-year planning period. In selecting this option, the advisory committee would be in effect concluding that the intangible benefits potentially attendant to the higher cost fixed guideway modes of light rail transit and bus on busway do not outweigh the capital cost differences between these plans and the bus-on-metered freeway alternative, and that the intangible benefits of the commuter rail alternative are insufficient to outweigh the performance and cost-effectiveness advantages of the bus-on-metered freeway alternative. Under this option, the bus-on-metered freeway primary transit system plan would consist of 24 routes totaling 955 route miles in length and having a total of 53 stations, 47 of which would have park-ride lots. Of the 53 stations, 22 would be located within Milwaukee County, of which 16 would have park-ride facilities. All bus-on-metered freeway routes would be operated between outlying park-ride lots and the Milwaukee central business district over existing and proposed metered freeways using high-capacity articulated motor buses. It is envisioned that this primary transit system plan would be implemented in stages over the plan design period as public transit needs and ridership warrant facility and service expansion, and as financial resources become available.

Source: SEWRPC.

quarter mile. Wisconsin Avenue would be converted to a mall for the exclusive use of public transit vehicles between N. 10th Street and N. Prospect Avenue—a distance of about 1.3 miles.

The Milwaukee area freeways over which the buses in primary transit service would operate under this bus-on-metered freeway plan would be operationally controlled during peak travel periods, requiring the expansion of the present limited freeway traffic management system serving central Milwaukee County to an areawide system. All freeway on-ramps in the Milwaukee urbanized area would need to be ramp-metered to restrain automobile and truck access to the freeways during peak travel periods. The ramp meters would need to be operated through a central control system which would continuously measure traffic volumes on those portions of the freeway system needed for transit service through an interconnected series of traffic-sensing devices. As freeway traffic volumes approached the levels beyond which freeway operating speeds may be expected to deteriorate, fewer automobiles and trucks would be permitted to enter the freeway system. Sufficient constraint would be exercised to ensure uninterrupted freeway traffic flow and operating speeds of at least 40 mph on all freeway segments, including otherwise congested segments. Consequently, average speeds on the bus-on-freeway routes, including all stops, would range between 19 and 35 mph.

This bus-on-metered freeway system plan also envisions complementary expansion and improvement of the express and local elements of the Milwaukee area transit system. Five express, or limited-stop, routes would be provided in addition to the seven routes included in the base plan—only three of which were actually in operation in 1980. These 12 express routes would operate in a coordinated manner with the expanded bus-on-freeway primary transit system. The local transit system element in the Milwaukee area would be extended where cost-effective under the bus-on-freeway plan into all contiguous areas of urban development, including all of northern and most of southern Milwaukee County, southern Ozaukee County, southeastern Washington County, and eastern Waukesha County.

Primary Transit Plan Staging: This bus-on-metered freeway primary transit system plan would be implemented in stages over the plan design period, not only because the extent of primary transit service proposed in the plan must evolve gradually over the planning period as financial resources become available, but also because only if public transit needs and ridership increase as anticipated will the proposed bus-on-metered freeway facilities and services warrant expansion to the extent envisioned in the plan. It is proposed that this plan be implemented in three stages. Those proposals of the plan which are the most certain to be needed and which have been identified as the most cost-effective would be implemented in the first stage. This stage would include all those bus-on-metered freeway facilities and services which were shown to work well under the full range of alternative future conditions considered. As shown on Map 39 and in Tables 52 and 53, these routes and stations are those of the truncated bus-on-metered freeway plan tested and evaluated under the stable or declining growth scenario-decentralized land use plan alternative future—the most pessimistic of the alternative futures.

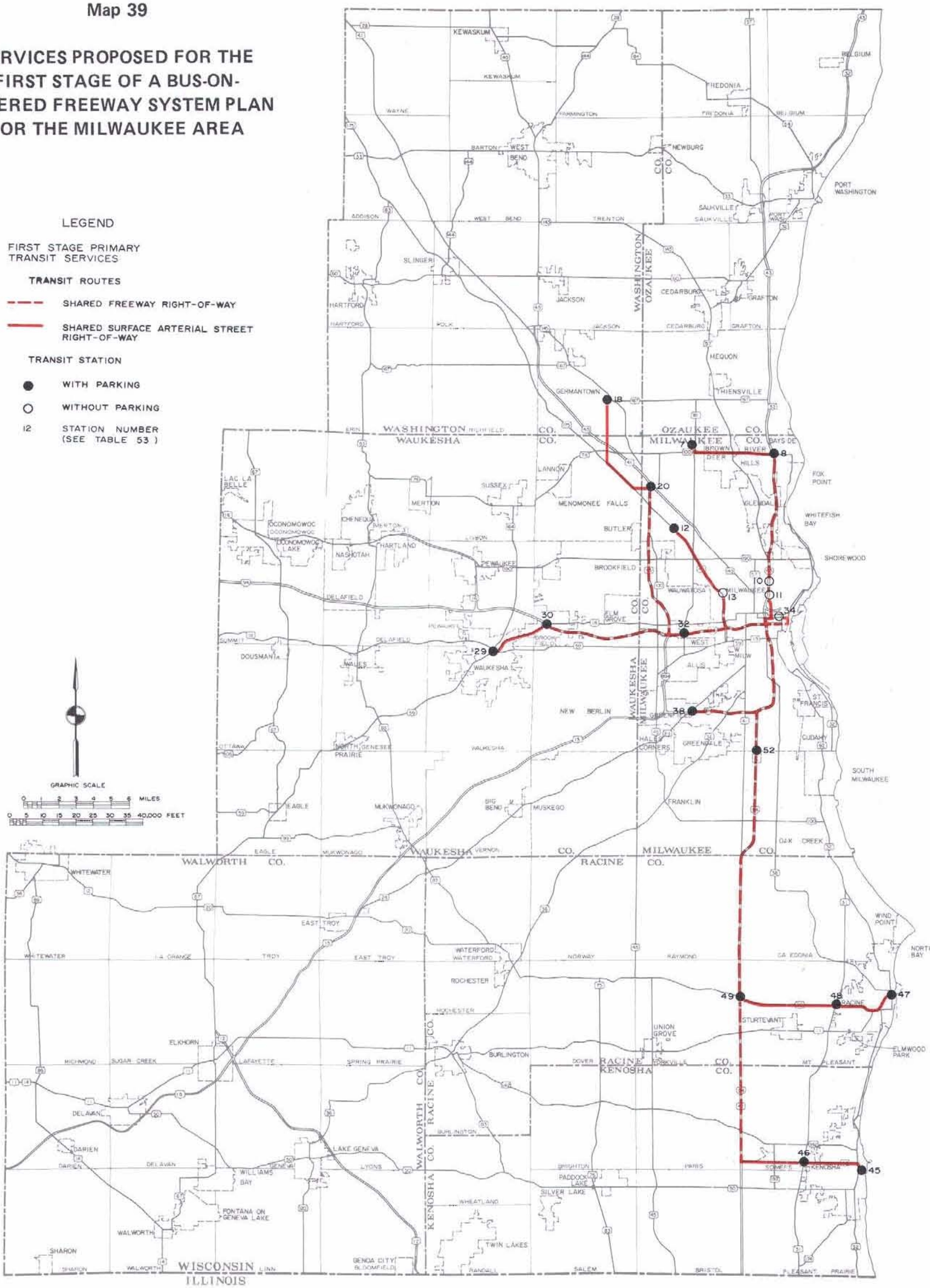
Under this first stage of plan implementation, primary transit service would be provided on seven routes totaling 317 route miles between downtown Milwaukee and Brown Deer to the north; Menomonee Falls and Germantown to the northwest; West Allis, Brookfield, and Waukesha to the west; Greenfield and Greendale to the southwest; and Oak Creek, Racine, and Kenosha to the south. The service to the communities of Menomonee Falls and Germantown to the northwest and Racine and Kenosha to the south would represent extensions of existing bus-on-freeway service. All of the other bus-on-freeway primary transit service under this first stage of plan implementation would represent an expansion of the bus-on-freeway service presently provided from peak-period service only to midday and evening off-peak-period service as well.

Under the first stage of plan implementation, a total of 18 transit stations would be provided outside the Milwaukee central business district, 15 of which would have park-ride lots. Fifteen of these 18 stations and 12 of the 15 park-ride lots are not part of the present bus-on-freeway system. Ten of the 18 stations would be located in Milwaukee County, 7 of which would have park-ride facilities. It is also recommended that the Wisconsin Avenue transit mall and the areawide freeway traffic management system be implemented as part of the first stage of this plan.

If warranted, the second stage of implementation of the plan would include those bus-on-freeway facilities and services which would be expected to work well under the intermediate future conditions

Map 39

SERVICES PROPOSED FOR THE FIRST STAGE OF A BUS-ON-METERED FREEWAY SYSTEM PLAN FOR THE MILWAUKEE AREA



Under the first of the two options considered by the study advisory committee for selection as the primary transit system plan for the Milwaukee area, a bus-on-metered freeway system would be developed over the plan design period in three stages. During the first stage of plan implementation, the existing system of motor buses operating over freeways would be expanded from operation during weekday peak travel periods only to all-day operation at minimum headways of 30 minutes in peak travel periods and 60 minutes in off-peak travel periods. In addition, extensive preferential treatment would be provided for buses operating in primary transit service through the development of an areawide freeway traffic management system and a transit mall in downtown Milwaukee. Primary transit service would be provided on seven routes totaling 317 route miles, and would include a total of 18 transit stations outside the Milwaukee central business district, of which 15 would have park-ride lots. Of these 18 stations, 10 would be located in Milwaukee County, 7 of which would have park-ride facilities. All the service improvements recommended to be carried out during the first stage of implementation of the plan were shown by the plan test and evaluation to work well under even the most pessimistic future for transit use and development in the Region.

Source: SEWRPC.

for the Milwaukee area, but not under the most pessimistic conditions. The second stage facilities and services would be implemented only after the first stage facilities and services had been implemented, and then only if it appeared that future conditions in the Milwaukee area were progressing toward those considered under this study to be intermediate with respect to future transit needs and use—that is, those postulated under either of the two intermediate alternative futures: the stable or declining growth scenario-centralized land use plan future or the moderate growth scenario-decentralized land use plan future.

As shown on Map 40 and in Tables 52 and 53, seven additional bus-on-freeway routes, representing 252 route miles of service, would be added to the bus-on-freeway primary transit system under this second stage of plan implementation. This second stage of the plan would extend bus-on-freeway service to the communities of Saukville and Port Washington. In addition, it would increase bus-on-freeway service to the communities of Whitefish Bay, Glendale, West Allis, Oak Creek, Oconomowoc, Nashotah, Hartland, Pewaukee, and Waukesha over that provided under the first stage of the plan. Twelve transit stations in addition to those existing after implementation of the first stage of the plan would be required under the second stage, all of which would have park-ride lots. Four of these additional stations would be located in Milwaukee County. Thus, implementation of the second stage of the plan would result in an extent of bus-on-metered freeway facilities and services equivalent to that proposed under the truncated bus-on-freeway plans tested and evaluated under the intermediate stable or declining growth scenario-centralized land use plan and moderate growth scenario-decentralized land use plan futures.

The remaining 10 routes of this bus-on-metered freeway plan, which would be implemented under the third and final stage of development, are those routes which would be expected to work well only if future conditions in the Milwaukee area approach those considered to be the most optimistic for transit needs and use over the plan design period, as shown on Map 41 and in Tables 52 and 53. These 10 routes would provide an additional 386 route miles of service. This third stage of the plan would extend bus-on-freeway service to the communities of Mequon, Thiensville, Cedarburg, and Grafton in Ozaukee County; Hales Corners, Franklin, and South Milwaukee in Milwaukee County; West Bend and Jackson in Washington County; and Mukwonago, Big Bend, Muskego, New Berlin, and Butler in Waukesha County. It would also expand bus-on-freeway service provided under the second stage of plan implementation to the communities of Wauwatosa, Menomonee Falls, Brookfield, and Greendale.

An additional 22 transit stations would be provided with these routes, 20 of which would have park-ride lots. Seven of these stations and 5 of these park-ride lots would be located in Milwaukee County. These additional facilities and services would be implemented only after the first two stages of recommendations had been implemented, and only if it appeared that conditions in the Milwaukee area were progressing toward those considered under this study to be the most optimistic with respect to future transit needs and use. This third stage of plan implementation would include all bus-on-freeway facilities and services in the truncated bus-on-freeway plan tested under the moderate growth scenario-centralized land use plan alternative future.

Option Two—Recommendation of a Two-Tier System Plan: The other option presented by the Commission staff to the study Advisory Committee was a two-tier plan. The lower tier of the plan would recommend implementation of all the bus-on-freeway facilities and services of the other option recommended by the staff except in the northwest corridor of the Milwaukee area, where a light rail transit facility would be recommended for implementation. In addition, in those four Milwaukee area corridors other than the northwest corridor within which quantitative test and evaluation had indicated light rail transit would work well under the full range of future conditions, and in the corridor between the Milwaukee and Racine and Kenosha areas shown to be feasible for commuter rail, the bus-on-freeway facilities recommended for implementation under the lower tier of the plan would be modified as necessary to permit eventual upgrading to light rail transit or commuter rail operation as appropriate. These light rail transit and commuter rail facilities would comprise an upper tier of the plan. The bus and rail facilities in that upper tier would not be recommended for immediate implementation; rather, the upper tier would be intended to assure that actions were not taken to foreclose their possible implementation in the future.

Selection of this option by the study Advisory Committee would mean that it had concluded that the intangible benefits attendant to the higher cost light rail transit alternative sufficiently outweigh

Table 52

STAGING OF IMPLEMENTATION OF BUS-ON-METERED FREEWAY SYSTEM PLAN ROUTES

Bus-on-Freeway Routes Recommended for Implementation Under the First Stage of the Recommended Plan		
Route	Station Number	Stations
4—Brown Deer	7	N. 76th Street and W. Brown Deer Road
	8	IH 43 and W. Brown Deer Road
	10	IH 43 and W. Locust Street
	11	IH 43 and W. North Avenue
	34	N. 3rd Street and W. Wisconsin Avenue
6—Northwest Side	12	W. Appleton Avenue and W. Silver Spring Drive
	13	W. North Avenue and W. Lisbon Avenue
	34	N. 3rd Street and W. Wisconsin Avenue
9—Germantown/Menomonee Falls	18	N. Pilgrim Road and W. Mequon Road
	20	STH 175 and W. Good Hope Road
	32	N. 84th Street and IH 94
	34	N. 3rd Street and W. Wisconsin Avenue
13—Waukesha	29	N. Barstow Street and W. Main Street
	30	N. Barker Road and W. Blue Mound Road
	32	N. 84th Street and IH 94
	34	N. 3rd Street and W. Wisconsin Avenue
16—Greenfield	38	S. 76th Street and W. Cold Spring Road
	34	N. 3rd Street and W. Wisconsin Avenue
19—Kenosha	45	6th Avenue and 56th Street
	46	STH 31 and 52nd Avenue
	52	IH 94 and W. College Avenue
	34	N. 3rd Street and W. Wisconsin Avenue
20—Racine	47	Wisconsin Avenue and 6th Street
	48	STH 31 and 12th Street
	49	IH 94 and STH 20
	52	IH 94 and W. College Avenue
	34	N. 3rd Street and W. Wisconsin Avenue
Bus-on-Freeway Routes Recommended for Implementation Under the Second Stage of the Recommended Plan		
Route	Station Number	Stations
1—Port Washington	1	IH 43 and STH 33
	2	IH 43 and CTH Q
	9	IH 43 and W. Silver Spring Drive
	11	IH 43 and W. North Avenue
	34	N. 3rd Street and W. Wisconsin Avenue
5—River Hills	9	IH 43 and W. Silver Spring Drive
	11	IH 43 and W. North Avenue
	34	N. 3rd Street and W. Wisconsin Avenue
11—Oconomowoc	24	S. Main Street and E. Wisconsin Avenue
	25	Lakeland Road and STH 16
	26	Merton Avenue and STH 16
	27	Main Street and USH 16
	31	N. Moorland Road and IH 94
	32	N. 84th Street and IH 94
	34	N. 3rd Street and W. Wisconsin Avenue
12—Pewaukee	28	Grandview Boulevard and IH 94
	31	N. Moorland Road and IH 94
	32	N. 84th Street and IH 94
	34	N. 3rd Street and W. Wisconsin Avenue
17—West Allis	35	USH 45 and W. National Avenue
	34	N. 3rd Street and W. Wisconsin Avenue
21—Oak Creek/Ryan Road	50	IH 94 and Ryan Road
	34	N. 3rd Street and W. Wisconsin Avenue
24—South Side/Holt Avenue	53	IH 94 and W. Holt Avenue
	34	N. 3rd Street and W. Wisconsin Avenue

Table 52 (continued)

Bus-on-Freeway Routes Recommended for Implementation Under the Third Stage of the Recommended Plan		
Route	Station Number	Stations
2—Cedarburg/Grafton	3 4 9 11 34	S. 1st Avenue and Wisconsin Avenue IH 43 and CTH C IH 43 and W. Silver Spring Drive IH 43 and W. North Avenue N. 3rd Street and W. Wisconsin Avenue
3—Mequon	5 6 9 11 34	Cedarburg Road and Highland Road IH 43 and Mequon Road IH 43 and W. Silver Spring Drive IH 43 and W. North Avenue N. 3rd Street and W. Wisconsin Avenue
7—Wauwatosa	23 33 34	USH 45 and W. Watertown Plank Road Cemetery Access Road and IH 94 N. 3rd Street and W. Wisconsin Avenue
8—West Bend	14 15 16 17 19 32 34	S. Main Street and W. Washington Avenue S. Main Street and Paradise Avenue USH 45 and STH 60 USH 45 and USH 145 USH 41 and Main Street N. 84th Street and IH 94 N. 3rd Street and W. Wisconsin Avenue
10—Brookfield	21 22 32 34	N. Calhoun Road and W. Capitol Drive N. 124th Street and W. Capitol Drive N. 84th Street and IH 94 N. 3rd Street and W. Wisconsin Avenue
14—Mukwonago	41 42 43 44 31 32 34	STH 83 and STH 15 CTH F and STH 15 Racine Avenue and STH 15 S. Moorland Road and STH 15 N. Moorland Road and IH 94 N. 84th Street and IH 94 N. 3rd Street and W. Wisconsin Avenue
15—Hales Corners	36 34	S. 108th Street and STH 15 N. 3rd Street and W. Wisconsin Avenue
18—Franklin	37 39 40 34	W. Loomis Road and W. Rawson Avenue W. Loomis Road and W. Grange Avenue S. 27th Street and IH 894 N. 3rd Street and W. Wisconsin Avenue
22—Oak Creek/Rawson Avenue	51 34	Nicholson Avenue and E. Rawson Avenue N. 3rd Street and W. Wisconsin Avenue
23—South Side/College Avenue	52 34	College Avenue and IH 94 N. 3rd Street and W. Wisconsin Avenue

Source: SEWRPC.

the significant capital cost advantage of the bus-on-metered freeway alternative and the capital cost advantage of the bus-on-busway alternative to warrant development of a light rail transit facility in the northwest corridor of Milwaukee County. Selection of this option would also indicate that the study Advisory Committee considered very important the potential of light rail transit to operate during a motor fuel shortage and to operate in the very long-term future, when petroleum-based motor fuels may be expected to become scarce and quite costly. And perhaps even more importantly, it would indicate that the Committee considered the potential of light rail transit to shape urban land use development and redevelopment to be of great importance.

Table 53

STAGING OF IMPLEMENTATION OF BUS-ON-METERED FREEWAY SYSTEM PLAN STATIONS

Bus-on-Freeway Stations Recommended for Implementation Under the First Stage of the Recommended Plan

Station Number	Intersection	Civil Division	Status	Passenger Facilities	
				Shelter	Parking
7	N. 76th Street and W. Brown Deer Road.	City of Milwaukee	Proposed	Yes	Yes
8	IH 43 and Brown Deer Road	Village of River Hills	Existing	Yes	Yes
10	IH 43 and W. Locust Street	City of Milwaukee	Proposed	Yes	No
11	IH 43 and W. North Avenue	City of Milwaukee	Proposed	Yes	No
12	W. Appleton Avenue and W. Silver Spring Drive . .	City of Milwaukee	Proposed	Yes	Yes
13	W. North Avenue and W. Lisbon Avenue.	City of Milwaukee	Proposed	Yes	No
18	Pilgrim Road and Mequon Road	Village of Germantown	Proposed	Yes	Yes
20	N. 107th Street and W. Good Hope Road	City of Milwaukee	Proposed	Yes	Yes
29	N. Barstow Street and W. Main Street	City of Waukesha	Proposed	Yes	Yes
30	N. Barker Road and W. Blue Mound Road.	Town of Brookfield	Existing	Yes	Yes
32	N. 84th Street and IH 94.	City of Milwaukee	Proposed	Yes	Yes
34	N. 3rd Street and W. Wisconsin Avenue	City of Milwaukee	Existing	Yes	No
38	S. 76th Street and W. Cold Spring Road	City of Greenfield	Proposed	Yes	Yes
45	6th Avenue and 56th Street	City of Kenosha	Proposed	Yes	Yes
46	STH 31 and 52nd Avenue	City of Kenosha	Proposed	Yes	Yes
47	Wisconsin Avenue and 6th Street	City of Racine	Proposed	Yes	Yes
48	STH 31 and 12th Street	Town of Mt. Pleasant	Proposed	Yes	Yes
49	IH 94 and STH 20	Town of Mt. Pleasant	Proposed	Yes	Yes
52	IH 94 and W. College Avenue	City of Milwaukee	Existing	Yes	Yes

Bus-on-Freeway Stations Recommended for Implementation Under the Second Stage of the Recommended Plan

Station Number	Intersection	Civil Division	Status	Passenger Facilities	
				Shelter	Parking
1	IH 43 and STH 33	Village of Saukville	Proposed	Yes	Yes
2	IH 43 and CTH Q.	Town of Grafton	Proposed	Yes	Yes
9	IH 43 and W. Silver Spring Drive	Village of Glendale	Existing	Yes	Yes
24	S. Main Street and E. Wisconsin Avenue	City of Oconomowoc	Proposed	Yes	Yes
25	Lakeland Road and STH 16	Village of Nashotah	Existing	Yes	Yes
26	Merton Avenue and STH 16	Village of Hartland	Proposed	Yes	Yes
27	Main Street and USH 16	Village of Pewaukee	Proposed	Yes	Yes
28	Grandview Boulevard and IH 94	City of Waukesha	Proposed	Yes	Yes
31	N. Moorland Road and IH 94	City of Brookfield	Proposed	Yes	Yes
35	USH 45 and W. National Avenue	City of West Allis	Proposed	Yes	Yes
50	IH 94 and Ryan Road	City of Oak Creek	Proposed	Yes	Yes
53	IH 94 and W. Holt Avenue.	City of Milwaukee	Existing	Yes	Yes

Bus-on-Freeway Stations Recommended for Implementation Under the Third Stage of the Recommended Plan

Station Number	Intersection	Civil Division	Status	Passenger Facilities	
				Shelter	Parking
3	S. 1st Avenue and Wisconsin Avenue	Village of Grafton	Proposed	Yes	Yes
4	IH 43 and CTH C	Town of Grafton	Existing	Yes	Yes
5	Cedarburg Road and Highland Road	City of Mequon	Existing	Yes	Yes
6	IH 43 and Mequon Road.	City of Mequon	Proposed	Yes	Yes
14	N. Main Street and W. Washington Street	City of West Bend	Proposed	Yes	Yes
15	S. Main Street and W. Paradise Drive	City of West Bend	Proposed	Yes	Yes
16	USH 45 and STH 60	Town of Polk	Proposed	Yes	Yes
17	USH 45 and USH 145	Town of Polk	Proposed	Yes	Yes
19	USH 41 and Main Street	Village of Menomonee Falls	Proposed	Yes	Yes
21	N. Calhoun Road and W. Capitol Drive.	City of Brookfield	Proposed	Yes	Yes
22	N. 124th Street and W. Capitol Drive.	City of Wauwatosa	Proposed	Yes	Yes
23	USH 45 and W. Watertown Plank Road	City of Wauwatosa	Existing	Yes	Yes
33	Cemetery Access Road and IH 94.	City of Milwaukee	Proposed	Yes	No
36	S. 108th Street and STH 15	City of Greenfield	Existing	Yes	Yes
37	W. Loomis Road and W. Rawson Avenue	City of Franklin	Proposed	Yes	Yes
39	W. Loomis Road and W. Grange Avenue	Village of Greendale	Proposed	Yes	No
40	S. 27th Street and IH 894	City of Milwaukee	Proposed	Yes	Yes
41	STH 83 and STH 15	Town of Mukwonago	Existing	Yes	Yes
42	CTH F and STH 15.	Town of Vernon	Existing	Yes	Yes
43	Racine Avenue and STH 15	City of New Berlin	Existing	Yes	Yes
44	S. Moorland Road and STH 15	City of New Berlin	Proposed	Yes	Yes
51	Nicholson Avenue and E. Rawson Avenue.	City of Oak Creek	Proposed	Yes	Yes

Source: SEWRPC.

Map 40

SERVICE PROPOSED FOR THE SECOND STAGE OF A BUS-ON-METERED FREEWAY SYSTEM PLAN FOR THE MILWAUKEE AREA

LEGEND

FIRST STAGE PRIMARY TRANSIT SERVICES

TRANSIT ROUTES

SHARED FREEWAY RIGHT-OF-WAY

SHARED SURFACE ARTERIAL STREET RIGHT-OF-WAY

TRANSIT STATION

WITH PARKING

WITHOUT PARKING

12 STATION NUMBER (SEE TABLE 53)

SECOND STAGE PRIMARY TRANSIT SERVICES

TRANSIT ROUTES

SHARED FREEWAY RIGHT-OF-WAY

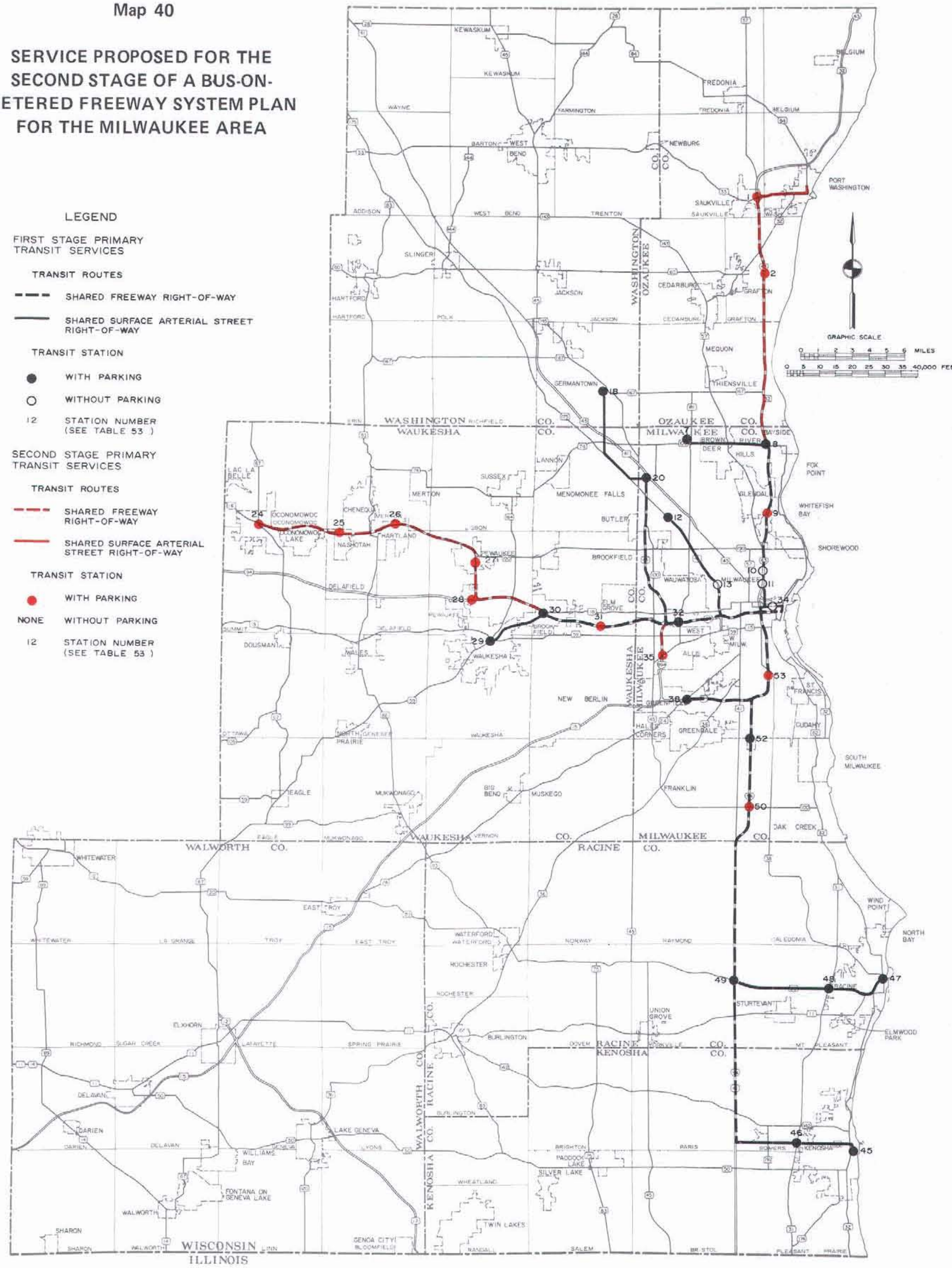
SHARED SURFACE ARTERIAL STREET RIGHT-OF-WAY

TRANSIT STATION

WITH PARKING

NONE WITHOUT PARKING

12 STATION NUMBER (SEE TABLE 53)



Under the first of the two options considered by the study advisory committee for selection as the best primary transit system plan for the Milwaukee area, a bus-on-metered freeway system would be developed over the plan design period in three stages. During the second stage of plan implementation, primary transit service to some communities served under the first stage of this plan would be increased, and service would be provided to additional communities not served by primary transit service under the first stage. The expansion of facilities and services under the second stage would be contingent upon future conditions in the Milwaukee area progressing toward those postulated under either of the two intermediate alternative futures. This stage would encompass the addition of seven primary transit routes to the system implemented under the first stage. Representing 252 additional route miles, this service would include a total of 12 additional transit stations, all of which would have park-ride lots. Of these 12 stations, 4 would be located within Milwaukee County.

Source: SEWRPC.

Map 41

SERVICES PROPOSED FOR THE THIRD STAGE OF A BUS-ON-METERED FREEWAY SYSTEM PLAN FOR THE MILWAUKEE AREA

LEGEND

FIRST AND SECOND STAGE PRIMARY TRANSIT SERVICES

TRANSIT ROUTES

SHARED FREEWAY RIGHT-OF-WAY

SHARED SURFACE ARTERIAL STREET RIGHT-OF-WAY

TRANSIT STATION

WITH PARKING

WITHOUT PARKING

12 STATION NUMBER (SEE TABLE 53)

THIRD STAGE PRIMARY TRANSIT SERVICES

TRANSIT ROUTES

SHARED FREEWAY RIGHT-OF-WAY

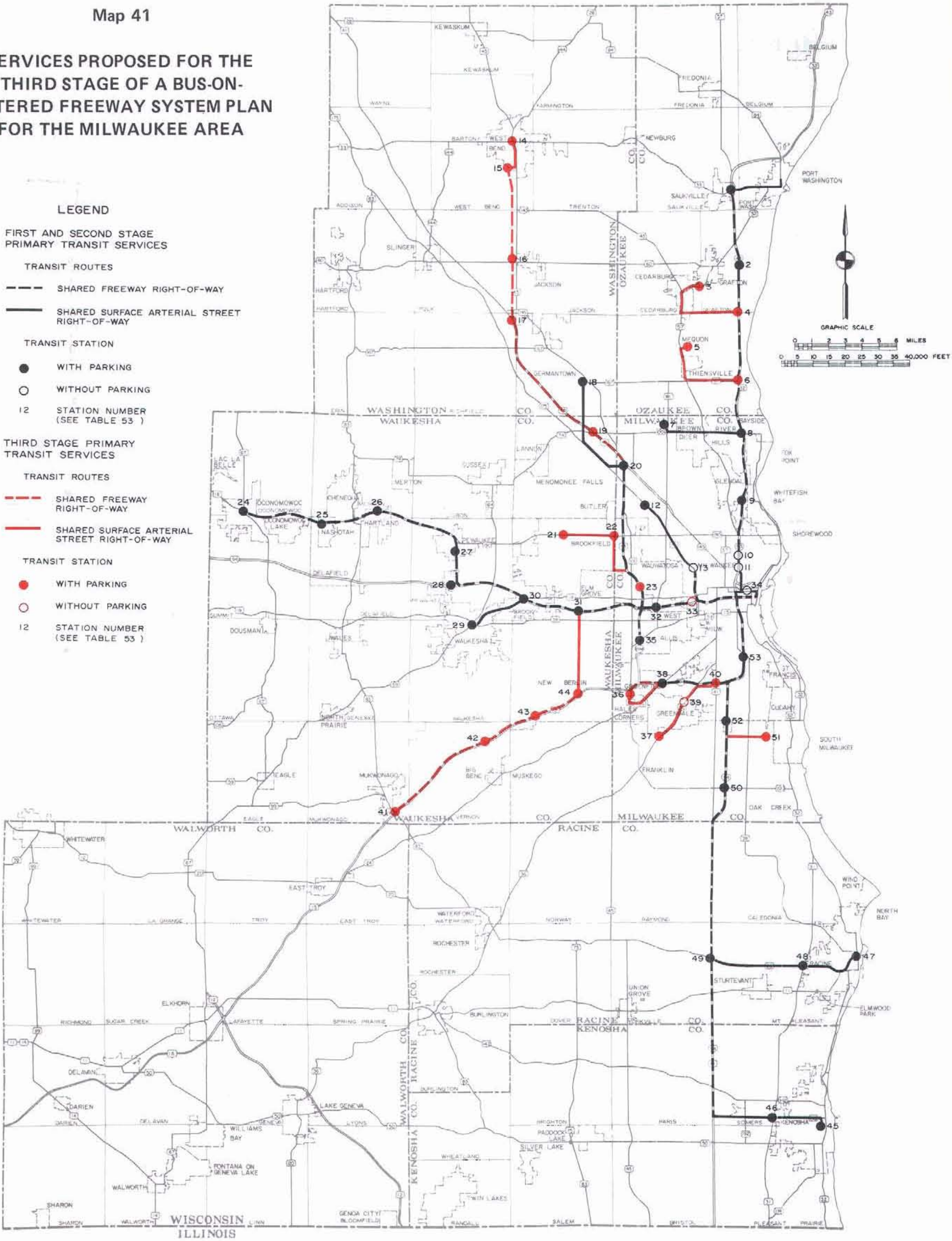
SHARED SURFACE ARTERIAL STREET RIGHT-OF-WAY

TRANSIT STATION

WITH PARKING

WITHOUT PARKING

12 STATION NUMBER (SEE TABLE 53)



Under the first of the two options considered by the study advisory committee for selection as the best primary transit system plan for the Milwaukee area, a bus-on-metered freeway system would be developed over the plan design period in three stages. During the third stage of plan implementation, primary transit service to some communities served under the first and second stages of this plan would be increased, and service would be further expanded to communities not served by primary transit service under the first or second stages. The expansion of facilities and services under the third stage would be contingent upon future conditions in the Milwaukee area progressing toward those considered to be the most optimistic for transit needs and utilization over the plan design period. This stage would encompass the addition of 10 primary transit routes to the system as it would exist following the complete implementation of the second stage. Representing 386 additional route miles over the second-stage system, this service would include a total of 22 additional transit stations over those provided under the second stage, 20 of which would have park-ride lots. Of these 22 stations, 7 would be located within Milwaukee County, 5 of which would have park-ride lots.

Source: SEWRPC.

Through the inducement of sound land use development by public transit, a land use pattern such as the centralized land use pattern postulated in the adopted regional land use plan could be encouraged to evolve in southeastern Wisconsin. Such a centralized land use pattern would require a reversal of the trend of diffused, low-density land development which has been prevalent in the Region since the 1950's. It would represent a reversal in the population out-migration in Milwaukee County and a return to the land use and population densities of the late 1960's and early 1970's in central Milwaukee County, when the resident population of that County peaked. Also, it would represent a return to the historic development trends that were evident within the Region prior to 1950, with new urban development occurring at high and medium densities largely in concentric rings outward from, and generally along, the full periphery of the established urban centers of the Region.

One of the benefits of a more centralized land use pattern is that it would better provide for the restoration of deteriorated urban areas and the conservation of stable urban areas than would a decentralized land use pattern. Such restoration and conservation would conserve substantial public and private financial resources by maximizing the use of sound existing buildings and urban improvements, including streets, sidewalks, and lighting; sewer and water mains and laterals; and gas, electric, and telephone lines. It would also provide for the preservation and revitalization of the central city of the Region. The preservation and revitalization of existing developed urban areas of the Region would also reduce the need for new urban development and the attendant conversion of agricultural and other open lands to urban use. Among the potential adverse environmental impacts associated with the expansion of urban development are the loss of wetlands, woodlands, and wildlife habitat areas; the loss of prime agricultural lands; an increase in storm water runoff and flood flows in streams and watercourses; an increase in soil erosion and attendant sedimentation in streams and lakes during the land development process; an increase in pollutant loadings in surface waters and groundwaters; and an increase in air pollution.

Also, if the new urban development is diffused, as has been the case in recent years in the Region, it would tend to break up economical farm units and create urban enclaves which cannot be efficiently served with basic urban services. This "urban sprawl" type of development typically relies on septic tanks which, if placed on improper soils or if poorly maintained and malfunctioning, can contribute to the pollution of surface water and contaminate groundwater underlying the Region.

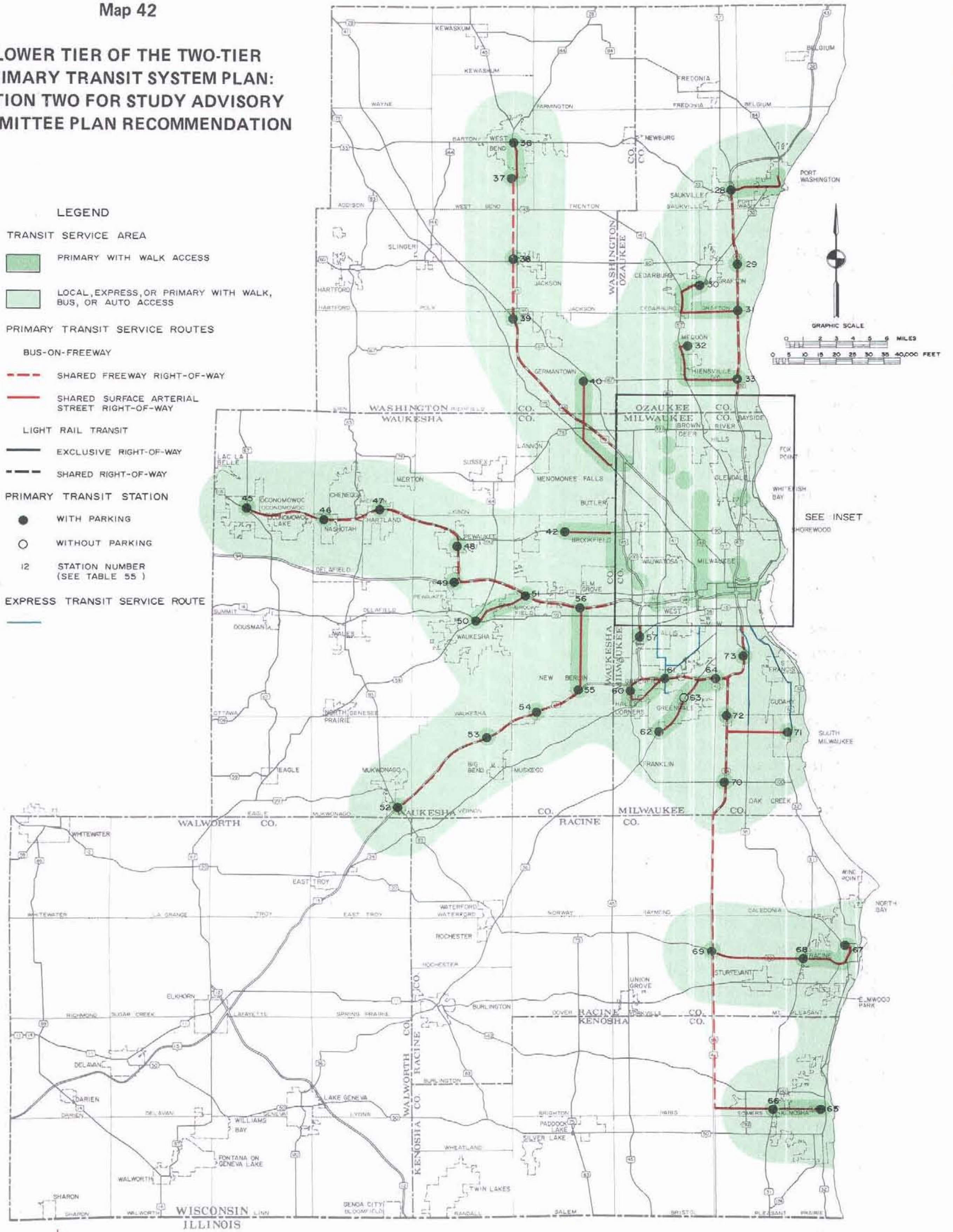
Finally, the more centralized land use pattern will result in a more efficient, economical, and environmentally sound transportation system in the Region. This has been shown in previous Commission transportation planning efforts and in this Milwaukee area primary transit system alternatives analysis. A decentralized land use pattern in the Southeastern Wisconsin Region has been shown consistently to result in higher levels of motor fuel consumption for transportation, higher levels of vehicle miles of travel, greater air pollutant emissions by the transportation system, and a less efficient public transit system.

Plan Description: The primary transit system plan recommended for adoption and implementation under this option is shown on Maps 42 and 43. Under the lower tier of the plan, a light rail transit facility would be operated in the northwest corridor, since light rail transit was shown to work well in this corridor under the full range of alternative future conditions considered under this study. The lower tier of the plan would also include, except in the northwest corridor, all those bus-on-freeway facilities and services which may be expected to provide cost-effective service throughout the day under the most optimistic alternative future for transit use—the moderate growth scenario-centralized land use plan alternative future. This extent of facilities and services can be recommended for implementation because even under the stable or declining growth scenario-decentralized land use plan alternative future—the most pessimistic future for transit in the Milwaukee area—all these bus-on-metered freeway services would be viable at least during the peak travel periods. Also, those bus-on-freeway facilities and services included in the plan but established as cost-effective only under the most optimistic future conditions will be staged to be implemented last, and then only if future conditions in the Milwaukee area are found over time to approximate the most optimistic conditions for transit use.

Under this lower tier of the plan, the locations of the routes and park-ride lots of these bus-on-freeway services would be modified as necessary to permit the ready conversion to light rail transit operation in four corridors, and to commuter rail operation in the Milwaukee-Racine-Kenosha cor-

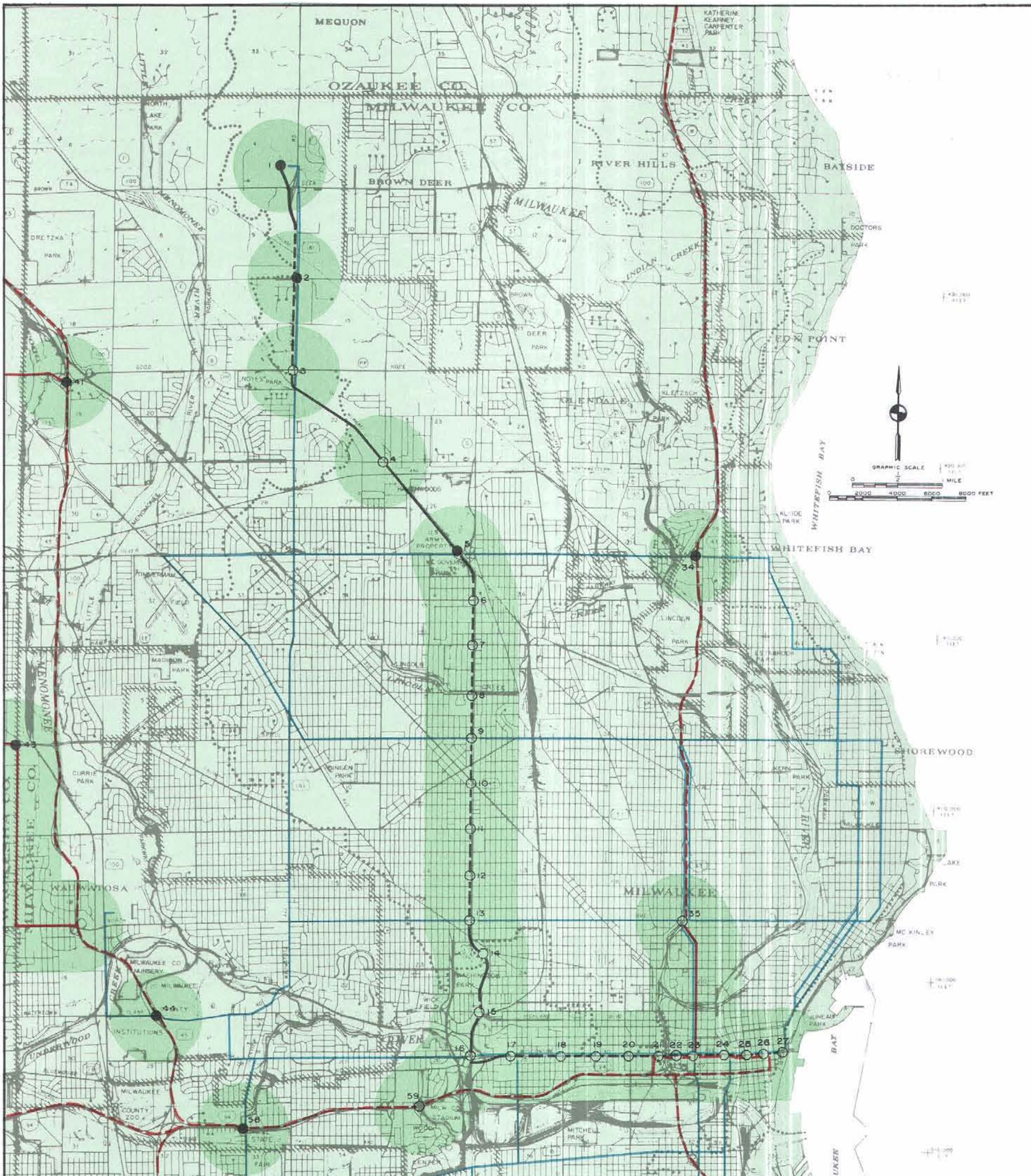
Map 42

LOWER TIER OF THE TWO-TIER PRIMARY TRANSIT SYSTEM PLAN: OPTION TWO FOR STUDY ADVISORY COMMITTEE PLAN RECOMMENDATION



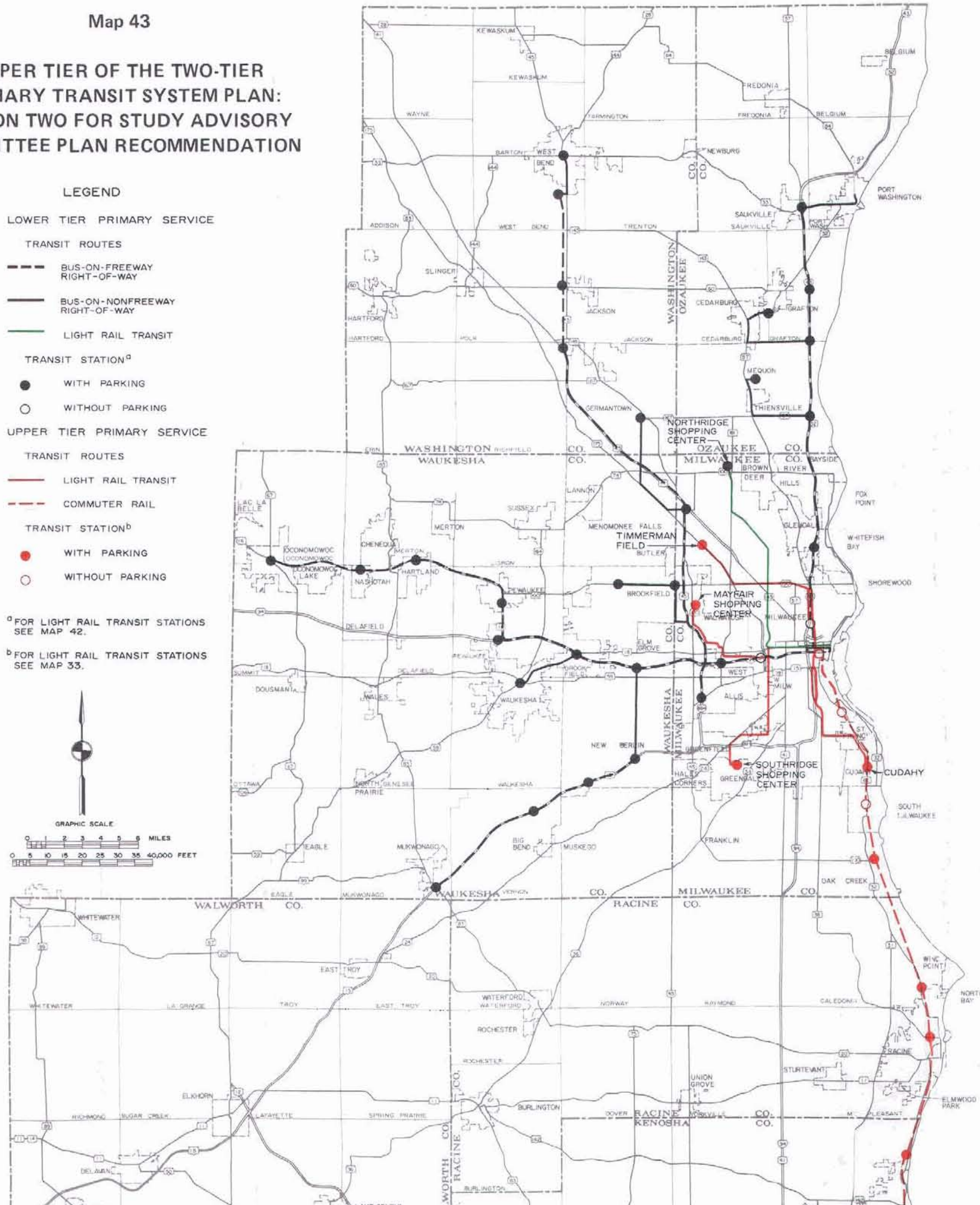
Two options were recommended by the Commission staff to the study advisory committee for possible selection as the best plan for primary transit system development in the Milwaukee area. The second option was a two-tiered system plan, of which only the lower tier would be recommended for immediate implementation. The purpose of the upper tier would be to help avoid actions which would foreclose options concerning primary transit system development in the area. The lower tier of the plan would provide for the development of a system of bus-on-metered freeway lines, except in the northwest corridor of Milwaukee County, within which a light rail facility would be developed. The lower-tier bus-on-freeway facilities and services would, however, be structured so that the service could be readily converted to light rail operation in four additional corridors and to commuter rail operation in the corridor between the Milwaukee and Racine and Kenosha areas, as recommended in the upper tier of the plan. The light rail transit facility recommended for implementation as part of the lower tier of the plan would consist of a single route of 14.3 miles in length within the northwest corridor. The facility would have a total of 27 stations, all of which would be located within Milwaukee County, and 3 of which would have park-ride lots. Service would be provided by one- or two-car trains of electrically propelled articulated light rail vehicles. Bus-on-metered freeway facilities and services under the lower tier would be expanded over those of the present system to consist of 22 routes of all-day operation totaling 900 route miles and having a total of 46 stations, 43 of which would have park-ride lots. Of the 46 stations, 16 would be located within Milwaukee County, of which 13 would have park-ride facilities. High-capacity articulated diesel motor buses would be used to provide the recommended bus-on-freeway service, which would be implemented in stages over the plan design period.

Source: SEWRPC.


MEQUON
OZAUKEE CO.
MILWAUKEE CO.
BROWN DEER
RIVER HILLS
BAYSIDE
MILWAUKEE
FOX POINT
GLENDALE
WHITEFISH BAY
SHOREWOOD
MILWAUKEE
WAUWATOSA
WEST MILWAUKEE
GREENFIELD
GRAPHIC SCALE
1 MILE
0 2000 4000 6000 8000 FEET
WHITEFISH BAY
MILWAUKEE BAY
MC KINLEY PARK
MITCHELL PARK
DOCTORS PARK
LINCOLN PARK
CURRIE PARK
DRETZKA PARK
NORTH LAKE PARK
NOYES PARK
DEER PARK
KATHERINE KEARNEY CARPENTER PARK
MILWAUKEE COUNTY ZOO
MILWAUKEE CO. INSTITUTIONS
INDIAN CREEK
MENOMONEE
LINCOLN CREEK

Map 43

UPPER TIER OF THE TWO-TIER PRIMARY TRANSIT SYSTEM PLAN: OPTION TWO FOR STUDY ADVISORY COMMITTEE PLAN RECOMMENDATION

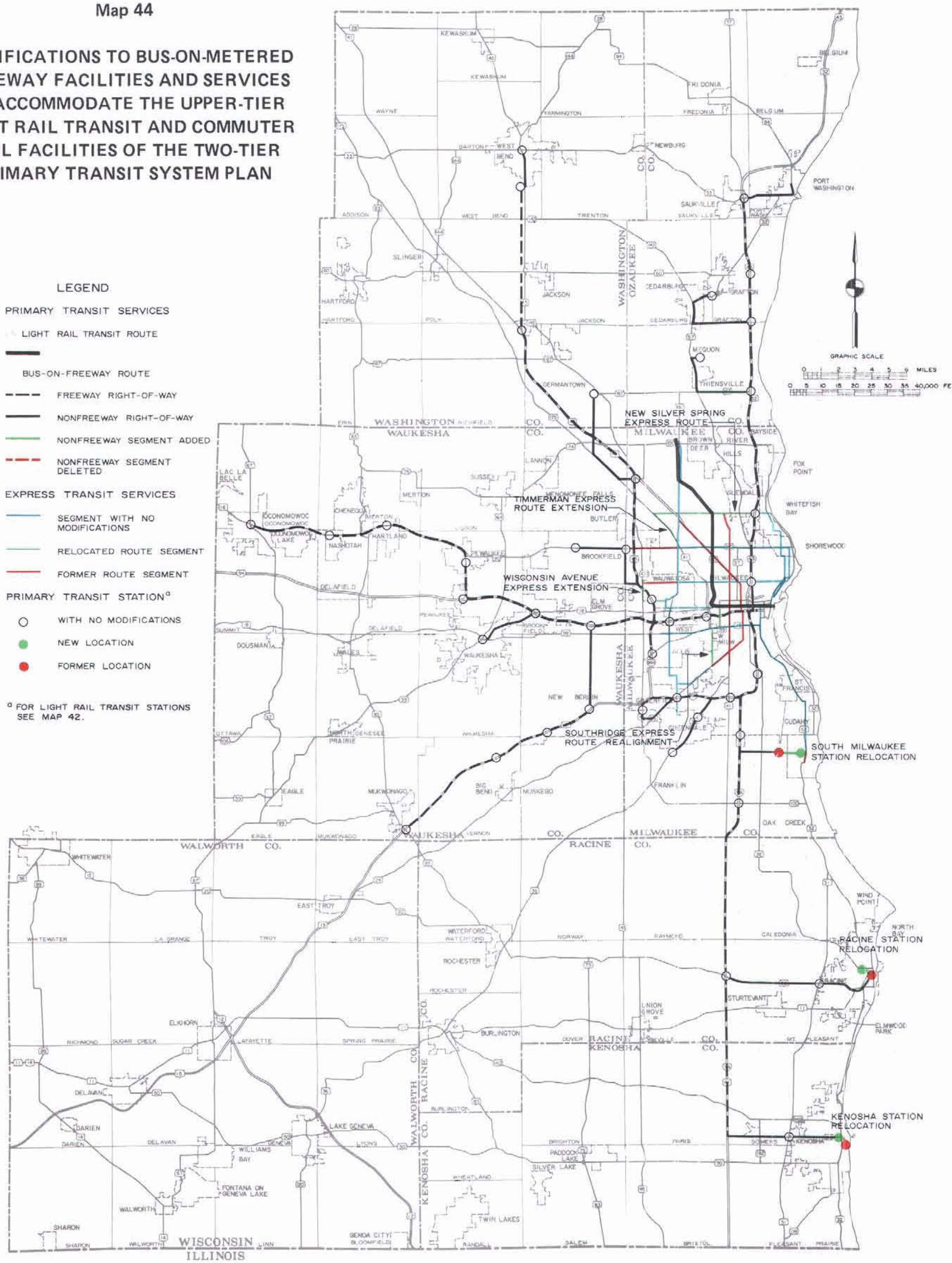


Under the second of the two options considered by the study advisory committee for selection as the best primary transit system plan for the Milwaukee area, only the lower of two tiers would be recommended for immediate implementation. Under the lower tier of this plan, a system of bus-on-metered freeway facilities and services would be developed except in the northwest corridor of Milwaukee County, within which a light rail facility would be developed. The lower-tier bus-on-freeway facilities and services would be developed so as to permit the ready eventual conversion to light rail operation in four additional corridors and to commuter rail operation in the corridor between the Milwaukee and Racine and Kenosha areas. These four additional light rail transit routes include all those routes other than the one in the northwest corridor which the plan test and evaluation efforts indicated had potential to work well under a full range of alternative conditions. The one commuter rail route in the upper tier of the plan is the only route shown by the plan test and evaluation to have the potential to work well under more than the most optimistic future conditions considered. Implementation of these light rail and commuter rail routes would occur only following the development of the light rail transit line in the northwest corridor and a determination, based on the experience with that line, of the extent to which the intangible benefits of rail transit were being achieved, particularly with respect to the shaping of land development and redevelopment. The four light rail transit routes in the upper tier of the plan would entail an additional 34.2 miles of fixed guideway, all located within Milwaukee County. These facilities would include an additional 63 stations, of which 12 would have park-ride lots. The single commuter rail facility in the upper tier of the plan would consist of a route 33.1 miles in length and would have 9 stations, 7 of which have park-ride lots. Of these 9 stations, 5 would be located within Milwaukee County, 3 of which would have park-ride facilities.

Source: SEWRPC.

Map 44

MODIFICATIONS TO BUS-ON-METERED FREEWAY FACILITIES AND SERVICES TO ACCOMMODATE THE UPPER-TIER LIGHT RAIL TRANSIT AND COMMUTER RAIL FACILITIES OF THE TWO-TIER PRIMARY TRANSIT SYSTEM PLAN



Under the two-tier primary transit system plan option considered by the study advisory committee, the lower tier would entail implementation of a single light rail transit route and 22 bus-on-metered freeway routes. These 22 routes and supporting express bus services would be structured to permit eventual ready conversion to light rail transit or commuter rail operation as proposed in the upper tier of this option. As shown on this map, the major modifications of these bus-on-metered freeway facilities and services to permit eventual upgrading would include: 1) relocation of the bus-on-freeway terminal in the City of Kenosha from 6th Avenue and 56th Street to 14th Avenue and 54th Street; 2) relocation of the bus-on-freeway terminal in the City of Racine from Wisconsin Avenue and 6th Street to Memorial Drive and State Street; 3) relocation of the bus-on-freeway terminal in the City of Oak Creek from S. Nicholson and E. Rawson Avenues to 13th and E. Rawson Avenues in the City of South Milwaukee; 4) replacement of portions of express routes along S. 16th Street, W. Forest Home Avenue, and S. Layton Boulevard with a new express route originating at the University of WisconsinMilwaukee and extending through the Milwaukee central business district to the Southridge Shopping Center in the Village of Greendale via W. Wisconsin Avenue, S. 35th and 43rd Streets, W. Forest Home Avenue, and S. 76th Street; 5) extension of the express route along W. Wisconsin Avenue from the Milwaukee County Institutions grounds to the Mayfair Mall Shopping Center along W. Watertown Plank and N. Mayfair Roads; 6) realignment of the express route along W. Capitol Drive west of W. Appleton Avenue such that it terminates at Timmerman Field instead of at N. 124th Street; and 7) deletion of the express routes along N. 17th Street, W. Fond du Lac Avenue, and N. 27th Street, with service to the areas situated at the northerly reaches of these routes provided by a new express route along W. Silver Spring Drive between N. Port Washington Road and Timmerman Field. The first, second, and third modifications would accommodate the possible future upgrading of bus-on-freeway service between the Cities of Milwaukee, Racine, and Kenosha to commuter rail service, and the fourth and fifth modifications would better accommodate the possible future conversion of certain primary and secondary motor bus facilities and services to light rail transit in the southwest and west corridors, respectively. The sixth and seventh modifications reflect the possible implementation of another light rail transit facility between downtown Milwaukee and Timmerman Field within the north corridor.

Source: SEWRPC.

ridor under the upper tier of this plan, as shown on Map 44. These four light rail transit corridors include all those corridors, except the northwest corridor, within which it was established that light rail transit would work well under the full range of alternative future conditions considered in the study. No actions would be proposed to be taken to implement this upper tier of recommendations other than those required to ensure that the concerned facilities could be developed at some time in the future, and that any bus-on-freeway facilities and services implemented in the corridors are adaptable to the possible eventual conversion to rail transit operation. Implementation of the upper-tier light rail transit and commuter rail recommendations would occur only following the recommended implementation of light rail transit in the northwest corridor, and following a determination, based on that implementation, of the extent to which the intangible benefits of rail transit, particularly with respect to land development and redevelopment, were being achieved.

Thus, the lower tier of the primary transit system plan recommended under this option for the Milwaukee area, as shown on Map 42, calls for the construction and operation of a light rail transit facility in the Milwaukee northwest corridor, the expansion of the existing system of routes of buses operating over freeways in all other Milwaukee area corridors, the expansion of all primary transit service from weekday peak-period service to all-day weekday service at maximum headways of 30 minutes in peak travel periods and 60 minutes in off-peak travel periods, and the provision of extensive preferential treatment for buses operating in primary transit service. It also calls for all new bus-on-freeway facilities and services to be implemented so as to permit possible eventual conversion to light rail operation in four additional corridors and to commuter rail operation in the Milwaukee-Racine-Kenosha corridor, as proposed under the upper tier of the plan shown on Map 43.

The light rail transit facility in the northwest corridor would extend through the City of Milwaukee from its central business district westerly along W. Wisconsin Avenue to N. 44th Street, and then north across the Menomonee River Valley to N. Sherman Boulevard. The facility would then extend along N. Sherman Boulevard to W. Silver Spring Drive, and thence northwesterly to the Northridge Shopping Center. The facility would have a length of about 14.3 miles, of which about 11.8 miles would be located on the surface and about 2.5 miles would be on elevated structure. All of the guideway would be constructed for exclusive light rail transit use. At-grade intersections with public streets would be located along the guideway, but the light rail vehicles would receive preferential treatment at these intersections through traffic signalization. A total of 27 stations, 3 of which would have park-ride lots, would be provided along the guideway. The stations would be located approximately one-quarter mile apart in the central business district, one-half mile apart in other high-density-development areas, and one mile apart in medium-density-development areas. Average speeds on the route would be about 20 mph. Headways during the peak periods would range from 4 to 12 minutes, with some service being provided by trains of two articulated light rail vehicles. During the off-peak periods, headways would range from 12 to 60 minutes both in the midday and evening travel periods, with all service being provided by trains made up of a single articulated vehicle.

The bus-on-metered freeway facilities and services recommended for implementation under the lower tier of the plan would expand primary transit service within Milwaukee County, and extend service to the south to the City of Kenosha in Kenosha County, to the southwest to the Village of Mukwonago in Waukesha County, to the northwest to the City of West Bend in Washington County, and to the north to the City of Port Washington in Ozaukee County. Throughout the entire Milwaukee area, bus-on-freeway service would be expanded to an all-day service.

This bus-on-freeway element would consist of 22 bus-on-freeway routes totaling 900 route miles in length and having a total of 46 stations, 43 of which would have park-ride lots. Sixteen of the 46 stations would be located in Milwaukee County, 13 of which would have park-ride lots. Under the plan, articulated, high-capacity buses would operate in primary transit service primarily over existing and proposed metered freeways between outlying park-ride lots and the Milwaukee central business district. Bus routes from park-ride lots in Milwaukee County to the central business district would be operated with a limited number of intermediate stops, as necessary, to connect and coordinate with feeder express and local bus service, and to provide access to major travel generators other than the Milwaukee central business district.

Primary transit bus routes originating at locations outside Milwaukee County but within the Milwaukee urbanized area would generally serve two outlying park-ride lots prior to proceeding in an essentially nonstop mode of operation to the Milwaukee central business district. Primary transit bus routes originating at locations outside the Milwaukee urbanized area would have stops at two to five outlying park-ride lots prior to proceeding in an essentially nonstop mode of operation to the central business district. The park-ride lots would be located, to the extent practicable, within or near freeway interchanges to minimize travel times. Within the Milwaukee central business district, all primary transit bus routes would be operated over E. and W. Wisconsin Avenue for a distance of about two miles, with stops approximately every one-quarter mile; and Wisconsin Avenue would be converted to a mall for exclusive use by public transit vehicles between N. 10th Street and N. Prospect Avenue—a distance of about 1.3 miles.

The Milwaukee area freeways over which the buses in primary transit service would operate would be operationally controlled during peak travel periods, requiring the expansion of the present limited freeway traffic management system serving central Milwaukee County to an areawide system. All freeway on-ramps in the Milwaukee urbanized area would need to be ramp-metered to restrain automobile and truck access to the freeways during peak travel periods. The ramp meters would need to be operated through a central control system which would continuously measure traffic volumes on those portions of the freeway system needed for transit service through an interconnected series of traffic-sensing devices. As freeway traffic volumes approached the levels beyond which freeway operating speeds may be expected to deteriorate, fewer automobiles and trucks would be permitted to enter the freeway system. Sufficient constraint would be exercised to ensure uninterrupted freeway traffic flow and operating speeds of at least 40 mph on all freeway segments, including otherwise congested freeway segments. Consequently, average speeds on the bus-on-freeway routes, including all stops, would range between 19 and 35 mph.

This plan also envisions complementary expansion and improvement of the express and local elements of the Milwaukee area transit system. Express, or limited-stop, routes would be provided in addition to the seven routes included in the base plan—only three of which were actually in operation in 1980. These 10 express routes would operate in a coordinated manner with the light rail and bus-on-metered freeway primary transit system. Under the plan, the local transit system element in the Milwaukee area would be extended where cost-effective into all contiguous areas of urban development, including all of northern and most of southern Milwaukee County, southern Ozaukee County, southeastern Washington County, and eastern Waukesha County.

Under the upper tier of the plan, four additional light rail transit routes, or corridors, are planned, along with one commuter rail corridor. The light rail facilities and services would be located on four routes in four corridors extending from the Milwaukee central business district. One route would extend about 9.4 miles from the intersection of N. 6th Street and W. Wisconsin Avenue north along N. 6th Street and the one-way pair of N. 7th and N. 8th Streets through Milwaukee's near north side. The route would then proceed in a northwesterly direction along W. Atkinson Avenue, W. Capitol Drive, and W. Appleton Avenue, terminating at Timmerman Field. A second route would extend from the intersection of N. 6th Street and W. Wisconsin Avenue south across the 6th Street viaduct, along the one-way pair of S. 4th and S. 5th Streets. The route would then continue along S. Chase and S. Howell Avenues, turning in an easterly direction following the former Milwaukee Electric Lines Lakeside Belt Line right-of-way to S. Kinnickinnic Avenue. At S. Kinnickinnic Avenue, the route would proceed along the Chicago & North Western Railway's right-of-way through the City of Cudahy, terminating at S. Whitnall Avenue. The third route would, as in the northwest corridor, extend from downtown Milwaukee along W. Wisconsin Avenue to N. 44th Street, where it would turn in a southerly direction passing Milwaukee County Stadium. The route would proceed along the cleared right-of-way of the Stadium Freeway-South extension through the City of West Milwaukee, continuing south along S. 43rd Street before proceeding southwesterly along the former Milwaukee Electric Lines Lakeside Belt Line right-of-way, W. Forest Home Avenue, and S. 76th Street and terminating at the Southridge Shopping Center in the Village of Greendale. The last route would extend from downtown Milwaukee along W. Wisconsin Avenue to S. 44th Street as in the routes to the Northridge and Southridge Shopping Centers, would pass Milwaukee County Stadium, and would then continue in a westerly direction along the former Milwaukee Electric Lines Local Rapid Transit Line as far west as N. Glenview Avenue. The route would then proceed in a northwesterly direction through the Milwaukee County Institutions grounds, terminating at the Mayfair Mall Shopping Center in the City of Wauwatosa.

These four light rail transit routes would entail an additional 34.2 miles of guideway, of which 30 miles, or 88 percent, would be on surface alignment and 4.2 miles, or 12 percent, would be on elevated structure. All this additional guideway, except about one mile, or less than 3 percent, would be exclusively for light rail transit use. A total of 63 stations would be provided along the guideway, of which 12 would have park-ride lots. Station spacing would be the same as along the facility in the northwest corridor. Average speeds along these four additional corridors would, as in the northwest corridor, be about 20 mph. Service headways during the peak periods would be about 5 to 12 minutes, with some service being provided by two-car trains. Headways would range from about 8 to 20 minutes during both the midday and evening off-peak travel periods.

Commuter rail service, radiating to the south from the Milwaukee central business district to Kenosha, would be provided under the upper tier of the plan over track owned and operated by the Chicago & North Western Transportation Company. Commuter rail service would be provided to the communities of St. Francis, Cudahy, South Milwaukee, Oak Creek, Racine, and Kenosha. Under the two-tier system plan option, commuter rail service was concluded by the Advisory Committee to be preferable in the long term to bus-on-freeway service in this corridor for two principal reasons. First, the implementation of such service between Milwaukee and Kenosha could—through proper integration with the existing commuter rail service between Kenosha and Chicago—contribute to the development of improved interregional passenger transportation services in the Milwaukee-Chicago intercity corridor. Second, the individual corridor analysis performed for this corridor indicated that the operating cost-effectiveness of this commuter rail route was very comparable to the combined operating cost-effectiveness of the bus-on-freeway routes serving this corridor.[7] This consideration plus the benefits attributable to the intangible advantages of a rail transit facility were felt to be important enough to recommend commuter rail service under the upper tier of the two-tier system plan option. A total of nine stops would be made along this 66-mile route. Speeds on the route would average 32 mph, and headways would be every half-hour in the peak direction during the peak periods and every hour otherwise. Trains would consist of a locomotive and between two and five coaches during the peak periods, and a locomotive and between one and three coaches in the off-peak periods.

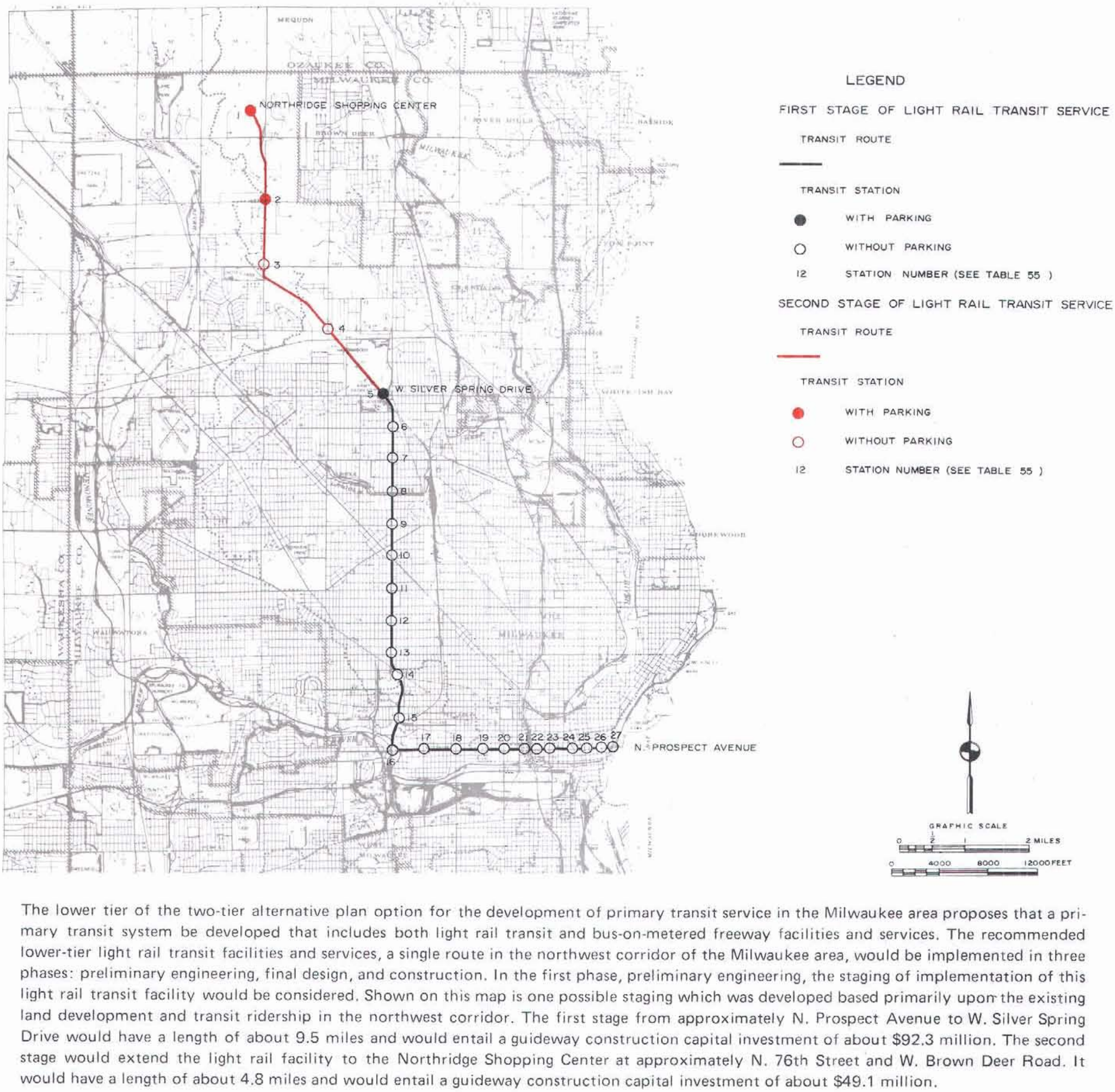
Primary Transit Plan Staging: The lower tier of this primary transit system plan is proposed to be implemented in stages over the plan design period. The development of the primary transit service proposed in the plan, if recommended, must evolve gradually over the planning period as financial resources become available, because the plan requires fairly substantial increases in both public capital and operating and maintenance cost subsidies over the plan design period. The staging of the plan is necessary also because only if public transit needs and ridership increase as anticipated will the plan's facilities and services warrant expansion to the extent envisioned. It should be noted that no staging is proposed for the upper tier of the plan, because it is not recommended for implementation. Its implementation is to be considered only following the implementation of the lower tier of the plan, and following an assessment of the intangible benefits attained by the light rail transit element of the plan's lower tier.

Light Rail Transit Element: The recommended light rail facility in the northwest corridor is proposed to be developed in three stages: preliminary engineering, final design, and construction. The preliminary engineering stage will consist of in-depth study, including an environmental impact analysis of variations in such characteristics of the recommended light rail facility as horizontal and vertical alignment, the location and sizing of stations and park-ride lots, vehicle selection, storage and maintenance needs, and the staging of guideway construction in order to determine the best way to implement the recommended light rail facility in this corridor. Map 45 shows one possible staging of the fixed guideway construction. It was developed based primarily upon existing development

[7] *In the truncated/composite plan analysis, the percent of operating cost met by farebox revenues for the bus-on-freeway services and the commuter rail services, respectively, was: 63 and 60 percent under the moderate growth scenario-centralized land use plan alternative future; 69 and 47 percent under the moderate growth scenario-decentralized land use plan alternative future; and 46 and 42 percent under the stable or declining growth scenario-centralized land use plan alternative future. The corridor analysis was not performed for the stable or declining growth scenario-decentralized land use plan alternative future.*

Map 45

POSSIBLE STAGING OF IMPLEMENTATION OF THE LIGHT RAIL ELEMENT OF THE LOWER TIER OF THE TWO-TIER PRIMARY TRANSIT SYSTEM ELEMENT



The lower tier of the two-tier alternative plan option for the development of primary transit service in the Milwaukee area proposes that a primary transit system be developed that includes both light rail transit and bus-on-metered freeway facilities and services. The recommended lower-tier light rail transit facilities and services, a single route in the northwest corridor of the Milwaukee area, would be implemented in three phases: preliminary engineering, final design, and construction. In the first phase, preliminary engineering, the staging of implementation of this light rail transit facility would be considered. Shown on this map is one possible staging which was developed based primarily upon the existing land development and transit ridership in the northwest corridor. The first stage from approximately N. Prospect Avenue to W. Silver Spring Drive would have a length of about 9.5 miles and would entail a guideway construction capital investment of about $92.3 million. The second stage would extend the light rail facility to the Northridge Shopping Center at approximately N. 76th Street and W. Brown Deer Road. It would have a length of about 4.8 miles and would entail a guideway construction capital investment of about $49.1 million.

Source: SEWRPC.

and transit ridership in the northwest corridor. The first stage from approximately N. Prospect Avenue to W. Silver Spring Drive would have a length of about 9.5 miles and would entail a guideway construction capital investment of about $92.3 million. The second stage would extend the guideway to the Northridge Shopping Center at N. 76th Street and W. Brown Deer Road. It would have a length of about 4.8 miles, and would entail a guideway construction capital investment of about $49.1 million.

The preliminary engineering stage will also include in-depth analysis of the potential for light rail transit to induce sound land development and redevelopment along the facility corridor. This analysis will include consideration of those factors which, according to recent studies, must be present in order for rail transit to influence land development and redevelopment. These factors include the presence of economic forces and a strong demand for land development and redevelopment in the area; the attractiveness of sites surrounding potential light rail transit stations in terms of ease of access, utilities, and other urban facilities and services, physical features, and social characteristics; the existence of a public land use policy which encourages land development and redevelopment along the corridor through coordinated tax policies, infrastructure supply, and appropriate land use controls, as well as local neighborhood and community acceptance and approval; and the presence of land near the stations which is available, or which can be readily assembled, for development. Only if it is concluded from this preliminary engineering phase of the study that light rail transit will, indeed, have a high probability of inducing sound land development and redevelopment in the northwest corridor would actual construction of the light rail transit facility in the corridor proceed.

Upon acceptance of the preliminary engineering report by the governmental units and agencies affected, the final design phase would be initiated. This work would be carried out either by the staff of one or more of the governmental units or agencies involved or by a consulting firm retained by those governmental units or agencies. Starting with the solution to the problem at hand as set forth in the final, approved version of the preliminary engineering phase, the final design phase would move toward the development of detailed construction plans and specifications needed to implement the recommended solution. The plans and specifications would be carried to sufficient detail not only to permit potential contractors to submit bids for the project, but also to permit those contractors actually to construct the recommended works. Engineers retained to carry out the final phase may also have responsibility for securing the necessary permits and other approvals from regulatory and review agencies, for providing supervisory and inspection services during the actual construction process, and for certifying to the governmental units and agencies involved that the construction has been carried out in accordance with the design provisions and specifications. Construction, the third and final phase of implementation necessary prior to the operation of a light rail transit facility in the northwest corridor, would then begin.

Bus-on-Freeway Element: It is proposed that the bus-on-freeway element of this plan, if recommended, be implemented in three stages. Those proposals of the plan which are the most certain to be needed and cost-effective are to be implemented in the first stage. This stage would include all those bus-on-metered freeway facilities and services which were shown to work well under the full range of future conditions in the Milwaukee area, as shown on Map 46 and in Tables 54 and 55. The bus-on-freeway routes and stations under this plan are those of the truncated bus-on-freeway plan tested and evaluated under the most pessimistic future, the stable or declining growth scenario-decentralized land use plan future, but modified to include a light rail transit facility in the northwest corridor and to be adaptable to the possible future conversion to light rail transit or commuter rail operation as proposed in the upper tier of the plan.

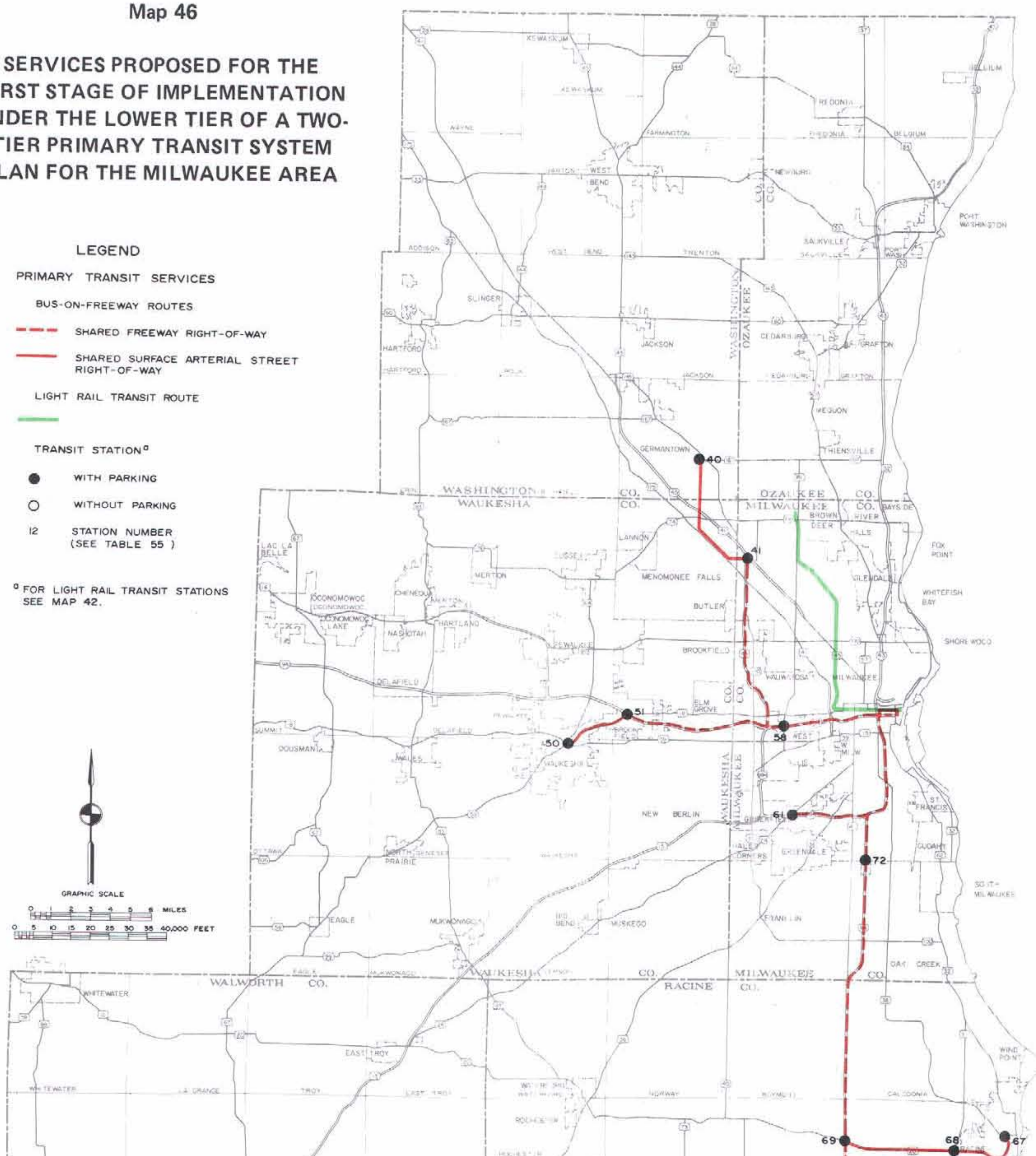
Under this first stage of plan implementation, bus-on-freeway primary transit service would be provided on five routes totaling 262 route miles between downtown Milwaukee, Menomonee Falls, and Germantown to the northwest; West Allis, Brookfield, and Waukesha to the west; Greenfield and Greendale to the southwest; and Oak Creek, Racine, and Kenosha to the south. The service to the communities of Menomonee Falls and Germantown to the northwest and Racine and Kenosha to the south would represent an extension of existing bus-on-freeway service. All the other bus-on-freeway primary transit service under this first stage of plan implementation would represent an expansion of the bus-on-freeway service presently provided from peak-period service only to midday and evening off-peak-period service as well.

Under the first stage of plan implementation, a total of 12 bus-on-freeway transit stations would be provided outside the Milwaukee central business district, all of which would have park-ride lots. Ten of these 12 stations, all of which would have park-ride lots, are not part of the present bus-on-freeway system. Four of the 12 stations would be located in Milwaukee County, all of which would have park-ride facilities. It is also recommended that the areawide freeway traffic management system be implemented as part of the first stage of the recommended plan.

If recommended, the second stage of implementation of the plan would include those bus-on-freeway facilities and services which would be

Map 46

SERVICES PROPOSED FOR THE FIRST STAGE OF IMPLEMENTATION UNDER THE LOWER TIER OF A TWO-TIER PRIMARY TRANSIT SYSTEM PLAN FOR THE MILWAUKEE AREA



The lower tier of the two-tier alternative plan option for the development of primary transit service in the Milwaukee area proposes that a primary transit system be developed that includes both light rail transit and bus-on-metered freeway facilities and services. Implementation of the single light rail transit route in Milwaukee's northwest corridor would occur in three phases: preliminary engineering, final design, and facility construction. Implementation of bus-on-freeway operations would occur in three stages, the first of which is shown on this map. The first stage would include those bus-on-freeway services which were shown to work well under the full range of future conditions expected to occur in the Milwaukee area. Service would be provided on five routes totaling 262 route miles and including 12 transit stations outside the Milwaukee central business district, all of which have park-ride lots. Of the 12 stations, 4 would be located within Milwaukee County, all of which have park-ride facilities. It is also recommended that, under this plan option, the areawide freeway traffic management system be implemented as part of this stage.

Source: SEWRPC.

Table 54

STAGING OF IMPLEMENTATION OF LIGHT RAIL TRANSIT AND BUS-ON-FREEWAY ROUTES UNDER THE LOWER TIER OF THE TWO-TIER SYSTEM PLAN

Primary Transit Routes Recommended for Implementation Under the First Stage of the Two-Tier System Plan		
Light Rail Transit Service		
Route	Station Number	Stations
Milwaukee-Northridge Shopping Center	1	Northridge Shopping Center
	2	N. 76th Street and W. Bradley Road
	3	N. 76th Street and W. Good Hope Road
	4	N. 60th Street and W. Mill Road
	5	N. Sherman Boulevard and W. Silver Spring Drive
	6	N. Sherman Boulevard and W. Villard Avenue
	7	N. Sherman Boulevard and W. Hampton Avenue
	8	N. Sherman Boulevard and W. Congress Street
	9	N. Sherman Boulevard and W. Capitol Drive
	10	N. Sherman Boulevard and W. Fond du Lac Avenue
	11	N. Sherman Boulevard and W. Burleigh Street
	12	N. Sherman Boulevard and W. Center Street
	13	N. Sherman Boulevard and W. North Avenue
	14	N. 40th Street and W. Lisbon Avenue
	15	W. Highland Boulevard and W. Vliet Street
	16	N. 44th Street and W. Wisconsin Avenue
	17	N. 35th Street and W. Wisconsin Avenue
	18	N. 27th Street and W. Wisconsin Avenue
	19	N. 21st Street and W. Wisconsin Avenue
	20	N. 16th Street and W. Wisconsin Avenue
	21	N. 12th Street and W. Wisconsin Avenue
	22	N. 9th Street and W. Wisconsin Avenue
	23	N. 6th Street and W. Wisconsin Avenue
	24	N. 2nd Street and E. Wisconsin Avenue
	25	N. Broadway and E. Wisconsin Avenue
	26	N. Jackson Street and E. Wisconsin Avenue
	27	N. Prospect Avenue and E. Wisconsin Avenue
Bus-on-Freeway Service		
Route	Station Number	Stations
7—Germantown/Menomonee Falls	40	N. Pilgrim Road and W. Mequon Road
	41	STH 175 and W. Good Hope Road
	58	N. 84th Street and IH 94
	24	N. 2nd Street and W. Wisconsin Avenue
11—Waukesha	50	N. Barstow Street and W. Main Street
	51	N. Barker Road and W. Blue Mound Road
	58	N. 84th Street and IH 94
	24	N. 2nd Street and W. Wisconsin Avenue
14—Greenfield	61	S. 76th Street and W. Cold Spring Road
	24	N. 2nd Street and W. Wisconsin Avenue
17—Kenosha	65	14th Avenue and 54th Street
	66	STH 31 and 52nd Avenue
	72	IH 94 and W. College Avenue
	24	N. 2nd Street and W. Wisconsin Avenue
18—Racine	67	Memorial Drive and State Street
	69	IH 94 and STH 20
	72	IH 94 and W. College Avenue
	24	N. 2nd Street and W. Wisconsin Avenue

Table 54 (continued)

Bus-on-Freeway Routes Recommended for Implementation Under the Second Stage of the Two-Tier System Plan		
Route	Station Number	Stations
1—Port Washington	28 29 34 35 24	IH 43 and STH 33 IH 43 and CTH Q IH 43 and W. Silver Spring Drive IH 43 and W. North Avenue N. 2nd Street and W. Wisconsin Avenue
4—River Hills	34 35 24	IH 43 and W. Silver Spring Drive IH 43 and W. North Avenue N. 2nd Street and W. Wisconsin Avenue
9—Oconomowoc	45 46 47 48 56 58 24	S. Main Street and E. Wisconsin Avenue Lakeland Road and STH 16 Merton Avenue and STH 16 Main Street and USH 16 N. Moorland Road and IH 94 N. 84th Street and IH 94 N. 2nd Street and W. Wisconsin Avenue
10—Pewaukee	49 56 58 24	Grandview Boulevard and IH 94 N. Moorland Road and IH 94 N. 84th Street and IH 94 N. 2nd Street and W. Wisconsin Avenue
15—West Allis	57 24	USH 45 and W. National Avenue N. 2nd Street and W. Wisconsin Avenue
19—Oak Creek/Ryan Road	70 24	IH 94 and Ryan Road N. 2nd Street and W. Wisconsin Avenue
22—South Side/Holt Avenue	73 24	IH 94 and W. Holt Avenue N. 2nd Street and W. Wisconsin Avenue

Bus-on-Freeway Routes Recommended for Implementation Under the Third Stage of the Two-Tier System Plan		
Route	Station Number	Stations
2—Cedarburg/Grafton	30 31 34 35 24	S. 1st Avenue and Wisconsin Avenue IH 43 and CTH C IH 43 and W. Silver Spring Drive IH 43 and W. North Avenue N. 2nd Street and W. Wisconsin Avenue
3—Mequon	32 33 34 35 24	Cedarburg Road and Highland Road IH 43 and Mequon Road IH 43 and W. Silver Spring Drive IH 43 and W. North Avenue N. 2nd Street and W. Wisconsin Avenue
5—Wauwatosa	44 59 24	USH 45 and W. Watertown Plank Road Cemetery Access Road and IH 94 N. 2nd Street and W. Wisconsin Avenue
6—West Bend	36 37 38 39 58 24	S. Main Street and W. Washington Avenue S. Main Street and Paradise Avenue USH 45 and STH 60 USH 45 and USH 145 N. 84th Street and IH 94 N. 2nd Street and W. Wisconsin Avenue

Table 54 (continued)

Bus-on-Freeway Routes Recommended for Implementation Under the Third Stage of the Two-Tier System Plan		
Route	Station Number	Stations
8—Brookfield	42	N. Calhoun Road and W. Capitol Drive
	43	N. 124th Street and W. Capitol Drive
	58	N. 84th Street and IH 94
	24	N. 2nd Street and W. Wisconsin Avenue
12—Mukwonago	52	STH 83 and STH 15
	53	CTH F and STH 15
	54	Racine Avenue and STH 15
	55	S. Moorland Road and STH 15
	56	N. Moorland Road and IH 94
	58	N. 84th Street and IH 94
	24	N. 2nd Street and W. Wisconsin Avenue
13—Hales Corners	60	S. 108th Street and STH 15
	24	N. 2nd Street and W. Wisconsin Avenue
16—Franklin	62	W. Loomis Road and W. Rawson Avenue
	63	W. Loomis Road and W. Grange Avenue
	64	S. 27th Street and IH 894
	24	N. 2nd Street and W. Wisconsin Avenue
20—Oak Creek/Rawson Avenue	71	13th Avenue and E. Rawson Avenue
	24	N. 2nd Street and W. Wisconsin Avenue
21—South Side/College Avenue	72	College Avenue and IH 94
	24	N. 2nd Street and W. Wisconsin Avenue

Source: SEWRPC.

expected to work well under the intermediate future conditions for the Milwaukee area, but not under the most pessimistic conditions. These facilities and services would be implemented only after the first stage of recommendations had been implemented, and then only if it appeared that future conditions in the Milwaukee area were progressing toward those considered under this study to be intermediate with respect to future transit needs and use—that is, those postulated under either of the two intermediate alternative futures: the stable or declining growth scenario-centralized land use plan future or the moderate growth scenario-decentralized land use plan future.

As shown on Map 47 and in Tables 54 and 55, seven additional bus-on-freeway routes, representing 252 route miles of service, would be added to the primary transit system under this second stage of plan implementation. This second stage of the plan would extend bus-on-freeway service to the communities of Saukville and Port Washington. In addition, it would increase bus-on-freeway service to the communities of Whitefish Bay, Glendale, West Allis, Oak Creek, Oconomowoc, Nashotah, Hartland, Pewaukee, and Waukesha over that provided under the first stage of the plan. Thirteen transit stations in addition to those existing after implementation of the first stage of the plan would be required under the second stage, 12 of which would have park-ride lots. Five of these additional stations would be located in Milwaukee County, four of which would have park-ride facilities. Thus, implementation of the second stage of the plan would result in an extent of bus-on-metered freeway facilities and services equivalent to those of the bus-on-freeway truncated plans tested and evaluated under the intermediate stable or declining growth scenario-centralized land use plan and moderate growth scenario-decentralized land use plan futures, but modified to include a light rail transit facility in the northwest corridor and to be adaptable to the possible conversion to light rail transit or commuter rail.

The remaining 10 routes of this bus-on-metered freeway element of the plan, which would be implemented under the third and final stage of the plan, are those routes which would be expected to work well only if future conditions in the Milwaukee area approach those considered to be the most optimistic for transit needs and use over the plan design period. As shown on Map 48 and in Tables 54 and 55, these 10 routes would represent an additional 386 route miles of service. This third stage of the plan would extend bus-on-freeway service to the communities of Mequon, Thiensville, Cedarburg, and Grafton in Ozaukee County; West Bend and Jackson in Washington County; Mukwonago, Big Bend, Muskego, New Berlin, and Butler in Waukesha County; and Hales Corners, Franklin, and South Milwaukee in Milwaukee County. It would also expand bus-on-freeway service provided under the second stage of plan implementation to the communities of Wauwatosa, Menomonee Falls, Brookfield, and Greenfield. An additional 21 transit stations would be provided with these routes, 19 of which would have park-ride lots. Seven of these stations and 5 of these park-ride lots would be located in Milwaukee County. These additional facilities and services would be implemented only after the first two stages of recommendations had been implemented, and only if it appeared that conditions in the Milwaukee area were progressing toward those considered under this study to be the most optimistic for future transit needs and use. This third stage of plan implementation would include all bus-on-freeway facilities and services in the truncated bus-on-freeway plan tested and evaluated under the moderate growth scenario-centralized land use plan alternative future, but modified to include a light rail transit facility in the northwest corridor and to be adaptable to the possible future conversion to light rail transit or commuter rail as appropriate.

Performance and Cost of the Two Primary Transit Plan Options

In the following section of this chapter, the performance and cost of each of the two options which the Commission staff determined could be recommended for adoption as the long-range primary transit system plan for the Milwaukee area are presented. This comparison of the performance and cost of these two plan options is based upon the degree to which the plans could be expected to meet the primary transit system development objectives adopted early in the study, and includes consideration of cost and ridership, as well as of accessibility, level of service, energy consumption, and environmental impacts, including air pollution and community disruption. In addition, the comparison, to the extent possible, considers the intangible implications of the plan options which could not be quantitatively measured with any degree of certainty.

Table 56 provides a summary of the degree to which each of the two primary transit options meets the adopted objectives, and compares this performance to that of a base plan. The base plan consists of the existing transit system together with presently planned short-range improvements as adopted by the Milwaukee County Board on September 10, 1980. This comparison to the base plan is intended to make apparent the advantages of the long-range improvement of transit service, as well as the costs attendant to such improvement.

The two plan options provide substantial improvements and increases in transit service over the base system plan. As shown on Maps 38 and 42, the two recommended plan options call for the expansion of primary transit service within Milwaukee County, and the extension of service to the south to the Cities of Racine and Kenosha; to the southwest to the Village of Mukwonago in Waukesha County; to the northwest to the City of West Bend in Washington County; and to the north to the City of Port Washington in Ozaukee County. In addition, both of the improvement plans would expand primary transit service beyond operation during the weekday peak travel periods to all-day weekday service at maximum headways of 30 minutes in peak travel periods and 60 minutes in off-peak travel periods. The plans also recommend a higher level of primary transit service through the provision of extensive preferential treatment for transit vehicles.

The number of primary transit route miles of service under the recommended plan options increases from the 450 miles under the base plan to nearly 800 route miles under the stable or declining growth scenario-decentralized land use plan alternative future, and to nearly 1,000 route miles under the moderate growth scenario-centralized land use plan alternative future, as shown in Table 57. The number of vehicle miles of primary transit service under the recommended plan options would increase five-fold under the most optimistic future for transit use in the Milwaukee area, and would more than double under the most pessimistic future.

Both recommended plan options also envision complementary expansion and improvement of the express and local elements of the Milwaukee area

Table 55

STAGING OF IMPLEMENTATION OF LIGHT RAIL TRANSIT AND BUS-ON-FREEWAY STATIONS UNDER THE LOWER TIER OF THE TWO-TIER SYSTEM PLAN

Primary Transit Stations Recommended for Implementation Under the First Stage of the Two-Tier System Plan					
Light Rail Transit Service					
Station Number	Intersection	Civil Division	Status	Passenger Facilities	
				Shelter	Parking
1	Northridge Shopping Center	City of Milwaukee	Proposed	Yes	Yes
2	N. 76th Street and W. Bradley Road	City of Milwaukee	Proposed	Yes	Yes
3	N. 76th Street and W. Good Hope Road	City of Milwaukee	Proposed	Yes	No
4	N. 60th Street and W. Mill Road	City of Milwaukee	Proposed	Yes	No
5	N. Sherman Boulevard and W. Silver Spring Drive	City of Milwaukee	Proposed	Yes	Yes
6	N. Sherman Boulevard and W. Villard Avenue	City of Milwaukee	Proposed	Yes	No
7	N. Sherman Boulevard and W. Hampton Avenue	City of Milwaukee	Proposed	Yes	No
8	N. Sherman Boulevard and W. Congress Street	City of Milwaukee	Proposed	Yes	No
9	N. Sherman Boulevard and W. Capitol Drive	City of Milwaukee	Proposed	Yes	No
10	N. Sherman Boulevard and W. Fond du Lac Avenue	City of Milwaukee	Proposed	Yes	No
11	N. Sherman Boulevard and W. Burleigh Street	City of Milwaukee	Proposed	Yes	No
12	N. Sherman Boulevard and W. Center Street	City of Milwaukee	Proposed	Yes	No
13	N. Sherman Boulevard and W. North Avenue	City of Milwaukee	Proposed	Yes	No
14	N. 40th Street and W. Lisbon Avenue	City of Milwaukee	Proposed	Yes	No
15	W. Highland Boulevard and W. Vliet Street	City of Milwaukee	Proposed	Yes	No
16	N. 41st Street and W. Wisconsin Avenue	City of Milwaukee	Proposed	Yes	No
17	N. 35th Street and W. Wisconsin Avenue	City of Milwaukee	Proposed	Yes	No
18	N. 27th Street and W. Wisconsin Avenue	City of Milwaukee	Proposed	Yes	No
19	N. 21st Street and W. Wisconsin Avenue	City of Milwaukee	Proposed	Yes	No
20	N. 16th Street and W. Wisconsin Avenue	City of Milwaukee	Proposed	Yes	No
21	N. 12th Street and W. Wisconsin Avenue	City of Milwaukee	Proposed	Yes	No
22	N. 9th Street and W. Wisconsin Avenue	City of Milwaukee	Proposed	Yes	No
23	N. 6th Street and W. Wisconsin Avenue	City of Milwaukee	Proposed	Yes	No
24	N. 2nd Street and E. Wisconsin Avenue	City of Milwaukee	Proposed	Yes	No
25	N. Broadway and E. Wisconsin Avenue	City of Milwaukee	Proposed	Yes	No
26	N. Jackson Street and E. Wisconsin Avenue	City of Milwaukee	Proposed	Yes	No
27	N. Prospect Avenue and E. Wisconsin Avenue	City of Milwaukee	Proposed	Yes	No
Bus-on-Freeway Service					
Station Number	Intersection	Civil Division	Status	Passenger Facilities	
				Shelter	Parking
40	Pilgrim Road and Mequon Road	Village of Germantown	Proposed	Yes	Yes
41	N. 107th Street and W. Good Hope Road	City of Milwaukee	Proposed	Yes	Yes
50	N. Barstow Street and W. Main Street	City of Waukesha	Proposed	Yes	Yes
51	N. Barker Road and W. Blue Mound Road	Town of Brookfield	Existing	Yes	Yes
58	N. 84th Street and IH 94	City of Milwaukee	Proposed	Yes	Yes
61	S. 76th Street and W. Cold Spring Road	City of Greenfield	Proposed	Yes	Yes
65	14th Avenue and 54th Street	City of Kenosha	Existing	Yes	Yes
66	STH 31 and 52nd Avenue	City of Kenosha	Proposed	Yes	Yes
67	Memorial Drive and State Street	City of Racine	Proposed	Yes	Yes
68	STH 31 and 12th Street	Town of Mt. Pleasant	Proposed	Yes	Yes
69	IH 94 and STH 20	Town of Mt. Pleasant	Proposed	Yes	Yes
72	IH 94 and W. College Avenue	City of Milwaukee	Existing	Yes	Yes

Table 55 (continued)

Bus-on-Freeway Stations Recommended for Implementation Under the Second Stage of the Two-Tier System Plan					
Station Number	Intersection	Civil Division	Status	Passenger Facilities	
				Shelter	Parking
28	IH 43 and STH 33	Village of Saukville	Proposed	Yes	Yes
29	IH 43 and CTH Q	Town of Grafton	Proposed	Yes	Yes
34	IH 43 and W. Silver Spring Drive	Village of Glendale	Existing	Yes	Yes
35	IH 43 and W. North Avenue	City of Milwaukee	Proposed	Yes	No
45	S. Main Street and E. Wisconsin Avenue	City of Oconomowoc	Proposed	Yes	Yes
46	Lakeland Road and STH 16	Village of Nashotah	Existing	Yes	Yes
47	Merton Avenue and STH 16	Village of Hartland	Proposed	Yes	Yes
48	Main Street and USH 16	Village of Pewaukee	Proposed	Yes	Yes
49	Grandview Boulevard and IH 94	City of Waukesha	Proposed	Yes	Yes
56	N. Moorland Road and IH 94	City of Brookfield	Proposed	Yes	Yes
57	USH 45 and W. National Avenue	City of West Allis	Proposed	Yes	Yes
70	IH 94 and Ryan Road	City of Oak Creek	Proposed	Yes	Yes
73	IH 94 and W. Holt Avenue	City of Milwaukee	Proposed	Yes	Yes

Bus-on-Freeway Stations Recommended for Implementation Under the Third Stage of the Two-Tier System Plan					
Station Number	Intersection	Civil Division	Status	Passenger Facilities	
				Shelter	Parking
30	S. 1st Avenue and Wisconsin Avenue	Village of Grafton	Proposed	Yes	Yes
31	IH 43 and CTH C	Town of Grafton	Existing	Yes	Yes
32	Cedarburg Road and Highland Road	City of Mequon	Existing	Yes	Yes
33	IH 43 and Mequon Road	City of Mequon	Proposed	Yes	Yes
36	N. Main Street and W. Washington Street	City of West Bend	Proposed	Yes	Yes
37	S. Main Street and W. Paradise Drive	City of West Bend	Proposed	Yes	Yes
38	USH 45 and STH 60	Town of Polk	Proposed	Yes	Yes
39	USH 45 and USH 145	Town of Polk	Proposed	Yes	Yes
42	N. Calhoun Road and W. Capitol Drive	City of Brookfield	Proposed	Yes	Yes
43	N. 124th Street and W. Capitol Drive	City of Wauwatosa	Proposed	Yes	Yes
44	USH 45 and W. Watertown Plank Road	City of Wauwatosa	Existing	Yes	Yes
59	Cemetery Access Road and IH 94	City of Milwaukee	Proposed	Yes	No
60	S. 108th Street and STH 15	City of Greenfield	Existing	Yes	Yes
62	W. Loomis Road and W. Rawson Avenue	City of Franklin	Proposed	Yes	Yes
63	W. Loomis Road and W. Grange Avenue	Village of Greendale	Proposed	Yes	No
64	S. 27th Street and IH 894	City of Milwaukee	Proposed	Yes	Yes
52	STH 83 and STH 15	Town of Mukwonago	Existing	Yes	Yes
53	CTH F and STH 15	Town of Vernon	Existing	Yes	Yes
54	Racine Avenue and STH 15	City of New Berlin	Existing	Yes	Yes
55	S. Moorland Road and STH 15	City of New Berlin	Proposed	Yes	Yes
71	13th Avenue and E. Rawson Avenue	City of Oak Creek	Proposed	Yes	Yes

Source: SEWRPC.

transit system. Five express, or limited-stop, routes would be provided in addition to the seven routes included in the base plan—only three of which were actually in operation in 1980. These 12 express routes would operate in a coordinated manner with the expanded primary transit system. The local transit system element in the Milwaukee area would be extended, where cost-effective, into contiguous areas of urban development, including northern and southern Milwaukee County and parts of southern Ozaukee County, southeastern Washington County, and eastern Waukesha County. Route miles of express and local service operated would increase from about 1,300 miles under the base plan to between 1,400 and 1,500 miles under the recommended plan options—the lower total under the

Map 47

SERVICES PROPOSED FOR THE SECOND STAGE OF IMPLEMENTATION UNDER THE LOWER TIER OF A TWO-TIER PRIMARY TRANSIT SYSTEM PLAN FOR THE MILWAUKEE AREA

LEGEND

FIRST STAGE PRIMARY TRANSIT SERVICES

BUS-ON-FREEWAY ROUTES

SHARED FREEWAY RIGHT-OF-WAY

SHARED SURFACE ARTERIAL STREET RIGHT-OF-WAY

LIGHT RAIL TRANSIT ROUTE

TRANSIT STATION[a]

WITH PARKING

WITHOUT PARKING

12 STATION NUMBER (SEE TABLE 55)

SECOND STAGE PRIMARY TRANSIT SERVICES

BUS-ON-FREEWAY ROUTES

SHARED FREEWAY RIGHT-OF-WAY

SHARED SURFACE ARTERIAL STREET RIGHT-OF-WAY

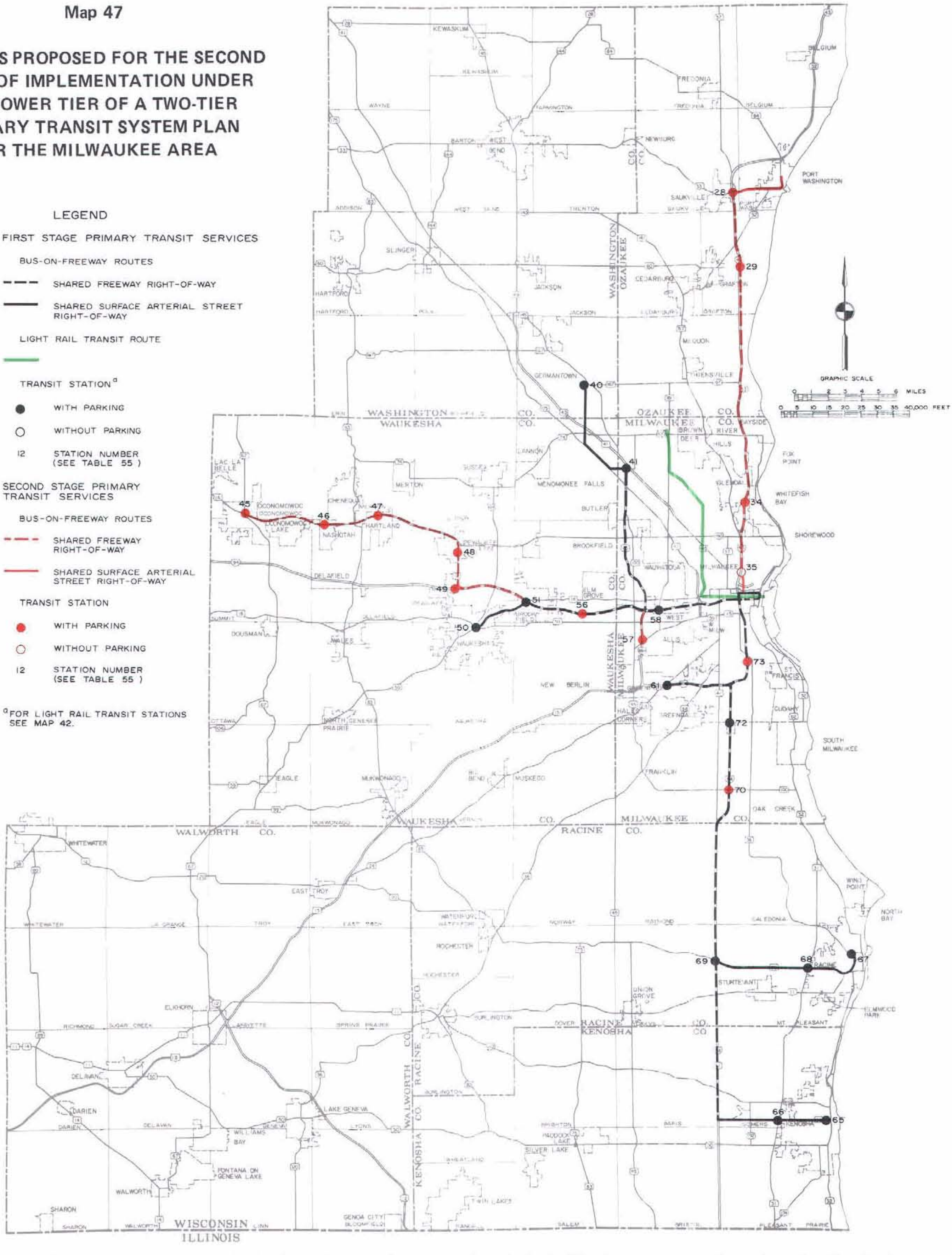
TRANSIT STATION

WITH PARKING

WITHOUT PARKING

12 STATION NUMBER (SEE TABLE 55)

[a]FOR LIGHT RAIL TRANSIT STATIONS SEE MAP 42.

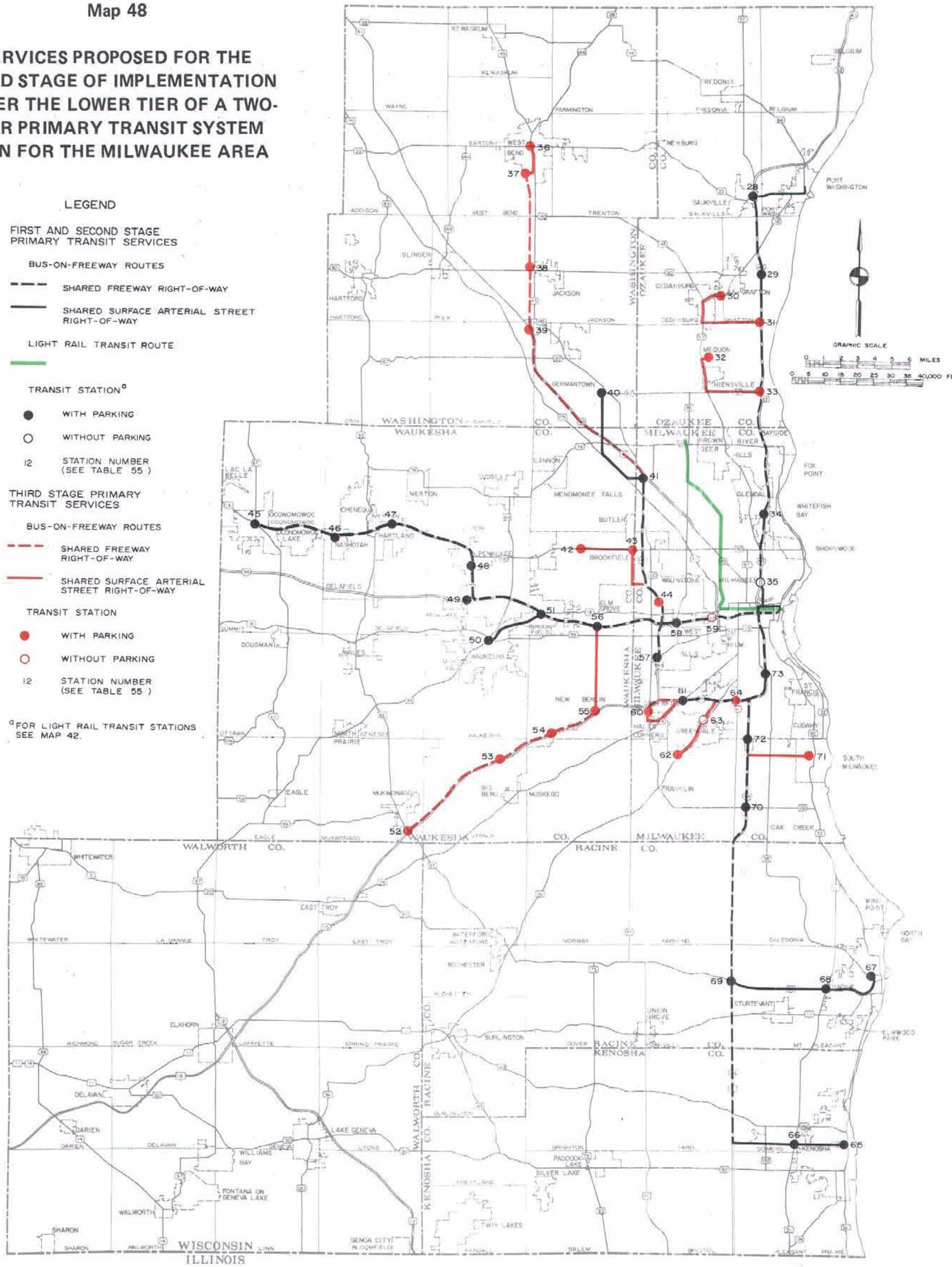


The lower tier of the two-tier alternative plan option for the development of primary transit service in the Milwaukee area proposes that a primary transit system be developed that includes both light rail transit and bus-on-metered freeway facilities and services. Implementation of the single light rail transit route in Milwaukee's northwest corridor would occur over three phases: preliminary engineering, final design, and actual facility construction. Implementation of bus-on-freeway operations would occur in three stages, the second of which is shown on this map. The second stage would include those bus-on-freeway services which were shown to work well under either of the two intermediate alternative futures postulated for the Milwaukee area under this study. Service would be provided on seven additional routes, adding 252 route miles to the system as developed under the first stage, and including 13 additional transit stations, outside the Milwaukee central business district, 12 of which would have park-ride lots. Of the 13 stations, 5 would be located within Milwaukee County, 4 of which would have park-ride facilities.

Source: SEWRPC.

Map 48

SERVICES PROPOSED FOR THE THIRD STAGE OF IMPLEMENTATION UNDER THE LOWER TIER OF A TWO-TIER PRIMARY TRANSIT SYSTEM PLAN FOR THE MILWAUKEE AREA



The lower tier of the two-tier alternative plan option for the development of primary transit service in the Milwaukee area proposes that a primary transit system be developed that includes both light rail transit and bus-on-metered freeway facilities and services. Implementation of the single light rail transit route in Milwaukee's northwest corridor would occur over three phases: preliminary engineering, final design, and facility construction. Implementation of bus-on-metered freeway operations would occur in three stages, the third of which is shown on this map. The third stage would include those bus-on-freeway services which were shown to work well only if future conditions in the Milwaukee area approach those considered to be the most optimistic for transit use over the plan design period. Under this final stage of plan implementation, service would be provided on 10 additional routes, adding 386 route miles to the system as developed under the second stage, and including 21 additional transit stations outside the Milwaukee central business district, 19 of which would have park-ride lots. Of the 21 stations, 7 would be located within Milwaukee County, 5 of which would have park-ride facilities.

Source: SEWRPC.

Table 56

SUMMARY OF EVALUATION OF THE BASE SYSTEM PLAN, BUS-ON-METERED FREEWAY SYSTEM PLAN, AND LOWER TIER OF THE TWO-TIER SYSTEM PLAN UNDER THE MODERATE GROWTH SCENARIO-CENTRALIZED LAND USE PLAN AND STABLE OR DECLINING GROWTH SCENARIO-DECENTRALIZED LAND USE PLAN

	Alternative					
	Base Plan		Bus-on-Metered Freeway Plan		Lower Tier of the Two-Tier System Plan	
	Optimistic Scenario	Pessimistic Scenario	Optimistic Scenario	Pessimistic Scenario	Optimistic Scenario	Pessimistic Scenario
Evaluative Measure	Moderate Growth-Centralized Land Use Plan	Stable or Declining Growth-Decentralized Land Use Plan	Moderate Growth-Centralized Land Use Plan	Stable or Declining Growth-Decentralized Land Use Plan	Moderate Growth-Centralized Land Use Plan	Stable or Declining Growth-Decentralized Land Use Plan
Objective No. 1—Serve Land Use						
Accessibility						
Average Overall Travel Time of Transit Trips to the Milwaukee Central Business District (minutes)	35	35	34	34	34	34
Objective No. 2—Minimize Cost and Energy Use						
Cost						
Total Public Cost to Design Year (capital cost and operating and maintenance deficit)	$579,742,000	$483,703,200	$722,873,900	$567,486,900	$812,880,000	$619,931,500
Average Annual Total Public Cost	27,606,600	23,033,500	34,422,600	27,023,100	38,708,600	29,520,500
Capital Cost						
Capital Cost to Design Year	148,840,000	107,761,000	214,323,900	160,906,900	306,300,000	217,931,500
Average Annual Capital Cost	7,087,600	5,131,500	10,205,900	7,662,200	14,585,700	10,377,700
Capital Investment to Design Year	233,328,700	161,597,700	329,729,600	229,867,300	470,700,000	364,526,300
Average Annual Capital Investment	11,110,900	7,695,100	15,701,400	10,946,000	22,414,300	17,358,400
Operating and Maintenance Deficit (net cost)						
Deficit in Design Year	23,198,300	16,328,700	32,904,700	20,158,500	32,658,400	19,481,200
Deficit to Design Year	430,900,000	375,942,200	508,550,000	406,580,000	506,580,000	402,000,000
Average Annual Deficit	20,519,000	17,902,000	24,216,700	19,360,900	24,122,900	19,142,900
Cost-Effectiveness						
Total Public Cost to Design Year per Passenger	0.39	0.43	0.46	0.50	0.52	0.54
Capital Cost to Design Year per Passenger	0.10	0.10	0.14	0.14	0.20	0.19
Operating Deficit to Design Year per Passenger	0.29	0.33	0.32	0.36	0.32	0.35
Total Public Cost to Design Year per Passenger Mile	0.10	0.11	0.09	0.12	0.10	0.13
Capital Cost to Design Year per Passenger Mile	0.03	0.03	0.03	0.03	0.04	0.05
Operating Deficit to Design Year per Passenger Mile	0.07	0.08	0.06	0.09	0.06	0.08
Percent of Operating and Maintenance Cost Met by Farebox Revenue in the Design Year						
Total Transit System	62	53	61	52	61	52
Primary Element	56	49	60	45	63	47
Energy						
Total Transit System Energy Use to Design Year (million BTU's)	20,278,020	15,037,280	22,305,100	16,120,900	23,213,700	16,551,300
Total Transit Construction Energy Use to Design Year (million BTU's)	1,498,400	1,044,480	1,840,100	1,335,200	2,414,700	1,875,800
Total Transit Operating and Maintenance Energy Use to Design Year (million BTU's)	18,779,620	13,992,800	20,465,000	14,785,700	20,799,000	14,675,500
Total Transit System Energy Use per Passenger Mile Traveled to Design Year (BTU's)	3,330	3,530	2,730	3,380	2,830	3,540
Total Transit Passenger Miles per Gallon of Diesel Fuel to Design Year (BTU's)	40.9	38.5	49.8	40.1	48.1	39.4
Dependence on Petroleum-Based Fuel	All trips dependent	All trips dependent	All trips dependent	All trips dependent	8 percent of transit trips not dependent	8 percent of transit trips not dependent
Petroleum-Based Fuel Use by Transit to Design Year (gallons of diesel fuel)	134,355,000	100,744,850	144,697,000	114,936,000	124,502,200	112,450,000
Automobile Propulsion Energy Use in Design Year (gallons of gasoline)	404,800,000	338,400,000	395,200,000	332,800,000	395,200,000	332,800,000
Objective Nos. 3 and 5—Provide Appropriate Service and Quick Travel						
Average Weekday Transit Trips in Design Year						
Total Transit System	326,800	169,400	371,300	176,000	372,900	176,300
Primary Element	15,000	9,500	75,100	22,500	96,300	34,200
Percent of Transit Trips Using Primary Element	4	6	20	12	26	19
Service Coverage						
Population Served Within a One-Half-Mile Walking Distance of Primary Transit Service	257,100	181,500	373,500	250,100	392,200	260,100
Population Served Within a Three-Mile Driving Distance of Primary Transit Service	1,012,400	698,800	1,620,700	933,167	1,300,000	930,600
Jobs Served Within One-Half-Mile Walking Distance of Primary Transit Service	237,000	194,600	293,600	253,100	309,300	260,200
Average Speed of Transit Vehicle (mph)						
Primary Element	19	24	29	27	29	27
Total System	14	15	18	17	18	17
Average Speed of Passenger Travel on Vehicle (mph)						
Primary Element	25	25	34	32	32	30
Total System	15	15	20	18	21	19

Table 56 (continued)

Evaluative Measure	Alternative: Base Plan — Optimistic Scenario: Moderate Growth-Centralized Land Use Plan	Base Plan — Pessimistic Scenario: Stable or Declining Growth-Decentralized Land Use Plan	Bus-on-Metered Freeway Plan — Optimistic Scenario: Moderate Growth-Centralized Land Use Plan	Bus-on-Metered Freeway Plan — Pessimistic Scenario: Stable or Declining Growth-Decentralized Land Use Plan	Lower Tier of the Two-Tier System Plan — Optimistic Scenario: Moderate Growth-Centralized Land Use Plan	Lower Tier of the Two-Tier System Plan — Pessimistic Scenario: Stable or Declining Growth-Decentralized Land Use Plan
Objective No. 4—Minimize Environmental Impacts						
Community Disruption						
Homes, Businesses, or Industries Taken	None	None	None	None	None	None
Land Required (acres)	12	10	70	20	120	60
Air Pollutant Emissions—Total Transportation System (Highway and Transit) in Design Year (tons per year)						
Carbon Monoxide	171,200	165,800	167,400	163,100	167,300	163,100
Hydrocarbons	17,400	16,700	16,900	16,400	16,900	16,400
Nitrogen Oxides	30,700	30,100	30,000	29,200	30,000	29,200
Sulfur Oxides	2,500	2,400	2,500	2,400	2,600	2,400
Particulates	4,100	4,000	4,000	3,900	4,000	3,900
Objective No. 6—Maximize Safety						
Proportion of Total Person Trips Made on Transit	0.074	0.047	0.084	0.050	0.084	0.050

Source: SEWRPC.

pessimistic stable or declining growth scenario-decentralized land use plan alternative future, and the higher total under the optimistic moderate growth scenario-centralized land use plan alternative future. Vehicle miles of express and local service operated would increase from the base plan level only under the more optimistic future, and then only by 5 percent from the base plan level of 85,000 miles on an average weekday to about 90,000 bus miles under the two recommended plan options.

Objective 1—Serve Land Use: The first objective under this study identified the need for an accessible primary transit system which, through its location, capacity, and design, will effectively serve existing, and promote sound future, land use development. This objective was measured by two standards. One standard measured the degree to which transit accessibility to the Milwaukee central business district would be maximized. The other standard measured the degree to which transit accessibility in the Milwaukee area would support the regional land use plan by providing a higher relative accessibility to areas in which high- and medium-density urban development is planned than to areas planned for low-density urban development or planned to be protected from urban development.

The standard calling for maximizing transit accessibility to the Milwaukee central business district was measured by determining the overall travel time, including all access, wait, and transfer time, for transit trips to the Milwaukee central business district from all parts of the Milwaukee area, and the travel times for transit trips as an average for the entire Milwaukee area. The average overall travel times of transit trips to the central business district were determined to be about the same under the two recommended plan options and under the base plan, ranging from 34 minutes under the bus-on-freeway and two-tier plans to 35 minutes under the base plan. However, this similarity is due in large part to the shorter average trips to the central business district expected to be made under the base plan. Transit speed and accessibility to the central business district would be significantly increased under both plan options compared to the base plan, as shown on Maps 49, 50, and 51, which show overall transit travel times from each part of the Milwaukee area to the central business district through travel time contour lines.

The attainment of the other standard under this objective, which calls for adjusting transit accessibility to land use plans, was measured by comparing these contours of central business district

Table 57

FACILITY AND OPERATION CHARACTERISTICS OF THE BASE SYSTEM PLAN AND ALTERNATIVE PRIMARY TRANSIT SYSTEM IMPROVEMENT PLANS UNDER THE MODERATE GROWTH SCENARIO-CENTRALIZED LAND USE PLAN AND STABLE OR DECLINING GROWTH SCENARIO-DECENTRALIZED LAND USE PLAN

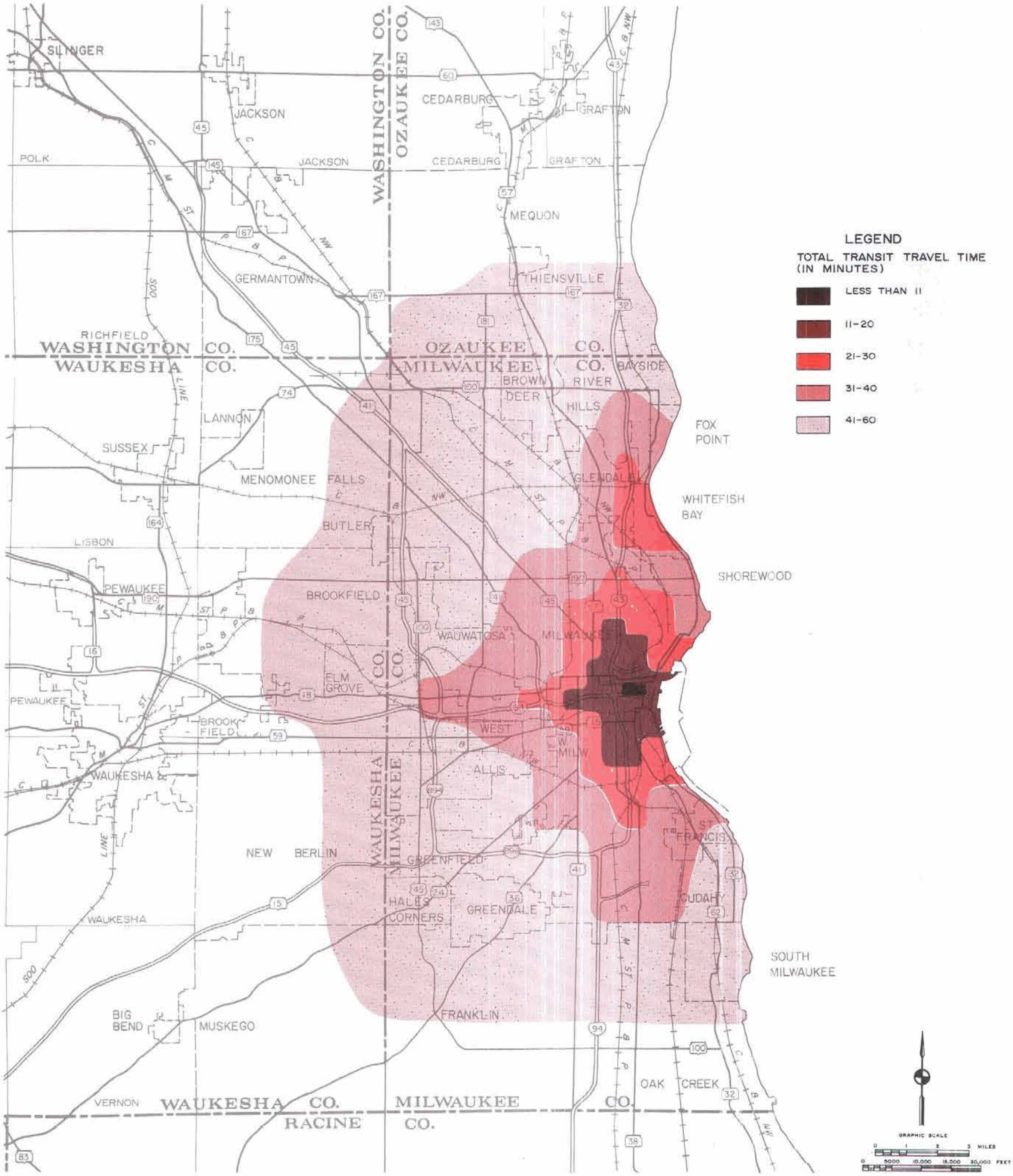
Characteristic	Optimistic Scenario			Pessimistic Scenario		
	Moderate Growth-Centralized Land Use Plan			Stable or Declining Growth-Decentralized Land Use Plan		
	Base Plan	Bus-on-Metered Freeway Plan	Two-Tier System Plan	Base Plan	Bus-on-Metered Freeway Plan	Two-Tier System Plan
Primary Element						
Exclusive Guideway Miles						
Subway	--	--	--	--	--	--
Elevated	--	--	2.5	--	--	2.5
At-Grade	--	--	11.8	--	--	11.8
Total	--	--	14.3	--	--	14.3
Shared Guideway Miles						
Freeways	51.5	141.0	138.6	51.5	141.0	138.6
Surface Arterial Streets	49.5	84.2	74.6	49.5	84.2	74.6
Total	101.0	225.2	213.2	101.0	225.2	213.2
Stations	20	52	73	20	52	73
Route Miles	449	955	975	449	755	775
Vehicle Miles[a]	8,900	40,140	42,500	6,620	14,250	14,310
Vehicle Hours	460	1,410	1,490	280	530	525
Vehicles Required						
Motor Buses	78	199	240	55	126	102
Light Rail Vehicles	--	--	32	--	--	9
Trains Required	--	--	16	--	--	9
Express and Local Element						
Route Miles	1,302	1,545	1,518	1,302	1,350	1,331
Vehicle Miles	85,900	90,460	88,220	52,680	52,410	51,390
Vehicle Hours	6,520	5,900	5,750	3,610	3,410	3,370
Motor Buses Required	823	797	776	521	522	487
Total System						
Route Miles	1,755	2,500	2,493	1,751	2,133	1,573
Vehicle Miles	94,800	130,600	130,720	59,300	66,660	65,700
Vehicle Hours	6,980	7,310	7,240	3,890	3,940	3,895
Vehicles Required						
Motor Buses	901	996	1,016	576	614	589
Light Rail Vehicles	--	--	16	--	--	9
Trains Required	--	--	16	--	--	9

[a] *Vehicle miles of travel per average weekday on the light rail transit route under the lower tier of the two-tier plan is estimated at 3,570 vehicle miles under the moderate growth scenario-centralized land use plan alternative future, and at 1,880 vehicle miles under the stable or declining growth scenario-decentralized land use plan alternative future.*

Source: SEWRPC.

Map 49

TOTAL TRANSIT TRAVEL TIME TO THE MILWAUKEE CENTRAL BUSINESS DISTRICT UNDER THE BASE SYSTEM PLAN OF THE MODERATE GROWTH SCENARIO-CENTRALIZED LAND USE PLAN

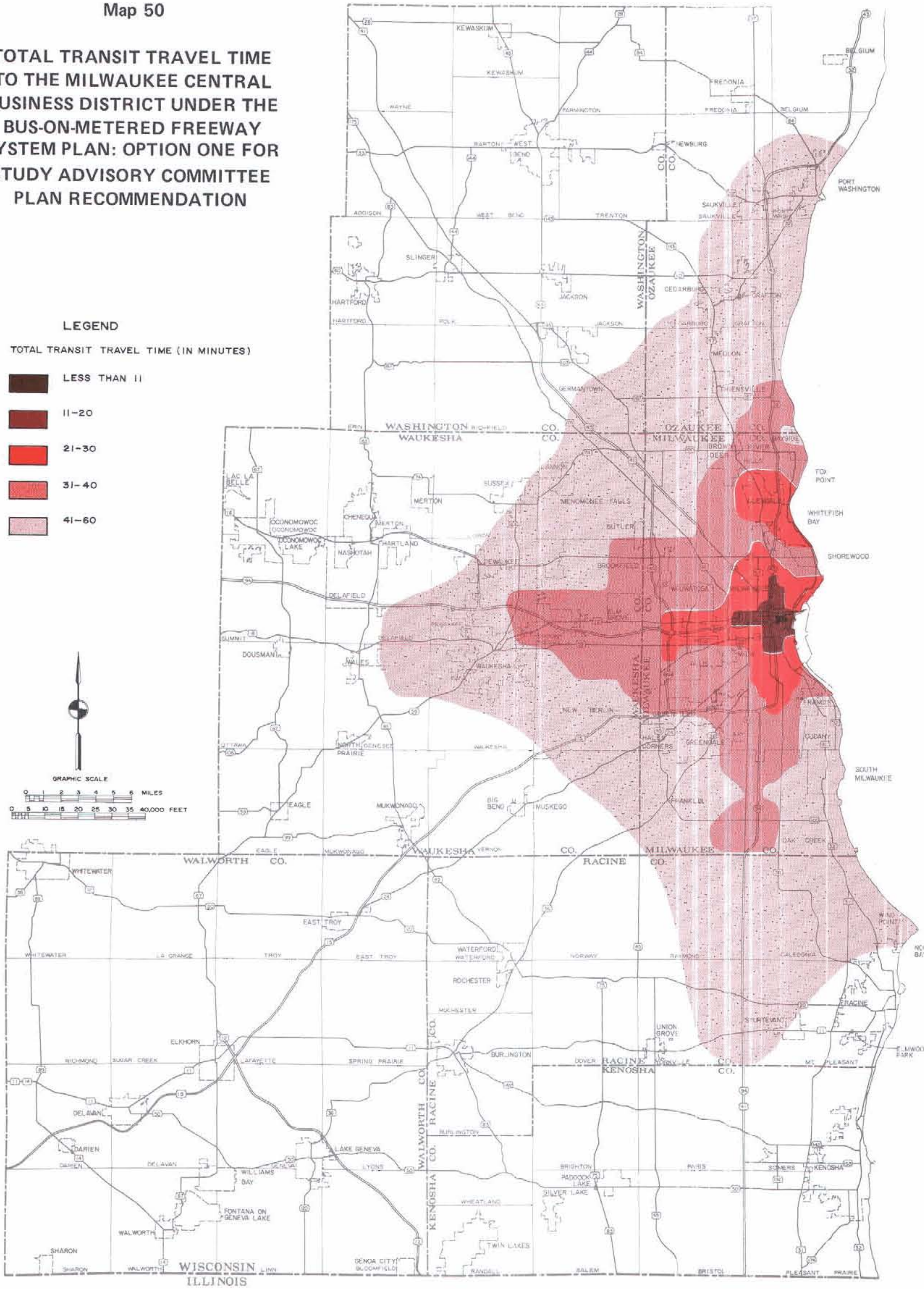


One of the standards utilized in the evaluation of each of the primary transit system plans calls for the maximization of transit accessibility to the Milwaukee central business district. This standard was measured by determining the overall travel time to the Milwaukee central business district from all parts of the Milwaukee area. These overall travel times are indicated on the map by travel time contour lines. Under the base system plan, the various travel time contours form a concentric ring pattern around the Milwaukee central business district, with areas up to 3 miles away being within 20 minutes travel time. Areas up to 6 miles away in a westerly direction and 8 miles away in a northerly and southerly direction are within 40 minutes travel time. Areas up to 11 miles away in a westerly direction, 13 miles away in a northerly direction, and 10 miles away in a southerly direction are within 60 minutes travel time of downtown Milwaukee.

Source: SEWRPC.

Map 50

TOTAL TRANSIT TRAVEL TIME TO THE MILWAUKEE CENTRAL BUSINESS DISTRICT UNDER THE BUS-ON-METERED FREEWAY SYSTEM PLAN: OPTION ONE FOR STUDY ADVISORY COMMITTEE PLAN RECOMMENDATION

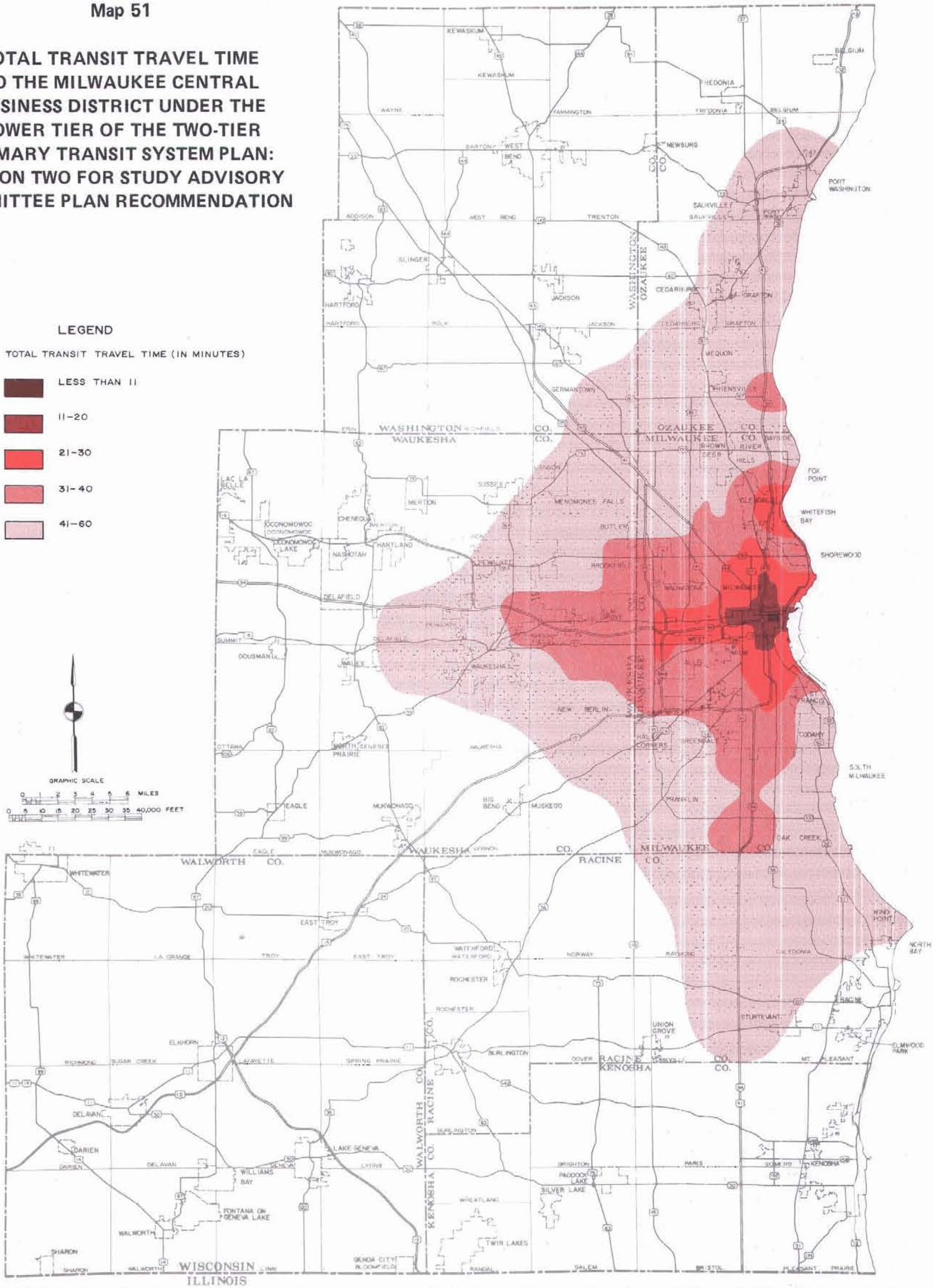


One of the standards utilized in the evaluation of each of the primary transit system plans calls for the maximization of transit accessibility to the Milwaukee central business district. This standard was measured by determining the overall travel time to the Milwaukee central business district from all parts of the Milwaukee area. These overall travel times are indicated on the map by travel time contour lines. Under the bus-on-metered freeway plan, the various travel time contours form a lobate pattern extending outward from downtown Milwaukee generally along the alignments of IH 43 to the north and IH 94 to the west and south. Areas up to 3 miles away are within 20 minutes travel time of downtown Milwaukee, and areas up to 13 miles in a northerly and southerly direction and up to 15 miles in a westerly direction are within 40 minutes travel time of downtown Milwaukee. Areas within 60 minutes travel time extend as far as 27 miles to the north, 25 miles to the south, and 23 miles to the west of downtown Milwaukee.

Source: SEWRPC.

Map 51

TOTAL TRANSIT TRAVEL TIME TO THE MILWAUKEE CENTRAL BUSINESS DISTRICT UNDER THE LOWER TIER OF THE TWO-TIER PRIMARY TRANSIT SYSTEM PLAN: OPTION TWO FOR STUDY ADVISORY COMMITTEE PLAN RECOMMENDATION



One of the standards by which the primary transit system plans were evaluated calls for the maximization of transit accessibility to the Milwaukee central business district. This standard was measured by determining the overall travel time to the Milwaukee central business district from all parts of the Milwaukee area. These overall travel times are indicated on the map by travel time contour lines. Under the lower tier of the two-tier primary transit system plan, the various travel time contour lines form a lobate pattern extending outward from downtown Milwaukee generally along the alignments of IH 43 to the north and IH 94 to the west and south. Areas up to 2 miles away are within 20 minutes travel time and areas up to 13 miles in a northerly and southerly direction, and up to 15 miles in a westerly direction, are within 40 minutes travel time of downtown Milwaukee. Areas within 60 minutes travel time extend as far as 27 miles to the north, as far as 22 miles to the west, and as far as 25 miles to the south of downtown Milwaukee.

Source: SEWRPC.

transit accessibility to the regional land use plan.[8] The Milwaukee central business district is the most important trip generator in the Milwaukee area and would, under the range of alternative futures, remain so, accounting for over 6 percent of the approximately 4.4 million trips expected to be made within the Milwaukee area on an average weekday under the optimistic moderate growth scenario-centralized land use plan alternative future; and for 5 percent of the approximately 3.6 million trips expected to be made under the pessimistic stable or declining growth scenario-decentralized land use plan alternative future. It would also be the singularly most important transit trip generator, accounting for about 25 percent of the average weekday transit trips made under each alternative plan. As shown on Maps 49, 50, and 51, all the plans would generally support the adopted regional land use plan through provision of a good accessibility pattern.

Objective 2—Cost and Energy: The second objective concerns the provision of a primary transit system which is economical and efficient, satisfying all other objectives at the lowest possible cost. This objective is supported by key standards relating to the minimization of costs and energy consumption, and the maximization of cost-effectiveness. As shown in Table 56, the base plan would, as expected, have the lowest total public cost, including all capital and net operating and maintenance costs. The total public cost of the base plan—which would primarily involve only the continuation of existing service and some short-range improvements—was estimated to range over the design period from about $484 million, or about $23 million annually, under the pessimistic stable or declining growth scenario-decentralized land use plan alternative future to $580 million, or about $28 million annually, under the optimistic moderate growth scenario-centralized land use plan alternative future. A higher total public cost would be incurred under the most optimistic future because of the need for more transit vehicles and transit vehicle miles to serve the larger transit demand under that future. The bus-on-metered freeway plan was estimated to have a total public cost of $567 million, or about $27 million annually, under the most pessimistic future, and of $723 million, or about $34 million annually, under the most optimistic future. The two-tier plan was estimated to have a total public cost of $620 million, or about $30 million annually, under the most pessimistic future, and of $813 million, or about $39 million annually, under the most optimistic future. The total public cost of the two-tier plan would be 40 percent greater than that of the base plan, and about 12 percent greater than that of the bus-on-freeway plan.

The base plan was estimated to have the lowest capital costs, ranging from about $108 million, or about $5 million annually, to about $149 million, or about $7 million annually. The capital costs of the bus-on-metered freeway plan were found to be about 44 to 49 percent greater than the capital costs of the base plan under each of the two alternative futures, ranging from about $161 million, or about $8 million annually, to about $214 million, or about $10 million annually. The capital cost of the two-tier plan would be the highest, ranging from about $218 million, or about $10 million annually, to about $306 million, or about $15 million annually. For each plan option, the lowest capital cost was attendant to the most pessimistic future for transit needs and use—the stable or declining growth scenario-decentralized land use plan alternative future—and the highest capital cost was attendant to the most optimistic future for transit needs and use—the moderate growth scenario-centralized land use plan alternative future.

The other element of the total public cost of transit considered was the public subsidy required for transit operating and maintenance costs over the plan design period. The base plan was determined to require a public subsidy of about $431 million, or about $21 million annually, under the most optimistic future, and of about $376 million, or about $18 million annually, under the most pessimistic future. The subsidy requirements of the recommended plan options were estimated to be somewhat greater, totaling between $507 and $509 million over the plan design period, or about $24 million annually, under the moderate growth

[8] *The regional land use plan recommends a highly centralized land use development pattern. Population and jobs are proposed to be reconcentrated in central Milwaukee County, and new urban development is proposed to occur principally at urban densities along and contiguous to the periphery of existing urban centers (see SEWRPC Planning Report No. 25, A Regional Land Use Plan and a Regional Transportation Plan for Southeastern Wisconsin: 2000, Volume Two, Alternative and Recommended Plans).*

scenario-centralized land use plan alternative future, and between $402 and $407 million over the plan design period, or about $19 million annually, under the stable or declining growth scenario-decentralized land use plan alternative future.

Thus, in terms of cost-effectiveness, the average total public cost per passenger trip over the 21-year plan design period for the base plan may be expected to range from $0.39 to $0.43. For the bus-on-metered freeway plan option, the average total public cost per passenger trip over the 21-year plan design period may be expected to range from $0.46 to $0.50, an increase of $0.07, or about 17 to 18 percent, over the base plan cost. The average total public cost per passenger trip for the two-tier plan would range between $0.52 and $0.54, an increase of between $0.11 and $0.13, or about 30 percent, over the base plan cost. It is important to recognize, however, that transit passenger trips under the recommended plan options will, on the average, be of longer distance; therefore, if the total costs were measured against passenger miles carried, both the recommended plan options would be at least as cost-effective as the base plan under future conditions which would be optimistic for public transit. For the bus-on-metered freeway plan option, the average total public cost per passenger mile may be expected to range between $0.09 and $0.12, or to be about 10 percent less than that of the base plan, under future conditions which would be optimistic for public transit. The average total public cost per passenger mile for the two-tier plan would be about the same as for the base plan under similar future conditions, ranging between $0.10 and $0.13.

The base system plan was estimated to result in the least energy consumption over the 21-year design period, including system construction as well as system operation and maintenance—an estimated 20,278 billion BTU's under the moderate growth scenario-centralized land use plan alternative future, and 15,037 billion BTU's under the stable or declining growth scenario-decentralized land use plan alternative future. The bus-on-metered freeway plan was estimated to have about 9 percent higher total energy consumption, estimated to range from 16,121 billion BTU's under the most pessimistic future to 22,305 billion BTU's under the most optimistic future. The total energy consumption under the two-tier plan was determined to be about 3 percent greater than under the bus-on-metered freeway plan, and about 12 percent greater than under the base plan, ranging from about 16,551 billion BTU's to about 23,214 billion BTU's.

The two-tier plan, on the other hand, would require the least petroleum-based motor fuel, up to 14 percent less than the bus-on-metered freeway plan and up to 7 percent less than the base plan, since under the two-tier plan about 8 percent of the transit trips would be made on electrically propelled vehicles. However, this savings of petroleum-based motor fuel—ranging between 10 million and 20 million gallons over the 21-year plan implementation period—was estimated to represent less than a one-tenth of 1 percent savings in petroleum-based motor fuel used on the total transportation system in the Milwaukee area. This is because levels of automobile tripmaking and travel are expected to be about the same under all three alternative transit plans, and to be at least three times greater than levels of transit tripmaking and travel in the Milwaukee area. Consequently, any savings in petroleum-based motor fuels through use of electrically propelled transit vehicles will be dominated by the petroleum-based fuel used for automobile travel.

It is important to recognize with respect to the energy efficiency of the plans that the bus-on-metered freeway and two-tier plans would be more efficient than the base plan. These plans would be about 17 percent more efficient under the most optimistic future than the base plan, expending between 2,730 and 2,830 BTU's per passenger mile compared with 3,330 BTU's per passenger mile under the base plan. Under the most pessimistic future, the energy expended per passenger mile would be about the same, ranging from 3,480 to 3,540 BTU's under the improvement plans, compared with 3,530 BTU's under the base plan.

<u>Objectives 3 and 5—Provision of Adequate Level of Service and Provision for Quick and Convenient Travel</u>: The third primary transit system development objective calls for a transit system which provides an adequate level of service, and the fifth calls for a primary transit system which provides for quick and convenient travel. These two objectives can be considered together for this evaluation. These objectives are supported by three key standards: level of transit ridership, number of residents and jobs served, and transit trip speed. The remaining standards under these two objectives either have all been met in the design of the alternative plans, or could be met by all the plans if properly implemented.

Of all the standards under these two objectives, the level of transit ridership perhaps best represents the level of transit service provided by alternative transit plans, as it indicates the extent to which trips have been attracted to use the transit system. The base system plan would attract the least total transit system ridership in the Milwaukee area, ranging from about 169,400 to about 326,800 trips per average weekday in the plan design year. Under the bus-on-metered freeway plan, between 176,000 and 371,300 trips may be expected to be made by public transit in the Milwaukee area on an average weekday in the plan design year, or between 4 and 14 percent more than under the base plan. The two-tier plan would attract slightly more total transit ridership in the plan design year than the bus-on-metered freeway option, but still only 4 and 14 percent more than the base plan, as under the two-tier plan between 176,300 and 372,900 trips would be expected to be made by transit in the Milwaukee area in the plan design year.

It should be noted further that the 6,600 to 46,100 transit trips not made under the base system plan under the range of futures considered would, nevertheless, be made, but by automobile rather than transit, and, importantly, about 30 percent of these trips would be made to the Milwaukee central business district during the peak travel periods. This difference in automobile travel to the Milwaukee central business district is equivalent to the design capacity of one lane of central business district freeway in the morning peak travel hour and two lanes of central business district freeway in the evening peak travel hour.

It is also important to note that, because both of the recommended plan options would attract a larger proportion of longer transit trips than the base plan, passenger miles traveled would increase significantly over the base plan. The bus-on-metered freeway plan option would be expected to carry between 0.8 million and 2.4 million passenger miles on an average weekday, compared to between 0.6 million and 1.4 million passenger miles under the base plan—between a 25 and 70 percent increase. The two-tier plan option would carry between 0.9 million and 2.5 million passenger miles on an average weekday in the plan design year—a 50 to 80 percent increase over the base plan.

With respect to the standard calling for maximizing the number of jobs and resident population served, the primary transit elements of the two-tier and bus-on-metered freeway plans under the moderate growth scenario-centralized land use plan alternative future would serve about 1.3 million and 1.6 million, or 30 and 60 percent, more residents, respectively, within a three-mile driving distance of rapid transit service than the base system plan, which would serve about 1.0 million residents. The two-tier plan would provide the greatest accessibility to residents and jobs within walking distance of primary transit stations and stops, estimated at 392,000 residents and 309,000 jobs, compared with 274,000 residents and 294,000 jobs under the bus-on-metered freeway plan, and 257,000 residents and 237,000 jobs under the base plan. Under the stable or declining growth scenario-decentralized land use plan alternative future, the bus-on-metered freeway and two-tier plans would serve about 933,000 and 931,000 residents within a three-mile driving distance of rapid transit service, or 33 percent more residents than the base system plan, which would serve 699,000 residents. The two-tier plan would provide the greatest accessibility to residents and jobs within walking distance of primary transit stations and stops—260,000 residents and 260,000 jobs, compared with 250,000 residents and 253,000 jobs under the bus-on-metered freeway plan and 182,000 residents and 195,000 jobs under the base plan.

With respect to the standard relating to the average speed provided by primary transit, the bus-on-metered freeway and two-tier plans would both provide somewhat faster service than the base system plan. Average vehicle speeds are expected to be about 12 to 50 percent faster—estimated at between 27 and 29 mph—under the primary transit element of both the two-tier plan and the bus-on-metered freeway plan than under the base plan, under which average vehicle speeds would range from 19 to 24 mph. With respect to average vehicle speeds on all elements of the plans—primary, express, and local—average vehicle speeds on the bus-on-metered freeway and two-tier plans would be expected to range between 17 and 18 mph, compared with between 14 and 15 mph under the base plan. The average speeds of passenger travel on the primary transit vehicles would be the highest under the bus-on-freeway and two-tier plans—estimated at 30 to 34 mph, compared with 25 mph under the base plan. Average speeds of passenger travel on vehicles of all service elements of the three plan options would also be highest under the bus-on-freeway and two-tier plans—estimated at 18 to 21 mph, compared with 15 mph under the base plan. Average speeds for passenger travel on vehicles are generally higher than vehicle speeds because passengers are typically concentrated on the transit facilities and services which operate at the highest speeds.

Objective 4—Environmental and Resource Disruption: The fourth objective is to minimize the disruption of existing neighborhood and community development and to minimize deterioration of the natural resource base. This objective is supported by key standards relating to community disruption and air quality.

In terms of community disruption, neither of the two primary transit system plan options nor the base plan would require the taking of any homes, businesses, or industries. They would, however, require the acquisition of right-of-way for guideway, stations, and maintenance and storage facilities. Under the most optimistic future for transit needs and use in the Milwaukee area, the two-tier plan would require the acquisition of about 120 acres of land, compared with 70 acres under the bus-on-metered freeway system plan and 12 acres under the base plan. Under the most pessimistic future, land requirements would be somewhat less, with the two-tier plan requiring 60 acres, the bus-on-metered freeway plan requiring 20 acres, and the base plan requiring 10 acres.

Table 56 summarizes the levels of highway and transit air pollutant emissions anticipated under each of the alternative primary transit system plans. The bus-on-metered freeway and two-tier plans are expected to have similar levels of total transportation system carbon monoxide, hydrocarbon, particulate matter, sulfur oxide, and nitrogen oxide air pollutant emissions. The total levels of pollutants would be about 2 percent less under the bus-on-freeway and two-tier plans, principally because of the decline in automobile travel anticipated under these plans.

Objective 6—Safety: The sixth transportation objective relates to the reduction of accident exposure and the provision of increased travel safety. This objective is supported by two key standards, one measuring the degree to which travel by transit is maximized and the other measuring the degree to which travel on exclusive guideway transit is maximized. Travel by transit is safer than travel by automobile, and travel on exclusive guideway transit is the safest travel by transit because of the elimination of many conflicts with pedestrian or vehicle traffic.

As demonstrated in Table 56, there is little difference between the three plans with respect to travel safety. The proportion of total person trips using transit is slightly higher under the bus-on-freeway and two-tier plans than under the base plan, and none of the alternatives utilize fully exclusive guideways with grade separation of all crossing vehicle and pedestrian traffic.

Summary

The comparative quantitative evaluation of the three primary transit options for the Milwaukee area—the base or "no build" plan, the bus-on-metered freeway plan, and the lower tier of the two-tier plan—indicated that under the range of alternative future conditions, the bus-on-metered freeway and two-tier recommended plan options would provide about equal levels of transit service in the Milwaukee area, and that both would represent substantial improvements over the base system plan. Under the range of future conditions considered, these two options were determined to perform better than the base system plan by providing service to more Milwaukee area residents and jobs, providing a higher level of service through quicker transit speeds, attracting higher levels of total and primary transit ridership, and having higher energy efficiencies and generating somewhat less air pollutant emissions.

However, because it would only maintain existing service, the base plan would entail the least public cost—an estimated $23 to $28 million per year. The bus-on-metered freeway plan would require an additional $4 million to $6 million annually over the plan design period, or an additional 17 to 25 percent. The two-tier plan would require an additional 12 to 13 percent, or $2 million to $4 million annually, over the bus-on-metered freeway plan, and 28 to 40 percent, or $6 to $11 million annually, over the base plan. Because the recommended plan options would carry between 4 and 14 percent more transit passenger trips and 25 and 80 percent more passenger miles than the base plan, their cost per trip, including both direct and indirect costs, would generally be less than that of the base plan, and their cost per passenger mile—even if only direct costs are considered—would generally be less than that of the base plan.

Further analysis of the key benefits and costs of the two-tier plan and bus-on-metered freeway plan relative to each other and the base plan is provided below. This analysis is presented by first comparing the base system plan against the bus-on-metered freeway and two-tier plans, and then comparing the two recommended plan options—the bus-on-metered freeway plan against the two-tier plan. This successive comparison of alternative plans is not unlike incremental economic plan evaluation techniques which have long been used to establish whether the marginal benefits of alternative plans exceed their additional costs over other alternative plans.

Comparison of the Bus-on-Metered Freeway and Two-Tier Plan Options Against the Base Plan: The comparative evaluation of the base plan against the bus-on-metered freeway and two-tier plan options indicated that under the range of alternative futures—although both of the recommended plan options could be expected to entail greater total cost, ranging from 17 to 40 percent, or $83 to $233 million, over the 21-year plan design period—each would have a number of benefits over the base plan which would make either option a more preferable course of action. Under the range of futures, the improvement plans would provide between about 24 and 60 percent greater accessibility to jobs and residents of the Milwaukee area than the base plan, and would carry between 4 and 14 percent more total transit trips. Because both of the recommended plan options would attract a larger proportion of longer transit trips than the base plan, the difference in passenger miles traveled between the recommended options and the base plan would be greater than the difference in total cost. The recommended options would carry from 32 to 75 percent more passenger miles than the base plan, while their total cost would be 17 to 40 percent greater than the base plan cost.

As set forth in Tables 58 and 59, the principal disadvantage of the bus-on-metered freeway plan and two-tier plan is that the total public costs of the two plans may be expected to be substantially higher than that of the base plan, in terms of both capital and operating cost requirements under the range of future conditions. Under the moderate growth scenario-centralized land use plan alternative future, the recommended improvement plans would entail between 44 and 109 percent, or between $65 million and $157 million, more capital cost over the plan design period, with the two-tier plan incurring the largest capital cost. With respect to public costs for operation and maintenance, both of the improvement plans would be somewhat less efficient than the base plan under the optimistic future, with the bus-on-freeway plan entailing about an 18 percent, or $78 million, greater deficit and the two-tier plan entailing about an 18 percent, or $76 million, greater deficit over the design period. Thus, under this scenario, the total public cost of the improvement options would be 25 to 40 percent greater than the base plan cost, with an additional $143 million, or $7 million annually, being required under the bus-on-metered freeway plan, and an additional $233 million, or $11 million annually, being required under the two-tier plan. Under the stable or declining growth scenario-decentralized land use plan alternative future, the difference in total public costs between the base plan and the improvement plans may be expected to range between 17 and 28 percent, with an additional $83 million, or $4 million annually, being required under the bus-on-metered freeway plan, and an additional $136 million, or $6 million annually, being required under the two-tier plan. The improvement plans would incur between 49 and 102 percent, or between $53 million and $110 million, more capital cost, and between 7 and 8 percent, or between $26 and $31 million, greater public subsidy of transit operating and maintenance costs over the 21-year plan design period.

One important advantage of the bus-on-metered freeway and two-tier plans which would partially offset the additional total public costs is the substantial increase in accessibility to residents and jobs over the accessibility provided under the base plan. Under the moderate growth scenario-centralized land use plan alternative future, the improvement plans would serve between 45 and 53 percent, or between 116,400 and 136,100, more people and between 24 and 30 percent, or between 60,600 and 72,300, more jobs within walking distance of primary transit facilities. Under the pessimistic future, between 38 and 43 percent, or 68,600 and 78,600, more residents and between 30 and 33 percent, or 58,500 and 65,600, more jobs would be served. It should be noted that the greatest increase in accessibility would be expected under the two-tier plan under the range of alternative future conditions. With respect to transit utilization, on an average weekday in the plan design year about 14 percent, or between 44,500 and 46,100, more total transit trips may be expected to be made under the optimistic future for transit needs and use in the Milwaukee area, and about 4 percent, or between 6,600 and 6,900, more total transit trips may be expected to be made under the pessimistic future. Moreover, trips made on the primary element would be expected to increase nearly five-fold, or by about 60,100 trips on an average weekday, under the bus-on-metered freeway plan, and nearly six-fold, or by

Table 58

KEY ADVANTAGES AND DISADVANTAGES OF THE BUS-ON-METERED FREEWAY SYSTEM PLAN IN COMPARISON TO THE BASE SYSTEM UNDER THE MODERATE GROWTH SCENARIO-CENTRALIZED LAND USE PLAN AND STABLE OR DECLINING GROWTH SCENARIO-DECENTRALIZED LAND USE PLAN

Factor	Advantages		Disadvantages	
	Moderate Growth-Centralized Land Use Plan	Stable or Declining Growth-Decentralized Land Use Plan	Moderate Growth-Centralized Land Use Plan	Stable or Declining Growth-Decentralized Land Use Plan
Cost	$0.01, or 10 percent, less total cost per passenger mile over design period $4.0 million transportation system user cost savings over design period, resulting from the diversion of 44,500 auto trips to transit and transit travel time savings averaging about 2 minutes per transit trip	$0.2 million transportation system user cost savings over design period, resulting from the diversion of 6,600 auto trips to transit and transit travel time savings averaging about 2 minutes per transit trip	$143 million, or 25 percent, more total cost over design period $65 million, or 44 percent, more capital cost over design period $97 million, or 42 percent, more capital investment over design period $78 million, or 18 percent, more operating and maintenance cost subsidy over design period $0.07, or 18 percent, more total cost per passenger over design period	$83 million, or 17 percent, more total cost over design period $53 million, or 49 percent, more capital cost over design period $68 million, or 42 percent, more capital investment over design period $31 million, or 8 percent, more operating and maintenance cost subsidy over design period $0.07, or 16 percent, more total cost per passenger over design period
Level of Service	Service on all primary transit routes under the plan would be provided on an all-day basis	Service would be provided on an all-day basis for the seven bus-on-freeway routes recommended under the first stage of the plan	--	--
Accessibility	116,400, or 45 percent, more resident population within walking distance of primary transit stations or stops 608,000, or 60 percent, more residents within driving distance of primary transit stations or stops 60,600, or 24 percent, more jobs within walking distance of primary transit stations or stops	68,600, or 38 percent, more resident population within walking distance of primary transit stations or stops 234,300, or 34 percent, more residents within driving distance of primary transit stations or stops 58,500, or 30 percent, more jobs within walking distance of primary transit stations or stops	--	--
Transit Ridership	44,500, or 14 percent, more total transit trips on an average weekday in design year 60,100, or five times, more primary transit trips on an average weekday in design year 2.4 million, or 72 percent, more passenger miles on an average weekday in design year	6,600, or 4 percent, more total transit trips on an average weekday in design year 13,000, or 137 percent, more primary transit trips on an average weekday in design year 0.2 million, or 32 percent, more passenger miles on an average weekday in design year	--	--
Energy	600 BTU's, or 18 percent, less total energy consumed per passenger mile traveled 8.9, or 22 percent, more passenger miles carried on the transit system per gallon of diesel fuel consumed for propulsion	12 BTU's, or 72 percent, less total energy consumed per passenger mile traveled 2, or 4 percent, more passenger miles carried on the transit system per gallon of diesel fuel consumed for propulsion	--	--
Disruption	58 acres, or 483 percent, more land required for system development	10 acres, or 100 percent, more land required for system development	--	--

Source: SEWRPC.

Table 59

KEY ADVANTAGES AND DISADVANTAGES OF THE TWO-TIER SYSTEM PLAN IN COMPARISON TO THE BASE SYSTEM PLAN UNDER THE MODERATE GROWTH SCENARIO-CENTRALIZED LAND USE PLAN AND STABLE OR DECLINING GROWTH SCENARIO-DECENTRALIZED LAND USE PLAN

Factor	Advantages		Disadvantages	
	Moderate Growth-Centralized Land Use Plan	Stable or Declining Growth-Decentralized Land Use Plan	Moderate Growth-Centralized Land Use Plan	Stable or Declining Growth-Decentralized Land Use Plan
Cost	Transportation system user cost savings of $4.0 million over design period, resulting from the diversion of 46,100 auto trips to transit and average transit travel time savings of 2 minutes per trip	Transportation system user cost savings of $0.2 million over design period, resulting from the diversion of 6,900 auto trips to transit and average transit travel time savings of 2 minutes per trip	$233 million, or 40 percent, more total cost over design period $157 million, or 109 percent, more capital cost over design period $237 million, or 102 percent, more capital investment over design period $76 million, or 18 percent, more operating and maintenance cost subsidy over design period $0.13, or 33 percent, more total cost per passenger over design period	$136 million, or 28 percent, more total cost over design period $110 million, or 102 percent, more capital cost over design period $203 million, or 126 percent, more capital investment over design period $26 million, or 7 percent, more operating and maintenance cost subsidy over design period $0.11, or 26 percent, more total cost per passenger over design period
Level of Service	Service on all primary transit routes under the plan would be provided on an all-day basis	Service would be provided on an all-day basis for the five bus-on-freeway routes and the light rail transit route recommended for implementation under the first stage of the plan	- -	- -
Accessibility	135,100, or 53 percent, more resident population within walking distance of primary transit stations or stops 287,600, or 28 percent, more residents within driving distance of primary transit stations or stops 72,300, or 30 percent, more jobs within walking distance of primary transit stations or stops	78,600, or 43 percent, more resident population within walking distance of primary transit stations or stops 231,800, or 33 percent, more residents within driving distance of primary transit stations or stops 65,600, or 33 percent, more jobs within walking distance of primary transit stations or stops	- -	- -
Transit Ridership	46,100, or 14 percent, more total transit trips on an average weekday in design year 81,300, or nearly six times, more primary transit trips on an average weekday in design year 1.1 million, or 75 percent, more passenger miles on an average weekday in design year	6,900, or 4 percent, more total transit trips on an average weekday in design year 25,700, or nearly three times, more primary transit trips on an average weekday in design year 0.2 million, or 36 percent, more passenger miles on an average weekday in design year	- -	- -
Energy	29,200 trips, or 8 percent of transit trips making all or a major portion of trip on transit vehicles, not dependent on petroleum-based fuels 500 BTU's, or 15 percent, less total energy consumed per passenger mile traveled 7.2, or 18 percent, more passenger miles carried on the transit system per gallon of diesel fuel consumed for propulsion	15,000 trips, or 8 percent of transit trips making all or a major portion of trip on transit vehicles, not dependent on petroleum-based fuels About the same total energy consumed per passenger mile traveled 1, or 3 percent, more passenger miles carried on the transit system per gallon of diesel fuel consumed for propulsion	- -	- -
Disruption	108 acres, or nine times, more land required for system development	50 acres, or five times, more land required for system development	- -	- -

Source: SEWRPC.

about 81,300 trips, under the two-tier plan for the most optimistic future. Primary transit trips under the most pessimistic future would increase by 13,000 trips under the bus-on-metered freeway plan and by about 25,700 trips under the two-tier plan.

It should be noted that because total transit ridership under the recommended improvement plans would not be expected to increase in proportion to the total costs required to implement either of the plans under the range of future conditions, the two plans would be somewhat less cost-effective than the base plan in terms of total public cost per passenger. For the bus-on-metered freeway plan option, the average total cost per passenger trip over the 21-year plan design period may be expected to range between $0.46 and $0.50, an increase of $0.07, or about 17 percent, over the base plan costs of $0.39 and $0.43. The average total public cost per passenger trip for the two-tier plan would range between $0.52 and $0.54, an increase of between $0.11 and $0.13, or about 30 percent, over the base plan costs. It is important to recognize, however, that transit passenger trips under the recommended plan options will, on the average, be of longer distance than transit trips under the base plan. Thus, if the total public costs are measured against passenger miles carried, both of the recommended plan options are at least as cost-effective as the base plan under optimistic future conditions for public transit. For the bus-on-metered freeway plan option, the average total public cost per passenger mile may be expected to range between $0.09 and $0.12, or to be about 10 percent less than that of the base plan under optimistic future conditions for public transit. The average total public cost per passenger mile for the two-tier plan under optimistic future conditions would be about the same as under the base plan—ranging between $0.10 and $0.13.

The improvement plans would also have some important advantages with respect to energy use over the base system plan. Under the moderate growth scenario-centralized land use plan alternative future, from 500 to 600 fewer BTU's—a difference of 15 to 18 percent—would be expended per passenger mile traveled under each of the plans—2,730 BTU's per passenger mile under the bus-on-freeway plan and 2,830 BTU's per passenger mile under the two-tier plan, compared with 3,330 BTU's per passenger mile under the base plan. In terms of propulsion energy efficiency, about 9, or 22 percent, more passenger miles per gallon of diesel fuel consumed would be carried under the bus-on-metered freeway plan; and 7, or 18 percent, more passenger miles per gallon of diesel fuel consumed would be carried under the two-tier plan. Under the stable or declining growth scenario-decentralized land use plan alternative future, about 72 percent less total energy per passenger mile would be expended and 4 percent more passenger miles would be carried per gallon of diesel fuel consumed under the bus-on-metered freeway plan. There would be only a negligible difference in energy use per passenger mile between the base plan and the two-tier system plan under this future, and about 3 percent more passenger miles would be carried per gallon of diesel fuel consumed. It should be noted that the use of electricity for propulsion of the light rail route under the two-tier plan would enable about 8 percent of all transit tripmaking, or 29,000 passenger trips under the moderate growth scenario-centralized land use plan alternative future, and 15,000 trips under the stable or declining growth scenario-decentralized land use plan alternative future, to be made on a transit route which is not dependent on petroleum-based fuels and which would not be subject to disruption if the availability of such fuels were limited.

In addition to these advantages, there would be certain benefits attendant to the improved transit service under the two recommended plan options, as set forth in Table 60. The base plan can be expected to result in additional indirect costs to the public, both privately and publicly incurred, over and beyond those attendant to the recommended plan options. The additional benefits that would be attendant to the two plan options include out-of-pocket automobile operating cost savings, accident and insurance cost savings, and travel time savings. Under the range of futures, the improvement plans could be expected to attract an additional 6,600 to 46,100 trips on an average weekday which would otherwise be made by automobile. The resultant reduction in out-of-pocket—or automobile user—costs attendant to the improvement plans in the design year is estimated to range from $40.3 million for the two-tier system plans under the moderate growth scenario-centralized land use plan alternative future to $13.3 million for the bus-on-metered freeway plan under the stable or declining growth scenario-decentralized land use plan alternative future. These benefits take into account the user cost, in terms of transit fares, of the diverted trips using public transit. Increased transit use under the improvement plans would

Table 60

ESTIMATED DESIGN YEAR 2000 TRANSIT SYSTEM USER BENEFITS ATTENDANT TO THE RECOMMENDED TRANSIT IMPROVEMENT PLAN OPTIONS

Source of Benefits	Moderate Growth-Centralized Land Use Plan		Stable or Declining Growth-Decentralized Land Use Plan	
	Bus-on-Metered Freeway Plan (millions of dollars)	Two-Tier Plan (millions of dollars)	Bus-on-Metered Freeway Plan (millions of dollars)	Two-Tier Plan (millions of dollars)
Out-of-Pocket Cost	38.658	40.251	13.291	14.309
Travel Time Savings of Continuing Transit Users and Auto Passengers Diverted to Transit Use	- 12.914	- 13.464	- 3.014	- 2.948
Accident and Insurance Cost Savings	7.830	8.075	2.761	2.858
Net Quantitative Benefits	33.574	34.862	13.038	14.219

Source: SEWRPC.

also provide residents of the Milwaukee area with an increase in overall transportation safety. The resultant reduction in accident and insurance costs attendant to the decrease in automobile travel would range from $8.1 million to $2.8 million in the plan design year.

Under the range of futures, travel time savings will be incurred by continuing transit users. The findings indicate that those trips made by continuing transit users under the improvement plans will average about two mph faster and will require an average of about two fewer minutes per trip. However, trips being made on transit by those who have diverted from private automobiles would take an average of about 19 to 22 minutes longer per trip than an equivalent trip made by automobile. Hence, the sum of the travel time cost savings incurred by both continuing and new transit users is a net disbenefit, estimated to range from $13.5 million to $2.9 million. As shown in Table 60, the total cost savings of all three of these components—out-of-pocket cost savings, accident and insurance cost savings, and travel time savings—is estimated to range from $33.6 million to $13.0 million for the bus-on-metered freeway plan. For the two-tier system plan, the total cost benefits are estimated to range from $34.9 million to $14.2 million, depending upon the particular alternative future. This estimate assumes an average value of travel time of about $2.20 per person-hour, expressed in 1979 dollars.[9] It is important to note that the total benefits—or cost savings—attributable to the improvement plans are greater than the additional public costs of the bus-on-metered freeway plan option under the full range of future conditions, and are greater than the additional public costs of the two-tier plan option under the optimistic end of the range of future conditions.

Benefit-Cost Analysis: The total cost and benefit estimates prepared above were supplemented by a benefit-cost analysis in order to demonstrate the economic value of the primary transit system plan proposals. Application of this approach permits a comparative analysis of "build" alternatives—those that include major transit improvements—with a "no build" alternative. The direct benefits derived from transit system improvements include a reduction in the cost of vehicle ownership and operation, in the cost of travel time, and in accidents. The direct costs of such improvements are the capital investments and the cost to public agencies to operate and maintain the physical facilities and transit services. In preparing the benefit-cost analysis, it should be noted that the benefits and

[9] *The value of time to the transit user has been the subject of considerable controversy. In this study, it was decided to use the average value recommended by the American Association of State Highway and Transportation Officials (AASHTO).*

costs were calculated as accruing over a period of time extending from 1980 to 2000. The benefit-cost ratios were calculated based on discount rates of 6 and 10 percent.[10]

Table 61 sets forth the present worth of transit system user costs and the transit system capital, operating, and maintenance costs for the base plan and each recommended plan option under the most optimistic and most pessimistic futures for transit use. Comparing the costs of each plan with the benefits derived from each plan option using the base system plan as a basis of comparison indicates that the bus-on-metered freeway plan would constitute a sound investment of public funds under the complete range of alternative future conditions which can reasonably be expected in the Milwaukee area. The results of the benefit-cost analysis indicate that the proposed bus-on-freeway system plan under the moderate growth scenario-centralized land use plan alternative future will have a benefit-cost ratio of 1.7. Under the stable or declining growth scenario-decentralized land use plan alternative future, the bus-on-freeway system plan would have a benefit-cost ratio of 1.0. Both of these ratios were calculated assuming a 6 percent rate of return. Assuming a 10 percent rate of return, the same benefit-cost ratios would be 0.8 and 0.7, respectively.

A benefit-cost analysis was also conducted for the lower tier of the two-tier system plan. The results of this analysis indicate that the two-tier plan could be expected to have a benefit-cost ratio of 1.3 under conditions attendant to the moderate growth scenario-centralized land use plan alternative future. A benefit-cost ratio of 0.6 could be expected under conditions attendant to the stable or declining growth scenario-decentralized land use plan alternative future. Both of these ratios were calculated assuming a 6 percent rate of return. Assuming a 10 percent rate of return, the benefit-cost ratios would be 0.7 and 0.4, respectively. It should be recognized that the benefit-cost ratios presented for both the bus-on-metered freeway plan and the two-tier system plan apply to the aggregations of not only primary transit services and facilities proposed within each plan, but also express and local transit services. Such ratios, therefore, cannot, and do not, imply that individual projects or services within the aggregation will necessarily have similar benefit-cost ratios. Moreover, it should be recognized that such an assessment alone is not a conclusive measure of the relative value of primary transit alternatives, but should be viewed together with the results of the cost-effectiveness analysis presented earlier. A more detailed discussion of the procedures used for the benefit-cost analysis of the two improvement plan options is presented in Appendix A of SEWRPC Technical Report No. 26, Milwaukee Area Alternative Primary Transit System Plan Preparation, Test, and Evaluation.

Comparison of the Bus-on-Metered Freeway Plan Option to the Two-Tier Plan Option: In order to help select one of the recommended improvement plans for implementation in the Milwaukee area over the next 20 years, a comparative evaluation of the key advantages and disadvantages of the bus-on-metered freeway plan and the two-tier system plan is provided below. Under the range of future conditions, the two-tier plan, although expected to entail a slightly greater total cost over the plan design period than the bus-on-metered freeway plan, would have a number of advantages over the bus-on-metered freeway plan, as indicated in Table 62. The inclusion of a light rail transit facility in the northwest corridor would provide primary transit accessibility to about 5 percent more of the resident population and jobs in the

[10] *Considerable debate continues on the discount rate that should be used when evaluating proposed investments in primary transit facilities. For transit projects, the discount rate has been tied closely to the long-term cost of borrowing money. In this study, the appropriate discount rate was based on an estimate of the average rate of return that is expected on possible investment before taxes and after inflation. Money invested privately is currently expected to return, generally, from 6 to 10 percent. Since implementation of the primary transit plan should return benefits to the public similar to those which could be attained through private investment, interest rates of 6 and 10 percent—representing the full range of discount rates currently being used—were recommended for use in the economic evaluation of the plans. It should be noted that in 1981 the Wisconsin Department of Transportation was using a rate of 8 percent for evaluating major highway improvement projects, and 4 percent in the evaluation of railway branch-line projects described in the 1981 Wisconsin Transportation Planning Program State Rail Plan.*

Table 61

COMPARISON OF TRANSIT USER COSTS AND BENEFIT-COST RATIOS: RECOMMENDED TRANSIT IMPROVEMENT PLAN OPTIONS

Alternative Plan		Discount Rate (percent)	Costs: 1980-2000		Benefits[a]	Costs[b]	Benefit-Cost Ratio
Land Use Plan	Transit Plan		Transit System User	Capital, Operating, and Maintenance			
Moderate Growth-Centralized Land Use Plan	Base Plan	6 10	$1,317,414,000 932,992,000	$333,200,000 208,700,000	$ - - - -	$ - - - -	- - - -
	Bus-on-Metered Freeway Plan	6 10	1,202,062,000 866,230,000	400,200,000 289,600,000	115,352,000 66,762,000	67,000,000 80,900,000	1.72 0.83
	Two-Tier Plan	6 10	1,197,637,000 863,669,000	427,600,000 308,600,000	119,777,000 69,323,000	94,400,000 99,900,000	1.27 0.69
Stable or Declining Growth-Decentralized Land Use Plan	Base Plan	6 10	1,032,113,000 767,869,000	268,500,000 199,500,000	- - - -	- - - -	- - - -
	Bus-on-Metered Freeway Plan	6 10	987,317,000 741,942,000	313,000,000 235,200,000	44,796,000 25,927,000	44,500,000 35,700,000	1.01 0.73
	Two-Tier Plan	6 10	983,259,000 739,594,000	345,200,000 266,800,000	48,854,000 28,275,000	76,700,000 67,300,000	0.64 0.42

[a] *Benefits are defined as the difference—or "savings"—in transit system user costs resulting from the implementation of either the bus-on-metered freeway plan option or the two-tier plan option instead of the base plan under the appropriate alternative future.*

[b] *Costs are defined as the difference—or "additional capital and operating expense"—incurred because of the implementation of either the bus-on-metered freeway plan option or the two-tier plan option instead of the base plan under the appropriate alternative future.*

Source: SEWRPC.

Milwaukee area. Partially for this reason, between 11,700 and 21,200, or between 28 and 52 percent, more transit trips may be expected to be made on the primary element of the two-tier plan on an average weekday in the design year than on the primary element of the bus-on-metered freeway plan. It should be noted that all of these additional trips on the light rail transit element of the two-tier plan may be expected to use transit, rather than private automobiles as under the bus-on-metered freeway plan, but would be made primarily on the local or express elements of that plan at a lower level of service. These trips would average about four mph slower over the on-vehicle portion of the trip, and would require an average of four additional minutes per trip.

The two-tier plan would have some important advantages with respect to energy use, as operation of some of the system would be based on an electrically propelled primary transit system. The two-tier plan may be expected to use about 14 percent less petroleum-based fuel for transit system propulsion over the plan design period than the bus-on-metered freeway plan. Importantly, this would enable between 15,000 and 29,000 transit trips on an average weekday, or 8 percent of all transit tripmaking, to be made on a transit route which is not dependent on petroleum-based fuels and would not be subject to disruption if the availability of such fuels were limited.

The two-tier plan would also be expected to be slightly more efficient at the end of the plan design period with respect to operating and maintenance costs. The two-tier plan may be expected to require between $2 and $4 million less operating subsidy over the plan design period than the bus-on-metered freeway plan. Primary transit revenues may be expected to recover 2 to 3 percent more operating and maintenance costs under the two-tier plan than under the bus-on-metered freeway plan, and farebox revenues of the total transit system would be expected to recover the same proportion of operating and maintenance costs under both improvement plans.

Table 62

KEY ADVANTAGES AND DISADVANTAGES OF THE LOWER TIER OF THE TWO-TIER SYSTEM PLAN IN COMPARISON TO THE BUS-ON-METERED FREEWAY SYSTEM PLAN UNDER THE MODERATE GROWTH SCENARIO-CENTRALIZED LAND USE PLAN AND STABLE OR DECLINING GROWTH SCENARIO-DECENTRALIZED LAND USE PLAN

Factor	Advantages		Disadvantages	
	Moderate Growth-Centralized Land Use Plan	Stable or Declining Growth-Decentralized Land Use Plan	Moderate Growth-Centralized Land Use Plan	Stable or Declining Growth-Decentralized Land Use Plan
Cost	- -	- -	$90 million, or 12 percent, more total cost over design period $92 million, or 43 percent, more capital cost over design period $141 million, or 43 percent, more capital investment over design period $0.06, or 13 percent, more total cost per passenger over design period $0.01, or 11 percent, more total cost per passenger mile over design period	$52 million, or 9 percent, more total cost over design period $57 million, or 35 percent, more capital cost over design period $135 million, or 59 percent, more capital investment over design period $0.04, or 8 percent, more total cost per passenger over design period $0.01, or 8 percent, more total cost per passenger mile over design period
Accessibility	18,700, or 5 percent, more resident population within walking distance of primary transit stations and stops 15,700, or 5 percent, more jobs within walking distance of primary transit stations or stops	10,000, or 4 percent, more resident population within walking distance of primary transit stations and stops 7,100, or 3 percent, more jobs within walking distance of primary transit stations or stops	- -	- -
Transit Ridership	21,200, or 28 percent, more primary transit trips on an average weekday in design year	11,700, or 52 percent, more primary transit trips on an average weekday in design year	- -	- -
Energy	29,000 trips, or 8 percent, of transit trips making all or a portion of trips on transit vehicles not dependent on petroleum-based fuels	15,000 trips, or 8 percent, of transit trips making all or a portion of trips on transit vehicles not dependent on petroleum-based fuels	- -	- -

Source: SEWRPC.

These small operating cost savings, however, would be offset by the greater capital cost of the two-tier plan over the bus-on-metered freeway plan, making it the more costly of the two plan options to implement. The capital cost of the two-tier plan would be between $57 million and $92 million, or about 35 to 43 percent, more than that of the bus-on-metered freeway plan. Consequently, the two-tier plan would require between $52 million and $90 million more total public cost and about $0.04 to $0.06, or 8 to 13 percent, more total public cost per passenger than the bus-on-metered freeway plan during the design period. The total public cost per passenger mile would also be higher, ranging between $0.10 and $0.13, compared with between $0.09 and $0.12 under the bus-on-metered freeway plan.

Thus, it may be concluded that the direct, tangible advantages of a primary transit plan which includes light rail transit over a comparable bus-on-freeway plan in the Milwaukee area would be small compared to the additional costs entailed, resulting in less than a 1 percent increase in weekday transit passengers and less than a 2 percent increase in daily passenger miles. The operating and maintenance cost efficiencies of the light rail transit plan would be offset over the plan design period by the additional capital costs. In addition, a light rail transit system, despite its greater cost, cannot be expected to divert substantially more trips from automobiles to public transit than a bus-on-metered freeway service, and, therefore, cannot be expected to provide any substantial incremental benefits with respect to motor fuel consumption or air pollutant emissions. Therefore, because the bus-on-metered freeway plan would have the lowest total public cost and lowest total cost per passenger and per passenger mile over the plan design period, it was determined to be the best option for the provision of primary service in the Milwaukee area under the full range of alternative future conditions.

However, as much as the bus-on-metered freeway plan option was found to be superior to the two-tier plan option with respect to total public costs and cost-effectiveness over the plan design period, it was determined that the two-tier plan would have certain advantages over the bus-on-metered freeway plan regarding the intangible implications of primary transit performance. As presented earlier in this chapter and as summarized in Table 63, the development of light rail transit in the Milwaukee area would have a greater, although uncertain and unmeasurable, potential to influence land development and redevelopment; to provide a more reliable and safe public transit system; and to be less subject to the adverse effects of possible future highway system deterioration from deferred maintenance. Because light rail vehicles are capable of carrying a greater number of passengers per vehicle, and because they can be coupled into trains, light rail transit was found to be able to transport a greater number of passengers per operator. The mode was determined to have greater long-range usefulness as it would require the acquisition of rights-of-way, and would require the construction of guideways which are essential to more advanced, but still unproven, futuristic transit technologies. Because of its electrical propulsion, it is believed that light rail transit would have an operational advantage in Milwaukee's winter climate, as well as advantages with respect to localized noise and air pollutant emission levels. Furthermore, light rail transit would have the greatest potential to continue and expand operations during a petroleum-based fuel shortage, and perhaps an advantage in long-term usefulness given the prospects for domestic and world petroleum production in the 21st century. Light rail transit was also concluded to have perhaps the greatest potential to influence land development and redevelopment because, compared to the bus-on-metered freeway plan, it would require a more permanent, less disruptive, and greater long-term public commitment to high-quality transit in a corridor.

Conclusions Drawn from the Alternative Primary Transit Plan Testing and Evaluation

The following conclusions were drawn by the Advisory Committee in reflecting upon the extensive data generated in the evaluation of the alternative primary transit system plans for each mode designed for each alternative future.

- Heavy rail rapid transit was eliminated from further consideration in the Milwaukee area since it was currently found to be not viable under even the most optimistic future for transit need and use considered. This determination was based upon the inability of this primary transit mode to utilize its inherent efficiencies for transporting very large numbers of passengers at high speeds in the Milwaukee area without substantial unused capacity in all corridors. In addition, because this mode requires a fully grade-separated, exclusive right-of-way, the capital costs for such an alternative would be very high, ranging from two-and-one-half times those of a comparable light rail transit plan, to about three-and-one-half times those of a comparable busway plan.

- As an areawide primary transit system, commuter rail could be expected to be viable under only the most optimistic of the alternative futures for transit need and use—the moderate growth scenario-centralized land use plan future. Under that future, three commuter rail routes radiating from the Milwaukee central business district—north to Grafton, west to Oconomowoc, and south to Racine and Kenosha—would have the potential to meet at least one-half of their annual operating and maintenance costs from farebox revenues. The route to Racine and Kenosha could also be expected to perform well under the two intermediate futures for transit need and use. Under the least optimistic future for transit use, however, not even the Racine/Kenosha route was found to be viable. These conclusions relate only to the provision of a system of true primary transit service—that is, service throughout the entire weekday period, as well as some service on weekends. They would not rule out the possible introduction of specialized peak-period, weekday-only service along one or more of the routes considered and the inclusion of such service in any final plan that may be selected.

- The bus-on-metered freeway, bus-on-busway, and light rail transit alternatives—the latter two modified as necessary to include supplemental bus-on-freeway service to make the plans comparable to the bus-on-freeway plan—may be expected to perform well in the Milwaukee area under a wide range of future conditions. These three alternatives were determined to have the potential to provide essentially identical levels of service, and to attract very similar levels of transit ridership. Under the range of alternative futures considered, a bus-on-freeway system could be expected to attract between 5.0 and 8.6 percent of the total person trips, and a light rail transit system could be expected to attract between 4.9 and 8.5 percent of the total person trips during an average weekday in the Milwaukee area. In addition, these three alternatives were found to have similar annual operating and maintenance cost subsidy requirements, and to have similar systemwide energy consumption and environmental impacts. The light rail transit plan would require the least amount of petroleum-based motor fuel, ranging from 5 percent to 8 percent less than the busway plan and 8 percent to 11 percent less than the bus-on-freeway plan, depending upon the alternative future considered. From 21 percent to 27 percent of all transit trips could be expected to be made on electrically propelled vehicles under the light rail transit plan. Any savings in the consumption of petroleum-based motor fuel attendant to implementation of a light rail transit plan would, however, represent less than a 1 percent savings in petroleum-based motor fuel used on the total transportation system in the Milwaukee area.

- The only significant measurable difference between the bus-on-metered freeway, bus-on-busway, and light rail transit alternative plans lies in the capital costs attendant to plan implementation—or in their total public costs. The bus-on-metered freeway plan would entail substantially less capital costs over the 21-year plan design period than either the bus-on-busway or light rail transit plans. Capital costs attendant to the bus-on-freeway plan could be expected to range from $7 million to $11 million annually, depending upon the alternative future. The bus-on-busway and light rail transit plans would entail 50 percent and 150 percent more capital costs because they require extensive new fixed guideway facility construction. The bus-on-busway plan would require capital costs ranging from $13 million to $17 million per year, with the light rail transit plan requiring capital costs ranging from $16 million to $21 million per year. Consequently, while the light rail transit and bus-on-busway plans would have greater potential annual net operating and maintenance cost savings, such savings would be offset by the capital cost requirements. Viewing tangible cost considerations alone, then, the bus-on-freeway plan was determined to be the best plan for the Milwaukee area under a wide range of future conditions.

- The light rail transit plan, however, was determined to be preferable to the bus-on-freeway plan if consideration is given to some of the intangible benefits of primary transit system performance. Light rail transit would probably have a greater, although uncertain and unmeasurable, potential to influence land development and redevelopment, would probably provide a more reliable and safer public transit system, and would be less subject to the adverse effects of highway system deterioration from deferred maintenance. Light rail transit has a potentially higher passenger-carrying capability per operator because of its ability to couple more than one vehicle into a train. Because of its electrical propulsion, light rail transit would also have environmental advantages in terms of localized noise and pollutant emission levels, as well as an operational advantage in the severe winter climate of the Milwaukee area, would have the best potential to continue and expand operations during a petroleum-based fuel shortage, and perhaps would have an advantage in long-term usefulness given the prospects for domestic and foreign petroleum production in the 21st century.

Thus, based on the quantitative test and evaluation of both the direct and indirect benefits of the recommended improvement plan options over the base plan, it was concluded that either plan option

Table 63

SUMMARY OF THE INTANGIBLE BENEFITS ATTENDANT TO THE IMPLEMENTATION OF THE RECOMMENDED TWO-TIER PRIMARY TRANSIT PLAN OPTION IN THE MILWAUKEE AREA

Benefit	Description	Potential Impact in the Milwaukee Area
Land Use	Potential to influence land development and redevelopment would permit public transit to be used to meet land use development objectives, as well as transportation development objectives, through the promotion of sound land use development and the inducement of urban development in desired locations	Would contribute to the evolution of a more desirable land use pattern along the northwest corridor under the lower tier of the plan, and potentially throughout other corridors of high travel demand within the Milwaukee area if the upper tier of the plan is implemented. The benefits which could be obtained include regional environmental and resource protection; preservation and revitilization of the City of Milwaukee; and reductions in the public and private costs of land development and supporting facilities and services, including public transit. Areas within the northwest corridor which would particularly lend themselves to new development or redevelopment include the Milwaukee central business district, the northwest industrial land bank area, and older central city areas of Milwaukee located along the final selected alignment. In addition, a light rail transit facility could provide a high level of service in the northwest corridor of Milwaukee County in light of the abandonment of certain once planned freeway segments.
Energy	Potential for operation in the event of a serious petroleum shortage	About 8 percent of all transit trips would be made on vehicles not dependent on petroleum-based fuels
Environment	Light rail transit vehicles emit no air pollutants along routes of operation and would generate about 20 percent less noise than diesel motor buses	Although the potential reduction in air pollution and noise pollution would be experienced to some degree along the light rail transit facility, the largest positive impacts would be concentrated along the proposed transit mall in the Milwaukee central business district, the W. Wisconsin Avenue area, and the N. Sherman Boulevard area, because of the reduction in the number of diesel motor buses
Traffic	Light rail transit would offer more attractive service which, accordingly, would have the potential to increase transit ridership and reduce automobile travel, and thus reduce the associated negative impacts on street and highway capacity	Because of its perceived attractiveness, light rail transit would be expected to be more effective in reducing traffic growth within the northwest corridor, particularly in the N. Sherman Boulevard area and the N. 76th Street area
Safety	Greater safety is provided on public transit modes that extensively use reserved and exclusive rights-of-way and have preferential treatment at intersections	The light rail transit facility proposed for Milwaukee's northwest corridor requires a fixed guideway and would be located almost entirely on either a reserved or exclusive alignment, resulting in a smaller probability of vehicle-to-vehicle and vehicle-to-fixed object collisions compared with transit vehicles which must operate in mixed traffic. In addition, the larger size and stronger construction of rail transit vehicles over that of motor buses offers more protection against personal injuries. Also, boarding and deboarding accidents and injuries can be significantly reduced if the light rail transit facility incorporates high-level loading at stations
Reliability	Public transit provided over fixed guideways is typically considered to be more reliable than public transit provided over arterial streets in mixed traffic	Light rail vehicles would experience fewer operational problems caused by traffic congestion and traffic accidents, street and utility repairs, and inclement weather than buses operated on public streets. In particular, light rail transit service in Milwaukee's northwest corridor could be expected to be very reliable since the entire alignment would be located on a reserved or exclusive right-of-way. Importantly, this advantage would be particularly critical to the Milwaukee area during the winter months because of the severe winter weather conditions frequently experienced

Table 63 (continued)

Benefit	Description	Potential Impact in the Milwaukee Area
Attractiveness	Studies have indicated that light rail transit has a greater potential to attract ridership than motor bus alternatives. Rider comfort will be enhanced by the smooth acceleration and ride afforded by light rail vehicles. Interior noise levels in light rail vehicles are also less than in motor buses	The most heavily used Milwaukee County Transit System route currently operates along N. Sherman Boulevard. A light rail transit facility in the same area serving much of the same ridership that currently uses the local bus routes could be expected to provide comfortable and attractive service to a large number of transit users
Flexibility	Light rail transit has the greatest potential to respond to sudden ridership increases. This potential becomes even more significant if future local or national policies encourage a large shift from the use of private automobiles to transit	Light rail vehicles typically allow greater "crush capacity" loads to be accommodated than do motor buses because of vehicle design and performance characteristics. During a given period of the day, additional passenger-carrying capacity can be added to the system without changing operating headways or speeds, by increasing train size

Source: SEWRPC.

would be a more preferable course of action than merely maintaining the existing system. Compared to the base plan, both plan options would provide a higher level of transit service, would provide significantly greater accessibility to residents and jobs, and would attract a higher level of both total and primary transit ridership. Furthermore, because the recommended plan options would carry between 4 and 14 percent more transit passenger trips and between 25 and 80 percent more passenger miles than the base plan, their cost per trip, including both direct and indirect costs, would generally be less than that of the base plan, and their cost per passenger mile—even if only direct costs are considered—would generally be less than that of the base plan.

Given these conclusions, the Advisory Committee determined that two final plans should be prepared and presented together with the base plan at a series of public informational meetings and at a public hearing. One of the two improvement plans would be the bus-on-metered freeway plan, and would represent a continued public commitment to the provision of primary transit service in the Milwaukee area exclusively through the bus-on-freeway mode. The other improvement plan, however, would recognize the importance of the intangible advantages inherent in light rail transit technology, and would recommend implementation of that mode in the Milwaukee area in at least one important travel corridor. This would be done by dividing the second plan into a lower and upper tier. The lower tier would seek to implement a basic bus-on-freeway system plan, together with a light rail transit facility in the northwest travel corridor of the Milwaukee area—one of the corridors not served by existing or proposed freeway facilities. Under the upper tier of the plan, certain of the bus-on-freeway routes could eventually be converted to light rail transit or commuter rail operation, as may be appropriate, depending upon future conditions.

Had the Advisory Committee supported the bus-on-metered freeway option, it would mean that the Committee—after careful review of the comments and suggestions presented by the general public and elected officials at the public informational meetings and public hearing—had concluded that the intangible benefits attendant to development of the two-tier system plan do not outweigh the capital cost differences between the two recommended final plan options. Furthermore, it would mean that the intangible advantages of light rail transit do not appear certain enough to outweigh a selection of a final alternative plan based solely on measures of cost-effectiveness. Had the Advisory Committee supported the two-tier system plan, it would mean that the intangible benefits attendant to the light rail transit mode sufficiently outweigh the total public cost advantage of the bus-on-metered freeway option. This conclusion would warrant a recommendation for light rail transit facility development in the northwest corridor of the study area in and around the Milwaukee metropolitan area. This conclusion would also indicate that the potential of light rail transit to operate during a motor fuel shortage, and to operate in the very long-term future when petroleum-based fuels may be expected to become scarce and very costly, is very important. And finally, it would indicate that the potential of a primary transit service operating on a fixed guideway to shape urban land use development and redevelopment is of great importance.

The findings and conclusions reached during the preparation, test, and evaluation of alternative primary transit system plans for the Milwaukee area could have far-reaching implications for both land use and transportation system development in the greater Milwaukee area. As noted above, the Advisory Committee—prior to making a final recommendation to the Regional Planning Commission—directed that the two final recommended plan options be presented together with the base plan at a series of public informational meetings, and that a formal public hearing be held to obtain the reaction of citizens and public officials to the study findings and conclusions to date. Upon completion of these public meetings, the Advisory Committee will meet to consider the record of the meetings and to prepare a final recommended plan. That final recommended plan is documented in the following chapter of this planning report.

Chapter VII

THE RECOMMENDED PRIMARY TRANSIT SYSTEM PLAN

INTRODUCTION

Previous chapters of this planning report have presented the information required for, and the process applied in, the design, test, and evaluation of alternative primary transit—that is, rapid transit—system plans for the greater Milwaukee area. More specifically, those chapters have documented the need for the preparation of a primary transit system plan for the area; and have set forth the objectives, principles, and standards by which alternative plans can be objectively compared and evaluated. Those chapters have also presented the salient findings of inventories conducted of the socioeconomic, land use, travel pattern, and technological factors affecting primary transit system development in the greater Milwaukee area, and have described alternative futures under which the various plans were rigorously tested and evaluated. Finally, the methodology by which alternative plans were designed, tested, and evaluated was described, together with the results of such design, test, and evaluation. The complex planning process used, although difficult and time-consuming, enabled more than 50 alternative primary transit system plans to be logically and efficiently designed, tested, and evaluated, and, thereby, provided a sound basis for the selection of a recommended plan.

The purpose of this chapter is to describe the recommended plan, to set forth the reasons for its selection from among the alternatives considered, and to present data relative to the anticipated performance of the facilities and services involved. This chapter is divided into four principal parts, the first of which briefly reviews the process of final plan development. The second summarizes the public reaction to the two preliminary recommended plan options, as presented for review at a series of public informational meetings and a formal public hearing. The third presents the Advisory Committee response to the information provided at the informational meetings and hearing, its recommendation concerning the selection of a plan for adoption and implementation; and the reasons therefor. The fourth describes the recommended plan. A summary concludes this chapter.

PROCESS OF FINAL PLAN DEVELOPMENT

The task of selecting a recommended primary transit system plan from among the many alternatives available was, in fact, the central purpose of the Milwaukee area primary transit system alternatives analysis. The methodology utilized in that analysis provides for the identification and evaluation of all transportation technologies practicable for the provision of primary transit service in the greater Milwaukee area, and of the potential viability of primary transit service in the major travel corridors of the greater Milwaukee area under a wide range of future conditions. Through the extensive inventories and analyses—including simulation model studies—undertaken, it was possible to identify from among the broad range of technology-based and corridor-based alternatives considered two viable primary transit system plans for the greater Milwaukee area for public review, prior to the selection of a final recommended plan.

The extensive inventories undertaken resulted in four important conclusions which served to define the extent and limits of the alternative system plans that warranted full consideration under the analysis. These conclusions are:

- A careful review of the state-of-the-art of primary transit technology indicated that five modes had sufficient potential for the provision of viable primary transit service in the greater Milwaukee area over the next two decades to warrant consideration in the system planning. These modes are: 1) motor bus on metered freeway; 2) bus on busway; 3) light rail transit; 4) heavy rail rapid transit; and 5) commuter rail.
- There are numerous rights-of-way in the Milwaukee area—including existing and abandoned railway rights-of-way and existing freeway rights-of-way—which have potential for use in the location of primary transit facilities, thus offering the possibility of some reduction in the costs and urban disruption entailed in providing primary transit service, contingent, however, upon the degree

of congruence between the location of the rights-of-way and the location of the demand for primary transit service.

- There is a great deal of uncertainty regarding the future condition of the major factors which determine the need for and use of primary transit facilities within the greater Milwaukee area—such as the size and distribution of the resident population, the type and distribution of economic activity, and motor fuel cost and availability.

- O In order to cope with the uncertainties regarding the major factors which determine the need for and use of primary transit facilities, an "alternative futures" approach was utilized. Under this approach, each of the alternative primary transit system plans to be considered was tested and evaluated under each of four sets of widely differing future conditions in order to identify those primary transit technologies, and those system configurations, that could be expected to perform well over a wide range of future conditions.

Based on the inventory findings and conclusions, it was possible to design maximum extent system plans for each of the applicable primary transit modes under each of the alternative futures. Each of these maximum extent system plans was then quantitatively tested and evaluated using a battery of travel simulation models. Analyses of the results of this simulation modeling resulted in the elimination of certain modes from further consideration, the elimination of uneconomic segments of the maximum extent system plans, and certain other adjustments in the configuration of those plans to make each alternative modal plan more cost-effective. These truncated modal system plans were again tested and evaluated in order to develop a "best" plan under each alternative future. Based on the findings of this work, the study Advisory Committee was able to draw the following important conclusions:

- Heavy rail rapid transit should be eliminated from further consideration as a viable mode for providing primary transit service in the greater Milwaukee area, since the level of travel demand in even the most heavily traveled corridors of the greater Milwaukee area under the alternative future most favorable to transit use was found to be insufficient to utilize the efficiencies of this mode.

- As an areawide primary transit system, commuter rail may be expected to be viable only under the alternative future most favorable to transit use. This finding did not rule out, however, the viability of limited special commuter rail service in certain corridors, including particularly the Milwaukee-Racine-Kenosha and the Milwaukee-Oconomowoc corridors.

- The bus-on-metered freeway, bus-on-busway, and light rail transit modes may be expected to perform about equally well in the greater Milwaukee area under a wide range of future conditions, the only significant tangible difference between the performance of these modes being the capital cost requirements.

- If consideration is given to the intangible benefits of primary transit system performance, the potential advantages of certain fixed guideway modes could outweigh any attendant capital cost disadvantage.

Following the evaluation of more than 50 alternative primary transit system plans—including comparisons and evaluations of such tangible factors as capital and operating and maintenance costs; levels of service, accessibility, and ridership; farebox revenues; energy requirements; and environmental impacts, and of such intangible factors as the ability to influence land development and redevelopment and dependence on, and continued availability of, cheap petroleum-based fuels—the Advisory Committee determined that two preliminary recommended plan options together with a base—or status quo—plan should be presented at a series of public informational meetings and at a public hearing. The first recommended plan option was to be a bus-on-metered freeway plan. This plan would represent a continued public commitment to the provision of primary transit service in the Milwaukee area exclusively through the bus-on-freeway mode. The second recommended plan option would provide for the immediate development of a light rail transit facility in the northwest corridor of the greater Milwaukee area, as well as the eventual development of additional light rail transit facilities in up to four other corridors, along with the provision of commuter rail service in the Milwaukee-Racine-Kenosha corridor. Upon completion of the public meetings and hearing, the Advisory Committee met to consider the record of these meetings and hearing to determine a final plan recommendation.

Table 64

SCHEDULE OF PUBLIC INFORMATIONAL MEETINGS AND PUBLIC HEARING HELD CONCERNING THE PRIMARY TRANSIT SYSTEM PLAN FOR THE MILWAUKEE AREA

Target Counties	Place: Public Informational Meetings	Date and Time
Milwaukee	Wauwatosa Memorial Civic Center Wauwatosa, Wisconsin	February 1, 1982 7:30 p.m.-9:05 p.m.
Kenosha Racine	Racine County Highway and Office Building Ives Grove, Wisconsin	February 4, 1982 7:30 p.m.-9:25 p.m.
Ozaukee Washington	Washington County Courthouse West Bend, Wisconsin	February 17, 1982 7:30 p.m.-8:55 p.m.
Walworth	Walworth County Courthouse Elkhorn, Wisconsin	February 18, 1982 7:30 p.m.-8:15 p.m.
Waukesha	Waukesha County Office Building Waukesha, Wisconsin	February 22, 1982 7:30 p.m.-8:25 p.m.
	Public Hearing	
Regionwide	Milwaukee County Courthouse Annex Milwaukee, Wisconsin	February 25, 1982 7:30 p.m.-8:45 p.m.

Source: SEWRPC.

PUBLIC REACTION TO PRELIMINARY RECOMMENDED PLAN OPTIONS

The preliminary findings and recommendations of the alternatives analysis, including the two preliminary recommended system plan options, were presented at a series of five public informational meetings and a formal public hearing, held during February 1982. The meetings and hearing were held in accordance with the schedule set forth in Table 64. Prior to this series of meetings and hearing, the Commission prepared and widely distributed two SEWRPC Newsletters—Vol. 21, No. 5 and Vol. 21, No. 6—which together presented in summary form the findings and preliminary recommendations of the analysis. The first newsletter summarized the findings of the inventories conducted under the study; set forth the primary transit system development objectives formulated under the study; and described the application of the "alternative futures" approach to the design, test, and evaluation of the alternative rapid transit system plans. The second newsletter described and comparatively evaluated the alternative plans considered, with emphasis upon the two preliminary recommended plan options selected by the Advisory Committee for focused public review.

Special announcements of the series of public meetings were sent to specific elected and appointed public officials, technicians, interested citizens, and educators throughout the Region. A Commission news release concerning the informational meetings and public hearing was sent to about 80 daily and weekly newspapers, radio stations, and television stations throughout the Region. The news release contained a summary of the two newsletters and provided the schedule for the public informational meetings and public hearing. Special briefings on the study findings and recommendations were provided by the Chairman of the Advisory Committee and Commission staff representatives to certain elected and appointed public officials, including the State Secretary of Transportation and members of his staff; the Milwaukee County Executive and members of his staff; the Mass Transit Committee of the Milwaukee County Board; and the Utility and Licenses Committee and Public Improvements Committee of the Common Council of the City of Milwaukee.

The minutes of the public informational meetings and public hearing were published by the Commission for distribution to the Advisory Committee members and are available for review at the Commission offices. The minutes, along with attendance records, meeting announcements, written comments, and pertinent newspaper articles, are documented in Minutes of Informational Meetings and Public Hearing: The Milwaukee Area Rapid Transit Study.

The following text summarizes the public reaction to the preliminary recommended plan options, based upon the questions raised and comments made at the public informational meetings, the formal statements made at the public hearing, and the written comments which were received for inclusion in the formal record of the hearing. The reactions of interested citizens and concerned public officials to the findings and preliminary recommendations of the alternatives analysis can be categorized into three general areas of concern: 1) comments related to proposed bus-on-freeway service; 2) comments related to proposed light rail transit and commuter rail service; and 3) comments relating to funding and management of an areawide primary transit system.

Comments Related to Bus-on-Freeway Service

The record of the public informational meetings and public hearing reveals no expressed support by either interested citizens or concerned public officials for either the all-bus base system plan or the all-bus bus-on-freeway alternative plan option. Comments were made, however, concerning several aspects of the bus-on-freeway services included under both preliminary plan options. Residents of Kenosha, Racine, and Washington Counties all expressed support for the provision of direct bus-on-freeway service to the passenger terminal area of General Mitchell Field. In addition, the suggestion was made that the proposed bus-on-freeway services incorporate stops to receive and discharge passengers at key locations—in addition to the park-ride lots—on the nonfreeway portions of the routes. Concern was also expressed as to whether the metered freeway system envisioned for the operation of the primary transit bus service would be regarded as an infringement on the "rights" of automobile drivers by constraining access of automobiles to the freeway system.

Comments Related to Light Rail Transit and Commuter Rail Service

The record of the informational meetings and public hearing indicates support for the implementation of the two-tier system plan option among both interested citizens and concerned elected public officials, and particularly for the inclusion in the plan of light rail transit facilities and commuter rail services. Strong support was expressed for the light rail transit mode in general, and specifically for the light rail transit facility in the northwest corridor as proposed under the lower tier of the two-tier plan option. Specific reasons which were cited by concerned citizens and public officials for such support included the potential advantages of electrically propelled public transit services in view of the rising cost and decreasing supply of petroleum-based fuels; the increased reliability and safety of the light rail transit mode as compared with the motor bus mode; the perceived public preference for riding rail transit vehicles instead of bus transit vehicles; and the ability of light rail transit to be implemented with minimal urban disruption. In short, it was the expressed judgment of the concerned citizens and public officials who testified that the additional cost of the two-tier system plan over that of the bus-on-metered freeway system plan would be more than offset by the intangible, yet real, advantages attributable to the light rail transit mode.

Some comments supported the immediate implementation of this option on the basis that the rapidly increasing cost of living, together with the cost of owning and operating a private automobile, will make living within an intensively developed urbanized area and the use of public transit services increasingly popular in the future. Several North American cities which have recently begun the operation of light rail transit service or which are in the process of building such a facility were identified as being progressive in terms of meeting public transportation needs. Such cities include Portland, Oregon; San Diego, California; Buffalo, New York; and Calgary and Edmonton in Alberta, Canada. Selected characteristics of the light rail transit projects in Portland and San Diego are compared to such characteristics for the proposed northwest corridor line in Table 65.

Several individuals suggested that the light rail transit facility, as proposed in the lower tier of the two-tier plan, should be extended into the east side of the City of Milwaukee. The east side was noted as including a densely populated area of high-rise apartments as well as the University of Wisconsin-

Table 65

COMPARISON OF PROPOSED MILWAUKEE NORTHWEST CORRIDOR LIGHT RAIL TRANSIT FACILITY WITH OTHER NEW LIGHT RAIL TRANSIT PROJECTS IN THE UNITED STATES

Characteristic	Milwaukee Northwest Corridor Facility	Portland Banfield Transitway Project	San Diego Trolley
Project Status	Proposed	Under construction	In operation
Start of Operation	1987	1985	1981
Urbanized Area Population[a]	1,207,008	1,025,737	1,704,352
Fixed Guideway (miles)			
Total Length	14.3	15.1	15.9
Double Track	14.3	13.0	1.7
Exclusive Grade-Separated	4.5	7.1	--
Exclusive At-Grade	0.9	--	14.3
Street/Boulevard Median[b]	7.6	7.6	--
Mixed Traffic	--	--	1.1
Transit Mall	1.3	0.4	0.5
Stations			
Number	27	26	18
Average Spacing (miles)	0.53	0.58	0.88
With Park-Ride Lots	3	4	7
Vehicles			
Type	Articulated	Articulated	Articulated
Fleet Size	16-27[e]	26	14
Typical Train Length	1 car	2 cars	2 cars
Operation			
Overall Average Speed (mph)	20	23	29
Peak-Period Headway (minutes)	4-10	5	15
Off-Peak Headway (minutes)	12-30	10-30	15-30
Daily Ridership (projected)	15,000-30,500[e]	42,000	28,000
Costs			
Total Capital Investment	\$153 million - \$166 million[d,e]	\$147 million	\$86 million[f]
Total Capital Investment per Route Mile[c]	\$11-12 million[e]	\$ 10 million	\$ 5 million
Annual Operating Cost	\$1.6-3.1 million[e]	\$ 4.9 million	\$ 2.2 million

[a] *Provisional 1980 census data.*

[b] *Including reserved-lane operation.*

[c] *The total capital investment was about \$14 million per route mile for the new Edmonton Transit System light rail facility, and about \$21 million per route mile for the new City of Calgary light rail facility.*

[d] *The capital cost would be \$79-85 million.*

[e] *The range in values relates to extreme alternative future conditions.*

[f] *Phase II, to be completed by late 1982, consists of the addition of a second mainline railway track over much of the route and the acquisition of 10 additional light rail vehicles. This expansion of the facilities and equipment will cost an additional \$29 million.*

Source: SEWRPC.

Milwaukee campus, which was cited as being one of the largest trip generation centers in the greater Milwaukee area outside the Milwaukee central business district. In addition, it was noted that service to this area could be provided over an existing right-of-way, that of the former Chicago & North Western Transportation Company lakefront main line. It was also suggested that such a light rail transit line to the University of Wisconsin-Milwaukee area should be designed to loop through the campus, because such direct service would be important to attracting a high level of ridership.

Concern was expressed by interested citizens and an elected official as to the proposed alignment of the northwest corridor light rail transit facility. Specifically, it was indicated that the use of N. Sherman Boulevard for such an alignment would be disruptive to the neighborhoods concerned and that locations along W. Fond du Lac Avenue or the N. 33rd Street railway corridor would constitute better alternatives.

Support was expressed for the proposed commuter rail service in the Milwaukee-Racine-Kenosha corridor as envisioned under the upper tier of the two-tier system plan option. Most supporters of this element of the plan also supported early implementation of this service, possibly in the form of a specialized, peak-period-only service initially, or a limited-term demonstration project. It was pointed out that the travel patterns of Racine and Kenosha residents are linked closely to both the Milwaukee and Chicago areas. Therefore, it was felt that commuter rail service within this corridor should be integrated with the existing commuter rail service operated by the Regional Transportation Authority of Chicago between the Cities of Kenosha and Chicago.

In addition to supporting the provision of commuter rail service between Milwaukee, Racine, and Kenosha, some individuals suggested that such service should be considered between Milwaukee and other outlying communities in southeastern Wisconsin, including Grafton, Hartford, Oconomowoc, Port Washington, and Waukesha. The Oconomowoc route, however, was the only one of these additional routes to be repeatedly suggested.

Comments Related to the Management of a Regionwide Transit System

A number of comments were received from both concerned citizens and public officials relating to the need for an organizational structure for, and more certain and stable funding of, plan implementation. Several comments expressed the need for an organizational structure that would permit the development and operation of all transit facilities as a single areawide system, particularly with respect to scheduling, fare structure, transfer privileges, and marketing. Concern was expressed over the need to avoid having to needlessly change vehicles or to pay additional fares when crossing governmental boundaries such as county lines. The establishment of a regional transportation authority, similar to such authorities existing in the greater Chicago and Cleveland areas, was suggested. This view was countered, however, on the basis that a regional transportation authority may, at present, represent too sophisticated an organization for the plans in question, and may also be politically difficult to implement.

A special concern was expressed regarding the ability to conveniently transfer between any new primary services and rural or specialized demand-responsive services in outlying counties of the Region. Convenient access to the various services was indicated to be important by some interested citizens. It was indicated that this concern could be met by providing well-located, adequately sized park-ride lots, especially along commuter rail and bus routes. The opinion was expressed that stations for commuter rail routes should not necessarily be located at historic or existing station sites, but should be properly related to existing and proposed land uses and ease of access by private automobile.

Concern was expressed over the need to provide a source of revenue other than the property tax for the capital investment and operating subsidies needed for plan implementation. Alternative sources of funding suggested included increases in the sales tax, the use of parking meter revenues and the institution of parking surcharges, increases in driver and motor vehicle license fees, the institution of a lubricating oil tax, and increases in motor fuel taxes. Some public officials indicated that the State Legislature may be expected to be supportive of transportation system improvements, including transit improvements, but cautioned that support by local elected officials and ultimately the residents and taxpayers themselves will determine the amount and use of state aids provided for this purpose. Finally, public officials representing outlying counties in the Southeastern Wisconsin Region maintained that individual counties should be responsible for financially supporting only those services which directly benefit the county.

ADVISORY COMMITTEE REACTION TO PUBLIC COMMENTS

Members of the Milwaukee Area Primary Transit System Alternatives Analysis Citizens Intergovernmental and Technical Coordinating and Advisory Committee met on April 23, 1982, to deliberate on the public reaction to the preliminary recommended system plan options. After careful deliberation, the Advisory Committee concluded that the two-tier plan option should be recommended for adoption as the primary transit system plan for the greater Milwaukee area.

The Advisory Committee determined this recommendation to be sound and in the public interest for five critical reasons. First, the potential intangible benefits attendant to the development of an electrically propelled light rail transit system were deemed sufficient to outweigh the capital cost advantage of a plan which relies entirely on the operation of diesel motor buses. Such intangible benefits attendant to the use of this fixed guideway mode that were identified by the Advisory Committee include: the potential to favorably influence the location and intensity of land use development and redevelopment; increased public transit service reliability in times of bad weather and in times of petroleum shortages, and in light of possible deferred highway maintenance; increased safety; and the ability to reduce localized pollutant emission and noise levels. In addition, the larger total passenger-carrying capacities of light rail vehicles over motor buses and the ability of such vehicles to be operated in trains provide a higher passenger-carrying capability per operator, and, therefore, lower operating costs.

Second, the two-tier system plan option provides the greater Milwaukee area with a flexibility in transit system development not provided by the all-bus system. Such flexibility was regarded as especially important because of the uncertainties which exist with respect to future conditions in the Milwaukee area. Under the bus-on-metered freeway system plan, primary transit development would be locked into a single, specific technology, that being the diesel motor bus. Under the two-tier system plan, primary transit development could begin from the base provided by the existing bus-on-freeway ("Freeway Flyer") services and facilities, and be gradually evolved as needs and events dictated into a system that could include a network of light rail transit lines in the most heavily traveled corridors of the Milwaukee area, as well as commuter rail service between the Cities of Milwaukee, Racine, and Kenosha. The flexibility needed to convert certain primary transit services to light rail transit in the future would thus be preserved. Until this occurs, bus-on-metered freeway services would be expanded, but such services would be designed and located so as to facilitate eventual conversion to rail transit technology. Preservation of this flexibility was identified by the Advisory Committee as being of crucial importance, particularly in view of the long-term uncertainties with respect to the cost and availability of petroleum-based motor fuels.

Third, the possibility of implementing rail transit technology in the Milwaukee area represents an issue too complex and too important to be quickly settled by the public officials and electorate concerned. This issue can, accordingly, be expected—and, indeed, given the nature of the costs and benefits involved, should be expected—to remain the subject of public debate over a period of some years to come. The uncertainty regarding future conditions within the greater Milwaukee area that will determine the need for and use of primary transit service, including the cost and availability of energy, the size and distribution of the resident population, personal lifestyles, and the economic base and structure of the Region, only serves to emphasize the complexity of this issue. Adopting the two-tier plan and proceeding with the first stage of its implementation, including preliminary engineering of the light rail line proposed to serve the northwest corridor,[1] would serve to continue in a focused manner the debate concerning the need for and the costs and benefits of rail transit technology by the public officials and citizens concerned. To dismiss rail transit technology by rejecting the two-tier plan option would serve only to stifle that needed debate.

[1] *Under this plan, the first stage of light rail transit implementation would consist of a detailed corridor analysis, which would include environmental and land use impact analyses as well as preliminary engineering. This proposed work is explained in more detail in Chapter VIII of this report.*

Fourth, the initial light rail transit facility in the northwest corridor of the Milwaukee area would serve a large sector of Milwaukee County in which no freeway facilities exist or are proposed. The Park Freeway-West and Stadium Freeway-North facilities were removed from the most recent regional transportation system plan by the Regional Planning Commission during a major plan reevaluation effort completed in 1978. It was originally intended that the Park Freeway-West and Stadium Freeway-North "gap closure" be utilized for the provision of bus-on-freeway primary transit service in the northwest corridor. This no longer being possible, light rail transit appears to be a viable alternative for providing a high level of public transit service to this portion of Milwaukee County.

Fifth, the Advisory Committee noted that public support of the two-tier system plan option was evident in the minutes of the public informational meetings and public hearing held on the preliminary recommended plan options. It was noted that there was no support expressed in the record of the meetings and hearing by either concerned citizens or public officials for either the all-bus base system plan or the all-bus bus-on-freeway alternative system plan option. This public reaction was interpreted by the Advisory Committee to indicate that the public considers the potential intangible benefits attendant to the development of rail technology in the Milwaukee area sufficiently important to justify the additional fiscal investment required over and above that for implementation of either the base system plan or the bus-on-freeway alternative system plan option.

The Advisory Committee accordingly directed the Commission staff to prepare a final recommended primary transit system plan. This plan was to be identical to the two-tier system plan option that was presented at the public informational meetings and the public hearing, with but the following three modifications:

1. Direct bus-on-freeway service to General Mitchell Field was to be added under the lower tier of the plan as part of the Racine and Kenosha bus-on-freeway routes. A new transit station without park-ride facilities was to be added at the airport passenger terminal. This modification would envision some, but not necessarily all, trips on each of the two routes concerned—Route 18-Kenosha, and Route 19-Racine—stopping at the General Mitchell Field terminal.
2. Specialized commuter rail demonstration service, possibly operating during weekday peak periods only, was to be added as an option under the lower tier of the plan. If evidence of substantial public interest in, and demand for, such trial service is demonstrated, such service could be operated on one or more of three routes, including Milwaukee to Grafton, Milwaukee to Oconomowoc, and Milwaukee to Racine and Kenosha, the latter possibly in conjunction with the existing Chicago Regional Transportation Authority commuter rail service between Kenosha and Chicago. If such trial service is implemented, it should be operated for a period of at least one year and should incorporate carefully designed attitudinal and behavioral surveys in order to permit sound appraisal of the long-term viability of such service.[2]
3. Light rail transit service in the northeast corridor of the greater Milwaukee area was to be added to the upper tier of the plan. This modification would acknowledge the existence of two competing corridors, those being the north corridor, located along IH 43 between downtown Milwaukee and Glendale, and the northeast corridor, located east of the Milwaukee River between downtown Milwaukee and Shorewood. At the time of upper-tier implementation, this issue would be reopened as to the precise alignment of a fixed guideway in either the north or northeast corridor.

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[2] *A trial run of a commuter train between the Cities of Milwaukee, Oconomowoc, and Watertown was conducted during the week of October 13th, 1980. The objective of this experimental run, sponsored by a private group known as the Revive the Cannonball Committee, Inc., was to demonstrate that reactivation of such a commuter rail service would be popularly supported. A survey of the passengers was conducted by the Wisconsin Department of Transportation, the conclusions of which are reported in the SEWRPC Technical Record Vol. 4, No. 3.*

FINAL RECOMMENDED PRIMARY TRANSIT SYSTEM PLAN

The recommended final primary transit system plan for the greater Milwaukee area consists essentially of the two-tier system plan option, as presented at the public informational meetings and public hearing. Under the lower tier of the plan, immediate implementation of the northwest corridor light rail transit facility would proceed. Primary transit service to other parts of the Milwaukee area would be provided by the bus-on-metered freeway mode. Under the upper tier of the plan, bus-on-metered freeway service in up to six additional Milwaukee area corridors could be converted to light rail transit service, or—in case of the Milwaukee-to-Racine and Kenosha corridor—to commuter rail service.

Description of the Lower Tier

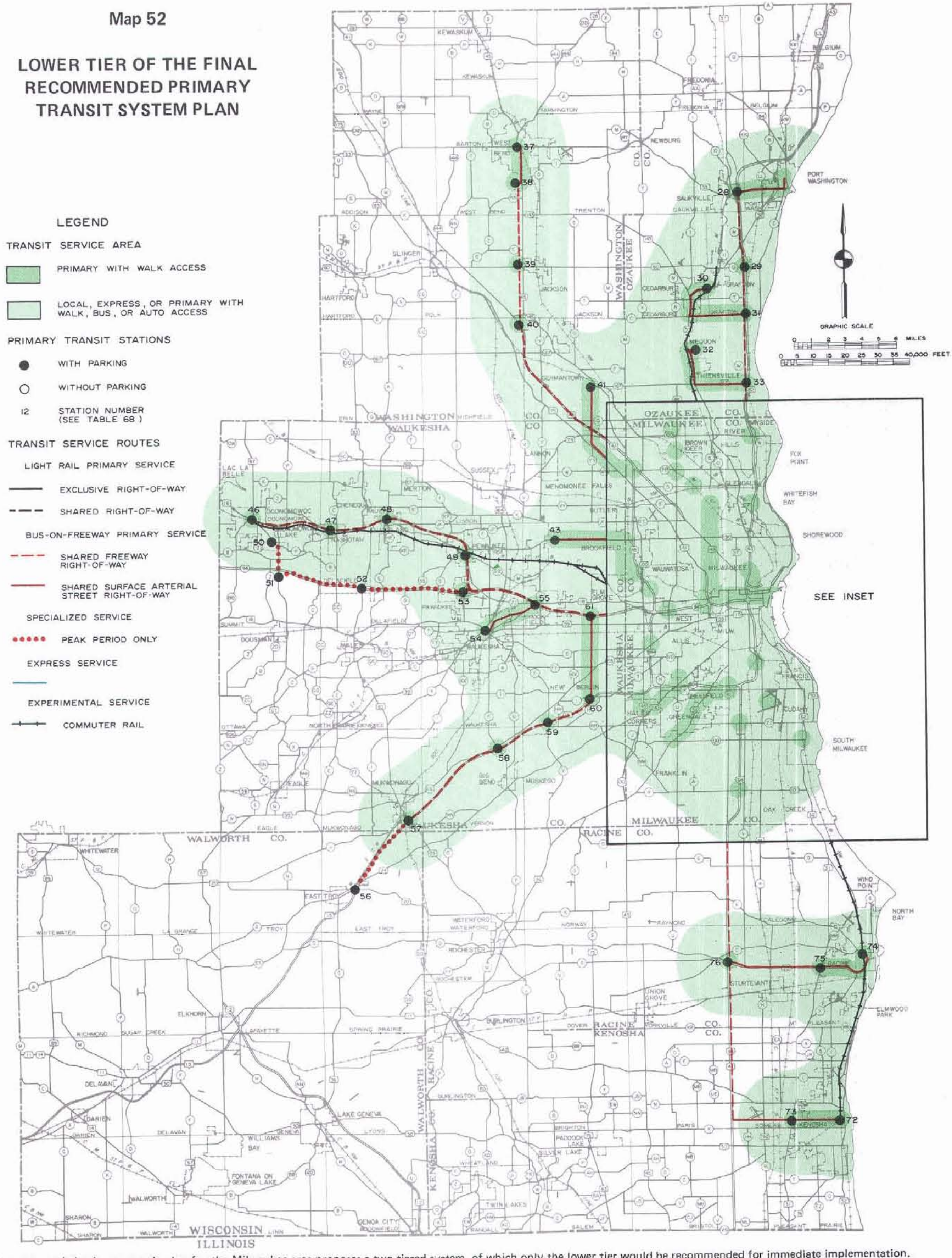
The lower tier of the primary transit system plan recommended for adoption and implementation is shown on Map 52, with attendant facility and operational characteristics given in Table 66. Recommendations under the lower tier of the plan call for the construction and operation of a light rail transit facility in the Milwaukee northwest corridor, the expansion of the existing system of routes of buses operating over freeways in all other Milwaukee area corridors, the expansion of most primary transit service from weekday peak-period service to all-day weekday service at maximum headways of 30 minutes in peak travel periods and of 60 minutes in off-peak travel periods, and the provision of extensive preferential treatment for buses operating in primary transit service. This preferential treatment would be provided by the establishment of an areawide freeway operational control system which would ensure uninterrupted traffic flow on the freeways during weekday peak periods while providing public transit vehicles with priority access at the on-ramps. Also, Wisconsin Avenue in downtown Milwaukee would be converted to a transit mall for the exclusive use of motor buses and light rail vehicles. The plan also calls for all new bus-on-freeway facilities and services to be implemented so as to permit possible eventual conversion to light rail transit operation in up to five additional corridors and to commuter rail operation in the corridor extending from Milwaukee to Racine and Kenosha.

The recommended primary transit system plan proposes the construction and operation of a light rail transit facility in the northwest corridor of the City and County of Milwaukee. The first phase of the primary transit alternatives analysis—the findings and recommendations of which are herein reported—is not intended to result in the recommendation of a specific alignment for such a facility. Rather, it is envisioned that, as discussed in later sections of this chapter, the selection of such an alignment properly will be the subject of detailed corridor analysis work to be conducted as the second phase of the alternatives analysis and the first step in plan implementation. It was, however, necessary in conducting the first phase of the alternatives analysis to select a single alignment for the purposes of testing and evaluating the primary transit system plan. It is proposed that this tested alignment, together with two other specific alignments suggested during and after the public informational meetings and public hearing, be explicitly considered in the preliminary engineering effort, together with any other specific alignments that may become evident as plan implementation proceeds. These three alignments may be described as follows:

1. The alignment tested under the first phase of the alternatives analysis would extend from the central business district westerly along W. Wisconsin Avenue to N. 44th Street, and then north across the Menomonee River Valley to N. Sherman Boulevard. The facility would then extend along N. Sherman Boulevard, thence northerly along N. Sherman Boulevard to W. Silver Spring Drive, and thence northwesterly and northerly to the Northridge Shopping Center along the Wisconsin & Southern Railroad line and N. 76th Street. The facility would have a length of about 14.3 miles, of which about 11.8 miles would be located on the surface and about 2.5 miles would be on elevated structure. All the fixed guideway would be constructed for exclusive light rail transit use, either by provision of an exclusive right-of-way over 4.7 miles of the line, or by the reservation of lanes or median areas of surface streets over the remaining 9.6 miles of line. At-grade intersections with public streets would occur along the fixed guideway, but the light rail vehicles would receive preferential treatment at these intersections through traffic signalization. A total of 27 stations, 3 of which would have park-ride lots, would be provided along the fixed guideway. The stations would be located approximately one-quarter mile apart in the central business district,

Map 52

LOWER TIER OF THE FINAL RECOMMENDED PRIMARY TRANSIT SYSTEM PLAN



The final recommended primary transit plan for the Milwaukee area proposes a two-tiered system, of which only the lower tier would be recommended for immediate implementation. The purpose of the upper tier would be to help avoid actions which would foreclose options concerning future primary transit system development in the area. The lower tier of the plan would provide for the development of a system of bus-on-metered freeway lines, except in the northwest corridor of Milwaukee County, within which a light rail transit facility would be developed. The lower-tier bus-on-freeway facilities and services would, however, be structured so that the service could be readily converted to light rail operation in up to five additional corridors and to commuter rail operation between the Cities of Milwaukee, Racine, and Kenosha, as recommended in the upper tier of the plan. The light rail transit facility shown here represents only a preliminary alignment developed for systems planning purposes. During the preliminary engineering phase of plan implementation, this alignment would be reevaluated and compared in detail with a number of other alignments within the northwest corridor, including alignments which are located within the N. 33rd Street railroad corridor. Bus-on-metered freeway facilities and services under the lower tier would be expanded over those of the present system to consist of 24 routes totaling 242 route miles and having a total of 55 stations, 50 of which would have park-ride lots. Of the 55 stations, 21 would be located within Milwaukee County, of which 16 would have park-ride facilities. High-capacity articulated diesel motor buses would be used to provide the recommended bus-on-freeway service, which would be implemented in stages over the plan design period.

Source: SEWRPC.

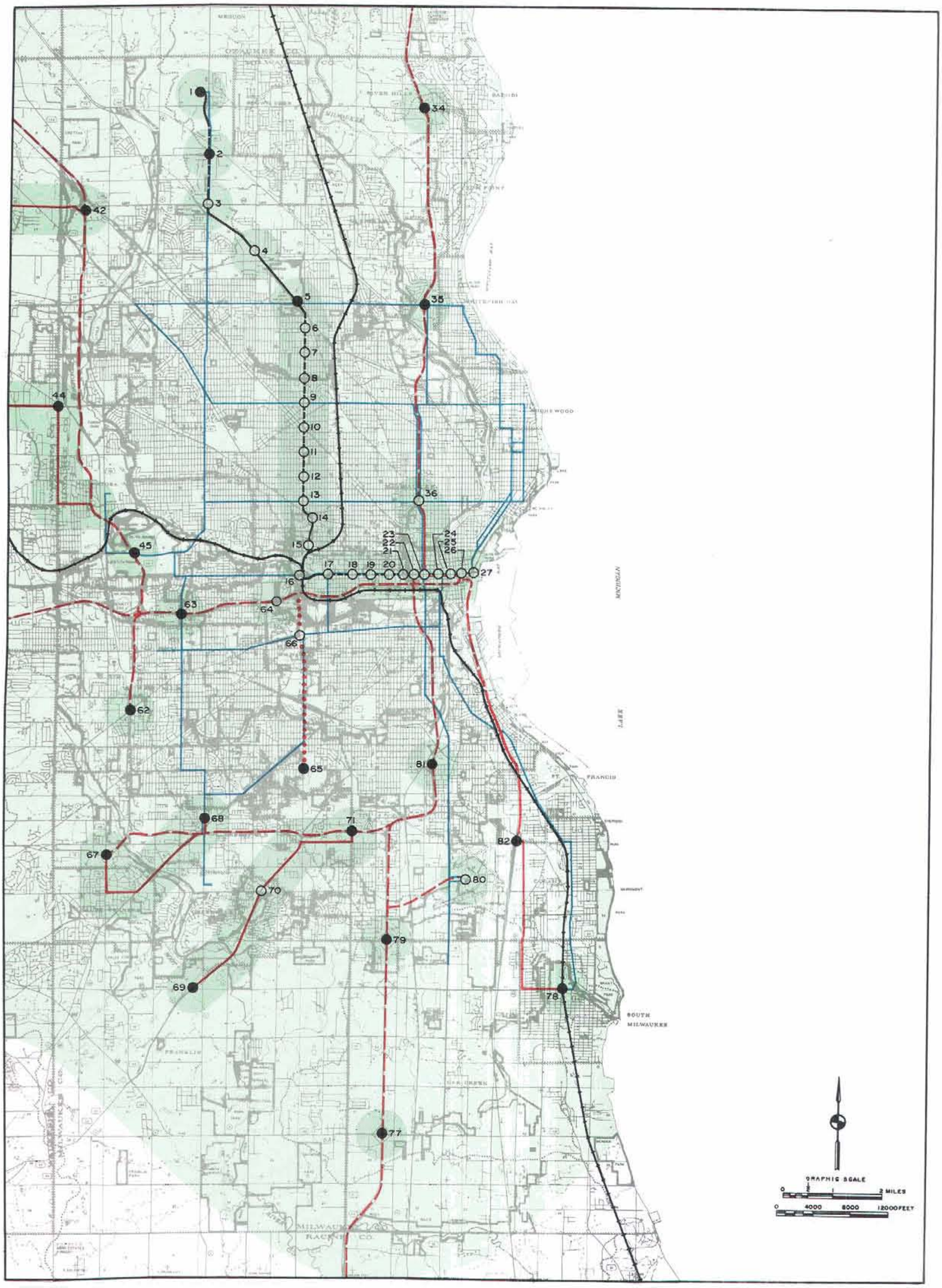


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Table 66

FACILITY AND OPERATION CHARACTERISTICS OF THE FINAL RECOMMENDED PRIMARY TRANSIT SYSTEM PLAN UNDER THE MODERATE GROWTH SCENARIO-CENTRALIZED LAND USE PLAN AND THE STABLE OR DECLINING GROWTH SCENARIO-DECENTRALIZED LAND USE PLAN

Characteristic	Lower Tier of the Two-Tier System Plan — Alternative Future: Optimistic Scenario—Moderate Growth-Centralized Land Use Plan	Pessimistic Scenario—Stable or Declining Growth-Decentralized Land Use Plan
Primary Element		
Exclusive Guideway Miles		
Subway	- -	- -
Elevated	2.5	2.5
At-Grade	11.8	11.8
Total	14.3	14.3
Shared Guideway Miles		
Freeways	163.4	163.4
Surface Arterial Streets	83.4	83.4
Total	246.8	246.8
Stations	82	82
Route Miles	1,057	1,057
Vehicle Miles[a]	43,150	14,810
Vehicle Hours	1,523	551
Vehicles Required		
Motor Buses	220	117
Light Rail Vehicles	24	14
Trains Required	24	14
Demonstration Commuter Rail Services (optional)		
Grafton Route		
Guideway Miles[b]	23.2	23.2
Possible Stations	10	10
Oconomowoc Route		
Guideway Miles[b]	32.2	32.2
Possible Stations	12	12
Kenosha Route		
Guideway Miles[b]	33.1	33.1
Possible Stations	9	9
Express and Local Elements		
Bus Service		
Route Miles	1,518	1,331
Vehicle Miles	87,430	51,100
Vehicle Hours	5,698	3,351
Motor Buses Required	696	439
Total System		
Route Miles	2,575	2,398
Vehicle Miles	130,580	65,910
Vehicle Hours	7,221	3,902
Vehicles Required		
Motor Buses	916	556
Light Rail Vehicles	24	14
Trains Required	24	14

[a]Vehicle miles of travel per average weekday on the light transit route under the lower tier of the two-tier plan is estimated at 3,570 vehicle miles under the moderate growth scenario-centralized land use plan alternative future, and at 1,880 vehicle miles under the stable or declining growth scenario-decentralized land use plan alternative future.

[b]Fixed guideway facilities for commuter rail operations are located largely at-grade on exclusive right-of-way but shared with railway freight traffic.

Source: SEWRPC.

one-half mile apart in other high-density-development areas, and one mile apart in medium-density-development areas. Average speeds on the route would be about 20 miles per hour (mph), with maximum operating speeds of approximately 50 mph. Headways during the peak periods would range from 4 to 12 minutes, with some service being provided by trains of two articulated light rail vehicles. During the off-peak periods, headways would range from 12 to 30 minutes both in the midday and evening travel periods, with all service being provided by trains made up of a single right rail vehicle.

2. An alignment suggested by Milwaukee County Board Supervisor Paul F. Mathews at the public hearing which is similar in nature to the alternative that was tested and described above except that instead of utilizing N. Sherman Boulevard, the light rail transit alignment would be located within the right-of-way of the Milwaukee Road's Fifth Subdivision, referred to as the N. 33rd Street railway corridor. The Milwaukee Road right-of-way would be used for a distance of about 5.2 miles between Grand Avenue Junction—located at N. 44th Street and W. Wisconsin Avenue—and North Milwaukee Station—located near N. 33rd Street and W. Hampton Avenue. Between the North Milwaukee Station area and the intersection of N. Sherman Boulevard and W. Silver Spring Drive, this alternative envisions the use of railroad right-of-way principally owned by the State of Wisconsin, but operated over by the Wisconsin & Southern Railroad Company.

3. An alignment offered by Congressman Henry S. Reuss after the public hearing record was closed extending from the Amtrak Station in downtown Milwaukee westerly along the Milwaukee Road right-of-way to County Stadium; thence northerly along the Milwaukee Road right-of-way past the Miller Brewery, Harley-Davidson, Master Lock, Koehring, A. O. Smith, Outboard Marine, Cutler-Hammer, and other industrial establishments to North Milwaukee Station at N. 33rd Street and W. Hampton Avenue; thence northerly along the Milwaukee Road's Fifth Subdivision to the Chicago & North Western's Airline Subdivision right-of-way; thence northwesterly past Graceland Cemetery, Tripoli Country Club, and Brynwood Country Club, terminating at N. 76th Street near Servite Woods and the Northridge Shopping Center—with a possible extension for about two more miles to Granville Station.

   Under a more detailed examination of this alignment, primary transit service alternatives would be considered which would use the existing railway trackage itself, or which would use only the right-of-way. Such alternatives which would utilize the railway right-of-way between the central business district and the northwest side of the City of Milwaukee would require the construction and operation of a separate fixed guideway over which the light rail vehicles would operate. Thus, the physical appearance of the trackage, stations, power supply system, and vehicles would be very similar to that envisioned under the two alternative alignments described above. An alternative which utilizes the existing railway trackage over the entire length of this proposed alignment would require vehicles and facilities—including stations, storage yards, signalization, and a power supply system—which are compatible with mainline railway operations. This would be necessary since the trackage would be shared with freight train and intercity passenger train operations. Thus, such an alternative would essentially be a commuter rail system, although possibly with service attributes, such as headways, which are generally associated with light rail transit systems.

A comparison of the characteristics attendant to each of these three specific alignments is set forth in Table 67. The three alignments are shown on Map 53.

The bus-on-freeway facilities and services recommended for implementation under the lower tier of the plan would expand the existing primary transit service within Milwaukee County, and extend service to the south to the Cities of Racine and Kenosha, to the southwest to the Village of Mukwonago with limited service to the Village of East Troy, to the northwest to the City of West Bend, and to the north to the City of Port Washington. Throughout the entire greater Milwaukee area, bus-on-freeway service would be expanded to an all-day service.

Table 67

SELECTED CHARACTERISTICS OF THREE ALTERNATIVE ALIGNMENTS FOR THE RECOMMENDED LIGHT RAIL TRANSIT FACILITY IN THE NORTHWEST CORRIDOR OF MILWAUKEE COUNTY

Characteristic	Alignment No. 1 as Tested and Evaluated in the Study	Alignment No. 2 as Proposed by Milwaukee County Board Supervisor Paul F. Mathews	Alignment No. 3 as Proposed by Congressman Henry S. Reuss	
			Uses Right-of-Way Only	Uses Existing Railway Trackage
Right-of-Way				
Type	Proposes extensive use of public street right-of-way plus some railroad and miscellaneous right-of-way	Proposes use of N. 33rd Street railway corridor instead of N. Sherman Boulevard	Proposes use of railroad right-of-way over entire length of route	Proposes use of existing railway trackage over entire length of route
Availability	Uses public street right-of-way with sufficient cross-sectional width plus railroad rights-of-way with good potential for fixed guideway development	N. 33rd Street railway corridor between W. Wis- Avenue and W. Hampton Avenue is 5.2 miles in length, of which 2.8 miles has poor potential because of conflicts with existing switching, yard, and industrial trackage, and 2.4 miles has good potential for fixed guideway development	Proposes use of railroad right-of-way,, about 7 miles of which was found to have fair or poor potential for fixed guideway development	Use of existing trackage would necessitate rehabilitation, plus the possible construction of some new track
Fixed Guideway (miles)				
Total Length	14.3	15.1	15.3	
Exclusive Grade-Separated	4.5	9.2	10.3	
Exclusive At-Grade	0.9	0.9	5.0	
Street/Boulevard Median	7.6	3.7	None	
Mixed Traffic	None	None	None	
Transit Mall	1.3	1.3	None	
Stations				
Number	27	27	8 or more	
Average Spacing (miles)	0.5	0.6	1.9	
Downtown Terminal	Wisconsin Avenue between N. 10th Street and N. Prospect Avenue (transit mall)	Wisconsin Avenue between N. 10th Street and N. Prospect Avenue (transit mall)	N. 5th Street and W. St. Paul Avenue (Amtrak Station)	
Northwest Terminal	N. 76th Street and W. Brown Deer Road (Northridge Shopping Center)	N. 76th Street and W. Brown Deer Road (Northridge Shopping Center)	N. 76th Street near Servite Woods, with possible shuttle to Northridge Shopping Center. Terminal of extension could be N. 107th Street and W. Brown Deer Road (Granville Station)	
Level of Service				
Average Vehicle Speeds	Similar to typical light rail transit operations	Similar to typical light rail transit operations	Faster; similar to typical heavy rail rapid transit operations	Similar to typical commuter rail operations
Accessibility				
Residential	Directly serves high-density area along N. Sherman Boulevard	Alignment in high-density area is generally surrounded by heavy industrial land use, but directly serves some high-density residential area south of W. North Avenue	Similar to Alignment No. 2	
Employment	Directly serves Milwaukee CBD without need for shuttle service	Directly serves industries in N. 33rd Street railway corridor	Directly serves industries in N. 33rd Street railway corridor	

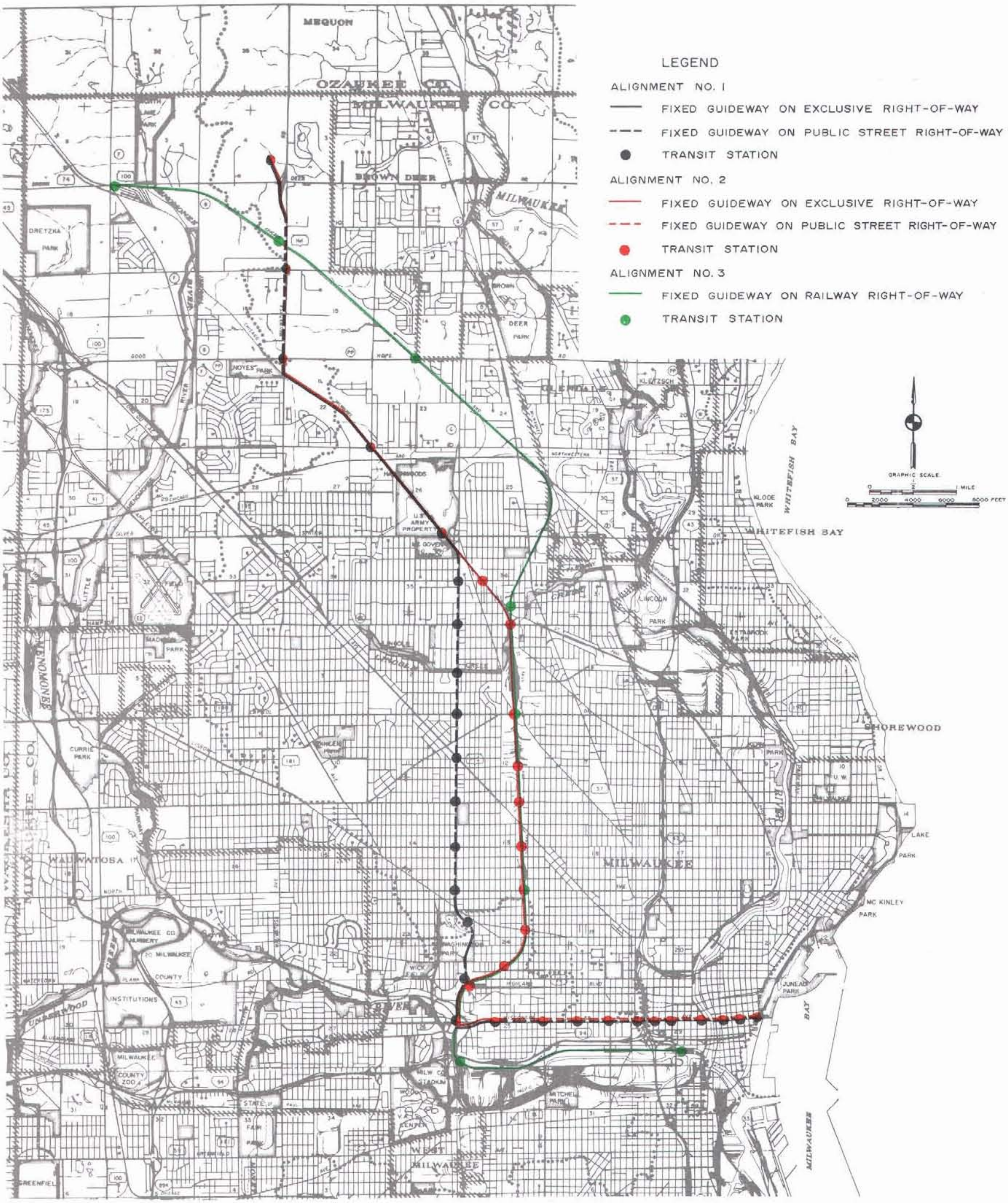
Table 67 (continued)

Characteristic	Alignment No. 1 as Tested and Evaluated in the Study	Alignment No. 2 as Proposed by Milwaukee County Board Supervisor Paul F. Mathews	Alignment No. 3 as Proposed by Congressman Henry S. Reuss	
			Uses Right-of-Way Only	Uses Existing Railway Trackage
Accessibility (continued)				
Other Major Trip Generators	Directly serves Marquette University and Northridge Shopping Center	Directly serves Marquette University and Northridge Shopping Center	Directly serves industries in W. Bradley Road area, and with shuttle would serve Northridge Shopping Center	
Service Area Coverage	Extensive coverage within one-half-mile walking and three-mile driving distances because of frequent station spacing	Extensive coverage within one-half-mile walking and three-mile driving distances because of frequent station spacing	Coverage is limited within one-half-mile walking and three-mile driving distances	
Disruption				
Aesthetic	Fixed guideway would be located on Wisconsin Avenue and in residential area along N. Sherman Boulevard	Fixed guideway in downtown would be located on Wisconsin Avenue; and in densely developed area of Milwaukee's north side, would be located along railroad right-of-way within industrial corridor	Fixed guideway would be located along railroad right-of-way and in predominantly industrial areas	Existing railway tracks would be used for fixed guideway in predominantly industrial areas
Motor Vehicle Traffic	Use of public street rights-of-way would involve extensive traffic engineering measures and some elimination of parking along those streets	About one-half of route would be grade-separated. Use of Wisconsin Avenue and N. 76th Street would involve extensive traffic engineering measures and some elimination of parking along those streets	About two-thirds of route would be grade-separated. Remainder of route would be at-grade on exclusive right-of-way, with possible grade separation of existing street and highway grade crossings	About two-thirds of route would be grade-separated. Remainder of route would be at-grade on exclusive right-of-way, with possible grade separation of existing street and highway grade crossings
Railroad Right-of-Way	All railroad right-of-way to be used is owned by WisDOT	Railroad right-of-way is owned by either *Milwaukee Road* or WisDOT	All railroad right-of-way to be used is privately owned	All railway trackage to be used is privately owned
		Use of N. 33rd Street railway corridor would require rearrangement and relocation of Glendale Yard trackage, industrial lead trackage, sidings, and spur tracks, and grade separations with new industrial leads and existing streets, plus possible relocation of mainline trackage	Use of Milwaukee Road right-of-way between Amtrak Station and Grand Avenue Junction would require either relocation of mainline, siding, and industrial trackage plus new right-of-way acquisition, or acquisition of new right-of-way adjacent to railway line with attendant removal of buildings	Use of existing railway trackage over entire route would require track rehabilitation, and could require construction of new mainline trackage, and possibly rearrangement of existing trackage, in classification yard areas, at junctions, and in industrial areas
		Use of the Wisconsin & Southern Railroad Company right-of-way between North Milwaukee Station and W. Silver Drive may require some property acquisition along with attendant building relocation	Use of N. 33rd Street railway corridor would require rearrangement and relocation of Glendale Yard trackage, industrial lead trackage, sidings, and spur tracks, and grade separations with new industrial leads and existing streets, plus possible relocation of mainline trackage	

Source: SEWRPC.

Map 53

THREE ALTERNATIVE ALIGNMENTS FOR THE RECOMMENDED LIGHT RAIL TRANSIT FACILITY IN THE NORTHWEST CORRIDOR OF MILWAUKEE COUNTY



The lower tier of the final recommended plan for the development of a primary transit system proposes that a single light rail transit facility be constructed in the northwest corridor of the greater Milwaukee area. While it was necessary to select a single preferred alignment for the purpose of testing alternative plans under the first phase of the alternatives analysis—shown as Alignment 1 above—the final selection of the best alignment is the subject of more detailed corridor analysis work. During preliminary engineering and environmental impact analysis, the three alignments shown here would be explicitly considered, along with other possible alternative alignments which may become evident.

Source: SEWRPC.

This bus-on-freeway element would consist of 24 bus-on-freeway routes totaling 1,057 route miles in length and having a total of 55 stations, 50 of which would have park-ride lots.[3] Twenty-one of the 55 stations would be located in Milwaukee County, of which 16 would have park-ride lots. Tables 68 and 69 describe the primary transit stations included under this plan under each of the sets of extreme future conditions considered in this study. Table 70 lists the primary transit routes included under this plan. Under the plan, articulated, high-capacity buses would operate in primary transit service primarily over existing and proposed metered freeways between outlying park-ride lots and the Milwaukee central business district. Bus routes from park-ride lots in Milwaukee County to the central business district would be operated with a limited number of intermediate stops, as necessary, to connect and coordinate with feeder express and local bus service, and to provide access to major travel generators other than the Milwaukee central business district.

Within the Milwaukee central business district, all primary transit motor bus routes, as well as the light rail transit service and some local and express bus service, would be operated over E. and W. Wisconsin Avenue for a distance of between one and two miles. Wisconsin Avenue would be converted to a transit mall for the exclusive use of public transit vehicles between N. 10th Street and N. Prospect Avenue—a distance of about 1.3 miles—and would have stops located about every one-quarter mile.

The Milwaukee area freeways over which the buses in primary transit service would operate would be operationally controlled during peak travel periods, requiring the expansion of the present limited freeway traffic management system serving central Milwaukee County to an areawide system. All freeway on-ramps in the greater Milwaukee area would need to be ramp-metered to constrain automobile and truck access to the freeways during peak travel periods. The ramp meters would need to be operated through a central control system which would continuously measure traffic volumes on those portions of the freeway system needed for transit service through an interconnected series of traffic-sensing devices. As freeway traffic volumes approached the levels beyond which the freeway operating speeds may be expected to deteriorate, fewer automobiles and trucks would be permitted to enter the freeway system. Sufficient constraint would be exercised to ensure uninterrupted freeway traffic flow and operating speeds of at least 40 mph on all freeway segments, including otherwise congested freeway segments. Consequently, average speeds on the bus-on-freeway routes, including all stops, would range between 19 and 35 mph.

This plan also envisions complementary expansion and improvement of the express and local elements of the Milwaukee area transit system. Five express, or limited-stop, routes would be provided in addition to the seven such routes included in the base plan—only three of which were actually in operation in 1980. These 12 express routes would be operated in a coordinated manner with the light rail transit and bus-on-metered freeway primary transit system. Under the plan, the local transit system element in the Milwaukee area would be extended where cost-effective into all contiguous areas of urban development, including such areas in northern and southern Milwaukee County, southern Ozaukee County, southeastern Washington County, and eastern Waukesha County.

For the purpose of alternatives analysis, it was assumed that a flat-fare system would continue to be used within Milwaukee County and that a graduated distance-related fare system would be used for primary transit service provided outside Milwaukee County. Expressed in 1979 dollars, the local, or base, fare for local and express service in Milwaukee County was assumed to be $0.50 per ride, and for primary, or Freeway Flyer, service was assumed to be $0.60 per ride. In 1982 dollars, these fares would be equivalent to $0.85 per ride for local and express service, and $1.00 per ride for primary service. For trips using primary transit services that either originate or terminate outside Milwaukee County, the fares would be based on the distance traveled. For example, one-way fares to downtown Milwaukee from the outer extremities of primary transit service were assumed to be $1.80 from Port Washington, $2.20 from West

[3] *Two of the 24 bus-on-freeway routes—the Stadium South and Cudahy routes—would consist of specialized service, with operation limited to peak periods in the peak direction. In addition, two other routes—the Oconomowoc-via-Delafield route and the East Troy route—would operate as specialized services over the outermost segments.*

Table 68

PRIMARY TRANSIT STATIONS FOR THE LOWER TIER OF THE FINAL RECOMMENDED PRIMARY TRANSIT SYSTEM PLAN UNDER THE MODERATE GROWTH SCENARIO-CENTRALIZED LAND USE PLAN

Station Number	Location		Facilities and Services					Travel Time to Milwaukee CBD (minutes)		Frequency of Service (per hour)							
	Intersection	Civil Division	Status	Shelter	Parking Spaces	Connecting Primary Routes	Connecting Express and Local Routes	Peak	Off Peak	Morning		Midday		Afternoon		Evening	
										In	Out	In	Out	In	Out	In	Out
LIGHT RAIL TRANSIT SERVICE																	
1	Northridge Shopping Center	City of Milwaukee	Proposed	Yes	400	1	5	41	41	11	11	5	5	16	16	3	3
2	N. 76th Street and W. Bradley Road	City of Milwaukee	Proposed	Yes	225	1	3	38	38	11	11	5	5	16	16	3	3
3	N. 76th Street and W. Good Hope Road	City of Milwaukee	Proposed	Yes	--	1	3	35	35	11	11	5	5	16	16	3	3
4	N. 60th Street and W. Mill Road	City of Milwaukee	Proposed	Yes	--	1	2	33	33	11	11	5	5	16	16	3	3
5	N. Sherman Boulevard and W. Silver Spring Drive	City of Milwaukee	Proposed	Yes	370	1	3	30	30	11	11	5	5	16	16	3	3
6	N. Sherman Boulevard and W. Villard Avenue	City of Milwaukee	Proposed	Yes	--	1	3	28	28	11	11	5	5	16	16	3	3
7	N. Sherman Boulevard and W. Hampton Avenue	City of Milwaukee	Proposed	Yes	--	1	2	27	27	11	11	5	5	16	16	3	3
8	N. Sherman Boulevard and W. Congress Street	City of Milwaukee	Proposed	Yes	--	1	2	26	26	11	11	5	5	16	16	3	3
9	N. Sherman Boulevard and W. Capitol Drive	City of Milwaukee	Proposed	Yes	--	1	3	24	24	11	11	5	5	16	16	3	3
10	N. Sherman Boulevard and W. Fond du Lac Avenue	City of Milwaukee	Proposed	Yes	--	1	2	23	23	11	11	5	5	16	16	3	3
11	N. Sherman Boulevard and W. Burleigh Street	City of Milwaukee	Proposed	Yes	--	1	2	21	21	11	11	5	5	16	16	3	3
12	N. Sherman Boulevard and W. Center Street	City of Milwaukee	Proposed	Yes	--	1	2	20	20	11	11	5	5	16	16	3	3
13	N. Sherman Boulevard and W. North Avenue	City of Milwaukee	Proposed	Yes	--	1	3	19	19	11	11	5	5	16	16	3	3
14	N. 40th Street and W. Lisbon Avenue	City of Milwaukee	Proposed	Yes	--	1	2	17	17	11	11	5	5	16	16	3	3
15	W. Highland Boulevard and W. Vliet Street	City of Milwaukee	Proposed	Yes	--	1	3	15	15	11	11	5	5	16	16	3	3
16	N. 44th Street and W. Wisconsin Avenue	City of Milwaukee	Proposed	Yes	--	1	3	14	14	11	11	5	5	16	16	3	3
17	N. 35th Street and W. Wisconsin Avenue	City of Milwaukee	Proposed	Yes	--	1	5	12	12	11	11	5	5	16	16	3	3
18	N. 27th Street and W. Wisconsin Avenue	City of Milwaukee	Proposed	Yes	--	1	6	11	11	11	11	5	5	16	16	3	3
19	N. 21st Street and W. Wisconsin Avenue	City of Milwaukee	Proposed	Yes	--	1	5	9	9	11	11	5	5	16	16	3	3
20	N. 16th Street and W. Wisconsin Avenue	City of Milwaukee	Proposed	Yes	--	1	7	8	8	11	11	5	5	16	16	3	3
21	N. 12th Street and W. Wisconsin Avenue	City of Milwaukee	Proposed	Yes	--	1	8	7	7	11	11	5	5	16	16	3	3
22	N. 9th Street and W. Wisconsin Avenue	City of Milwaukee	Proposed	Yes	--	1	8	6	6	11	11	5	5	16	16	3	3
23	N. 6th Street and W. Wisconsin Avenue	City of Milwaukee	Proposed	Yes	--	23	10	5	5	11	11	5	5	16	16	3	3
24	N. 2nd Street and W. Wisconsin Avenue	City of Milwaukee	Proposed	Yes	--	23	12	3	3	11	11	5	5	16	16	3	3
25	N. Broadway and E. Wisconsin Avenue	City of Milwaukee	Proposed	Yes	--	23	12	2	2	11	11	5	5	16	16	3	3
26	N. Jackson Street and E. Wisconsin Avenue	City of Milwaukee	Proposed	Yes	--	23	9	1	1	11	11	5	5	16	16	3	3
27	N. Prospect Avenue and E. Wisconsin Avenue	City of Milwaukee	Proposed	Yes	--	5	7	--	--	11	11	5	5	16	16	3	3
BUS-ON-FREEWAY SERVICE																	
28	IH 43 and STH 33	Village of Saukville	Proposed	Yes	300	1	--	47	44	2	2	2	2	4	4	1	1
29	IH 43 and CTH Q	Town of Grafton	Proposed	Yes	300	1	1	40	37	2	2	2	2	4	4	1	1
30	S. 1st Avenue and Wisconsin Avenue	Village of Grafton	Proposed	Yes	100	1	1	51	48	3	3	2	2	4	4	1	1
31	IH 43 and CTH C	Town of Grafton	Existing	Yes	150	1	1	37	34	3	3	2	2	4	4	1	1
32	Cedarburg Road and Highland Road	City of Mequon	Existing	Yes	200	1	1	46	43	3	3	2	2	5	5	1	1
33	IH 43 and Mequon Road	City of Mequon	Proposed	Yes	300	1	1	32	29	3	3	2	2	5	5	1	1
34	IH 43 and W. Brown Deer Road	Village of River Hills	Existing	Yes	400	1	2	28	25	7	7	2	2	9	9		
35	IH 43 and W. Silver Spring Drive	Village of Glendale	Existing	Yes	375	4	8	22	19	15	15	8	8	22	22	4	4
36	IH 43 and W. North Avenue	City of Milwaukee	Proposed	Yes	--	4	4	13	12	15	15	8	8	22	22	4	4
37	N. Main Street and W. Washington Street	City of West Bend	Proposed	Yes	80	1	--	83	78	2	2	1	1	2	2	1	1
38	S. Main Street and W. Paradise Drive	City of West Bend	Proposed	Yes	200	1	--	75	70	2	2	1	1	2	2	1	1
39	USH 45 and STH 60	Town of Polk	Proposed	Yes	120	1	--	66	61	2	2	1	1	2	2	1	1

Table 68 (continued)

Station Number	Location: Intersection	Location: Civil Division	Facilities and Services: Status	Shelter	Parking Spaces	Connecting Primary Routes	Connecting Express and Local Routes	Travel Time to Milwaukee CBD (minutes): Peak	Off Peak	Frequency of Service (per hour): Morning In	Morning Out	Midday In	Midday Out	Afternoon In	Afternoon Out	Evening In	Evening Out
40	USH 45 and USH 145	Town of Polk	Proposed	Yes	160	1	- -	57	52	2	2	1	1	2	2	1	1
41	Pilgrim Road and Mequon Road	Village of Germantown	Proposed	Yes	175	1	1	54	52	4	4	2	2	6	6	1	1
42	N. 107th Street and W. Good Hope Road	City of Milwaukee	Proposed	Yes	200	1	2	35	33	4	4	2	2	6	6	1	1
43	N. Calhoun Road and W. Capitol Drive	City of Brookfield	Proposed	Yes	350	1	1	40	35	5	5	2	2	7	7	2	2
44	N. 124th Street and W. Capitol Drive	City of Brookfield	Proposed	Yes	300	1	2	35	30	5	5	2	2	7	7	2	2
45	USH 45 and W. Watertown Plank Road	City of Wauwatosa	Existing	Yes	250	1	1	28	24	2	2	1	1	3	3	1	1
46	S. Main Street and E. Wisconsin Avenue	City of Oconomowoc	Proposed	Yes	100	1	- -	71	67	2	2	1	1	3	3	1	1
47	Lakeland Road and STH 16	Village of Nashotah	Existing	Yes	100	1	- -	63	59	2	2	1	1	3	3	1	1
48	Merton Avenue and STH 16	Village of Hartland	Proposed	Yes	125	1	- -	56	52	2	2	1	1	3	3	1	1
49	Main Street and USH 16	Village of Pewaukee	Proposed	Yes	175	1	1	46	42	2	2	1	1	3	3	1	1
50	E. Summit Avenue and Pabst Road	City of Oconomowoc	Proposed	Yes	25	1	- -	64	- -	1	- -	- -	- -	- -	1	- -	- -
51	Summit Avenue and Delafield Road	Town of Summit	Existing	Yes	85	1	- -	59	- -	1	- -	- -	- -	- -	1	- -	- -
52	STH 83 and IH 94	City of Delafield	Proposed	Yes	50	1	- -	50	- -	1	- -	- -	- -	- -	1	- -	- -
53	Grandview Boulevard and IH 94	City of Waukesha	Proposed	Yes	200	1	1	43	39	3	2	1	1	2	3	1	1
54	N. Barstow Street and W. Main Street	City of Waukesha	Proposed	Yes	80	1	10	44	40	3	3	1	1	3	3	1	1
55	N. Barker Road and W. Blue Mound Road	Town of Brookfield	Existing	Yes	300	1	1	34	30	3	3	1	1	3	3	1	1
56	STH 15 and STH 20	Town of East Troy	Proposed	Yes	50	1	- -	70	- -	1	- -	- -	- -	- -	1	- -	- -
57	STH 83 and STH 15	Town of Mukwonago	Existing	Yes	150	1	- -	65	61	2	2	1	1	4	4	1	1
58	CTH F and STH 15	Town of Vernon	Existing	Yes	100	1	- -	55	51	2	2	1	1	4	4	1	1
59	Racine Avenue and STH 15	City of New Berlin	Existing	Yes	175	1	- -	49	45	2	2	1	1	4	4	1	1
60	S. Moorland Road and STH 15	City of New Berlin	Proposed	Yes	150	1	1	43	39	4	4	2	2	6	6	2	2
61	N. Moorland Road and IH 94	City of Brookfield	Proposed	Yes	200	2	2	30	26	10	8	4	4	10	12	4	4
62	USH 45 and W. National Avenue	City of West Allis	Proposed	Yes	325	1	4	24	20	4	4	12	12	1	1	1	1
63	N. 84th Street and IH 94	City of Milwaukee	Proposed	Yes	375	7	2	22	18	24	22	10	10	29	31	9	9
64	Cemetery Access Road and IH 94	City of Milwaukee	Proposed	Yes	- -	1	- -	20	16	2	2	1	1	3	3	1	1
65	S. 43rd Street and W. Morgan Avenue	City of Milwaukee	Proposed	Yes	75	1	2	31	- -	2	- -	- -	- -	- -	2	- -	- -
66	S. 44th Street and W. National Avenue	Village of West Milwaukee	Proposed	Yes	- -	1	2	20	- -	2	- -	- -	- -	- -	2	- -	- -
67	S. 108th Street and STH 15	City of Greenfield	Existing	Yes	400	1	3	30	27	3	3	2	2	4	4	2	2
68	S. 76th Street and W. Cold Spring Road	City of Greenfield	Proposed	Yes	330	1	1	29	26	4	4	1	1	5	5	1	1
69	W. Loomis Road and W. Rawson Avenue	City of Franklin	Proposed	Yes	250	1	2	37	33	7	7	2	2	10	10	2	2
70	W. Loomis Road and W. Grange Avenue	Village of Greendale	Proposed	Yes	- -	1	1	29	26	7	7	2	2	10	10	2	2
71	S. 27th Street and IH 894	City of Milwaukee	Proposed	Yes	300	1	1	25	22	7	7	2	2	10	10	2	2
72	14th Avenue and 54th Street	City of Kenosha	Existing	Yes	100	1	6	69	66	5	5	4	4	8	8	3	3
73	STH 31 and 52nd Avenue	City of Kenosha	Proposed	Yes	500	1	1	63	60	5	5	4	4	8	8	3	3
74	Memorial Drive and State Street	City of Racine	Proposed	Yes	120	1	8	74	71	5	5	5	5	9	9	3	3
75	STH 31 and STH 20	Town of Mt. Pleasant	Proposed	Yes	525	1	1	52	49	5	5	5	5	9	9	3	3
76	IH 94 and STH 20	Town of Mt. Pleasant	Proposed	Yes	400	1	- -	42	39	5	5	5	5	9	9	3	3
77	IH 94 and Ryan Road	City of Oak Creek	Proposed	Yes	400	1	2	30	27	4	4	2	2	7	7	2	2
78	13th Avenue and E. Rawson Avenue	City of Oak Creek	Proposed	Yes	250	1	2	29	26	4	4	1	1	6	6	1	1
79	IH 94 and W. College Avenue	City of Milwaukee	Existing	Yes	530	3	2	26	23	12	12	7	7	20	20	4	4
80	General Mitchell Field	City of Milwaukee	Proposed	Yes	- -	1	3	24	21	2	2	2	2	2	2	2	2
81	IH 94 and W. Holt Avenue	City of Milwaukee	Existing	Yes	240	1	2	21	20	5	5	2	2	7	7	2	2
82	S. Pennsylvania Avenue and E. Layton Avenue	City of Cudahy	Proposed	Yes	325	1	- -	22	- -	3	- -	- -	- -	- -	5	- -	- -

Source: SEWRPC.

Table 69

PRIMARY TRANSIT STATIONS FOR THE LOWER TIER OF THE FINAL RECOMMENDED PRIMARY TRANSIT SYSTEM PLAN UNDER THE STABLE OR DECLINING GROWTH SCENARIO-DECENTRALIZED LAND USE PLAN

Station Number	Location		Facilities and Services					Travel Time to Milwaukee CBD (minutes)		Frequency of Service (per hour)							
	Intersection	Civil Division	Status	Shelter	Parking Spaces	Connecting Primary Routes	Connecting Express and Local Routes	Peak	Off Peak	Morning In	Morning Out	Midday In	Midday Out	Afternoon In	Afternoon Out	Evening In	Evening Out
LIGHT RAIL TRANSIT SERVICE																	
1	Northridge Shopping Center.	City of Milwaukee	Proposed	Yes	260	1	5	41	41	6	6	2	2	9	9	2	2
2	N. 76th Street and W. Bradley Road	City of Milwaukee	Proposed	Yes	200	1	3	38	38	6	6	2	2	9	9	2	2
3	N. 76th Street and W. Good Hope Road	City of Milwaukee	Proposed	Yes	- -	1	3	35	35	6	6	2	2	9	9	2	2
4	N. 60th Street and W. Mill Road	City of Milwaukee	Proposed	Yes	- -	1	2	33	33	6	6	2	2	9	9	2	2
5	N. Sherman Boulevard and W. Silver Spring Drive	City of Milwaukee	Proposed	Yes	175	1	3	30	30	6	6	2	2	9	9	2	2
6	N. Sherman Boulevard and W. Villard Avenue. .	City of Milwaukee	Proposed	Yes	- -	1	3	28	28	6	6	2	2	9	9	2	2
7	N. Sherman Boulevard and W. Hampton Avenue.	City of Milwaukee	Proposed	Yes	- -	1	2	27	27	6	6	2	2	9	9	2	2
8	N. Sherman Boulevard and W. Congress Street.	City of Milwaukee	Proposed	Yes	- -	1	2	26	26	6	6	2	2	9	9	2	2
9	N. Sherman Boulevard and W. Capitol Drive. . .	City of Milwaukee	Proposed	Yes	- -	1	3	24	24	6	6	2	2	9	9	2	2
10	N. Sherman Boulevard and W. Fond du Lac Avenue.	City of Milwaukee	Proposed	Yes	- -	1	2	23	23	6	6	2	2	9	9	2	2
11	N. Sherman Boulevard and W. Burleigh Street	City of Milwaukee	Proposed	Yes	- -	1	2	21	21	6	6	2	2	9	9	2	2
12	N. Sherman Boulevard and W. Center Street. . .	City of Milwaukee	Proposed	Yes	- -	1	2	20	20	6	6	2	2	9	9	2	2
13	N. Sherman Boulevard and W. North Avenue . .	City of Milwaukee	Proposed	Yes	- -	1	3	19	19	6	6	2	2	9	9	2	2
14	N. 40th Street and W. Lisbon Avenue	City of Milwaukee	Proposed	Yes	- -	1	2	17	17	6	6	2	2	9	9	2	2
15	W. Highland Boulevard and W. Vliet Street . . .	City of Milwaukee	Proposed	Yes	- -	1	3	15	15	6	6	2	2	9	9	2	2
16	N. 44th Street and W. Wisconsin Avenue.	City of Milwaukee	Proposed	Yes	- -	1	3	14	14	6	6	2	2	9	9	2	2
17	N. 35th Street and W. Wisconsin Avenue.	City of Milwaukee	Proposed	Yes	- -	1	5	12	12	6	6	2	2	9	9	2	2
18	N. 27th Street and W. Wisconsin Avenue.	City of Milwaukee	Proposed	Yes	- -	1	6	11	11	6	6	2	2	9	9	2	2
19	N. 21st Street and W. Wisconsin Avenue	City of Milwaukee	Proposed	Yes	- -	1	5	9	9	6	6	2	2	9	9	2	2
20	N. 16th Street and W. Wisconsin Avenue.	City of Milwaukee	Proposed	Yes	- -	1	7	8	8	6	6	2	2	9	9	2	2
21	N. 12th Street and W. Wisconsin Avenue.	City of Milwaukee	Proposed	Yes	- -	1	8	7	7	6	6	2	2	9	9	2	2
22	N. 9th Street and W. Wisconsin Avenue	City of Milwaukee	Proposed	Yes	- -	1	8	6	6	6	6	2	2	9	9	2	2
23	N. 6th Street and W. Wisconsin Avenue	City of Milwaukee	Proposed	Yes	- -	23	10	5	5	6	6	2	2	9	9	2	2
24	N. 2nd Street and W. Wisconsin Avenue	City of Milwaukee	Proposed	Yes	- -	23	12	3	3	6	6	2	2	9	9	2	2
25	N. Broadway and E. Wisconsin Avenue.	City of Milwaukee	Proposed	Yes	- -	23	12	2	2	6	6	2	2	9	9	2	2
26	N. Jackson Street and E. Wisconsin Avenue . . .	City of Milwaukee	Proposed	Yes	- -	23	9	1	1	6	6	2	2	9	9	2	2
27	N. Prospect Avenue and E. Wisconsin Avenue. .	City of Milwaukee	Proposed	Yes	- -	5	7	- -	- -	6	6	2	2	9	9	2	2
BUS-ON-FREEWAY SERVICE																	
28	IH 43 and STH 33	Village of Saukville	Proposed	Yes	30	1	- -	47	- -	2	2	- -	- -	2	2	- -	- -
29	IH 43 and CTH Q.	Town of Grafton	Proposed	Yes	40	1	1	40	- -	2	2	- -	- -	2	2	- -	- -
30	S. 1st Avenue and Wisconsin Avenue.	Village of Grafton	Proposed	Yes	30	1	1	51	- -	2	2	- -	- -	2	2	- -	- -
31	IH 43 and CTH C	Town of Grafton	Existing	Yes	30	1	1	37	- -	2	2	- -	- -	2	2	- -	- -
32	Cedarburg Road and Highland Road	City of Mequon	Existing	Yes	200	1	1	46	- -	2	2	- -	- -	2	2	- -	- -
33	IH 43 and Mequon Road.	City of Mequon	Proposed	Yes	50	1	1	32	- -	2	2	- -	- -	2	2	- -	- -
34	IH 43 and W. Brown Deer Road.	Village of River Hills	Existing	Yes	250	1	2	28	- -	4	4	- -	- -	5	5		
35	IH 43 and W. Silver Spring Drive	Village of Glendale	Existing	Yes	190	4	8	22	- -	10	10	- -	- -	11	11	- -	- -
36	IH 43 and W. North Avenue.	City of Milwaukee	Proposed	Yes	- -	4	4	13	- -	10	10	- -	- -	11	11	- -	- -
37	N. Main Street and W. Washington Street	City of West Bend	Proposed	Yes	20	1	- -	83	- -	2	2	- -	- -	2	2	- -	- -
38	S. Main Street and W. Paradise Drive	City of West Bend	Proposed	Yes	40	1	- -	75	- -	2	2	- -	- -	2	2	- -	- -
39	USH 45 and STH 60	Town of Polk	Proposed	Yes	25	1	- -	66	- -	2	2	- -	- -	2	2	- -	- -
40	USH 45 and USH 145	Town of Polk	Proposed	Yes	25	1	- -	57	- -	2	2	- -	- -	2	2	- -	- -

Table 69 (continued)

Station Number	Location: Intersection	Location: Civil Division	Facilities and Services: Status	Shelter	Parking Spaces	Connecting Primary Routes	Connecting Express and Local Routes	Travel Time to Milwaukee CBD (minutes): Peak	Off Peak	Frequency of Service (per hour): Morning In	Morning Out	Midday In	Midday Out	Afternoon In	Afternoon Out	Evening In	Evening Out
41	Pilgrim Road and Mequon Road	Village of Germantown	Proposed	Yes	45	1	1	54	52	2	2	1	1	2	2	1	1
42	N. 107th Street and W. Good Hope Road	City of Milwaukee	Proposed	Yes	100	1	2	35	33	2	2	1	1	2	2	1	1
43	N. Calhoun Road and W. Capitol Drive	City of Brookfield	Proposed	Yes	100	1	1	40	--	3	3	--	--	3	3	--	--
44	N. 124th Street and W. Capitol Drive	City of Brookfield	Proposed	Yes	125	1	2	35	--	3	3	--	--	3	3	--	--
45	USH 45 and W. Watertown Plank Road	City of Wauwatosa	Existing	Yes	200	1	1	28	--	2	2	--	--	2	2	--	--
46	S. Main Street and E. Wisconsin Avenue	City of Oconomowoc	Proposed	Yes	25	1	--	71	--	2	2	--	--	2	2	--	--
47	Lakeland Road and STH 16	Village of Nashotah	Existing	Yes	25	1	--	63	--	2	2	--	--	2	2	--	--
48	Merton Avenue and STH 16	Village of Hartland	Proposed	Yes	35	1	--	56	--	2	2	--	--	2	2	--	--
49	Main Street and STH 16	Village of Pewaukee	Proposed	Yes	25	1	1	46	--	2	2	--	--	2	2	--	--
50	E. Summit Avenue and Pabst Road	City of Oconomowoc	Proposed	Yes	25	1	--	64	--	1	--	--	--	--	1	--	--
51	Summit Avenue and Delafield Road	Town of Summit	Existing	Yes	85	1	--	59	--	1	--	--	--	--	1	--	--
52	STH 83 and IH 94	City of Delafield	Proposed	Yes	40	1	--	50	--	1	--	--	--	--	1	--	--
53	Grandview Boulevard and IH 94	City of Waukesha	Proposed	Yes	75	1	1	43	--	2	2	--	--	2	2	--	--
54	N. Barstow Street and W. Main Street	City of Waukesha	Proposed	Yes	70	1	10	44	40	2	2	1	1	2	2	1	1
55	N. Barker Road and W. Blue Mound Road	Town of Brookfield	Existing	Yes	250	1	1	34	30	2	2	1	1	2	2	1	1
56	STH 15 and STH 20	Town of East Troy	Proposed	Yes	25	1	--	70	--	1	--	--	--	--	1	--	--
57	STH 83 and STH 15	Town of Mukwonago	Existing	Yes	95	1	--	65	--	2	2	--	--	2	2	--	--
58	CTH F and STH 15	Town of Vernon	Existing	Yes	100	1	--	55	--	2	2	--	--	2	2	--	--
59	Racine Avenue and STH 15	City of New Berlin	Existing	Yes	60	1	--	49	--	2	2	--	--	2	2	--	--
60	S. Moorland Road and STH 15	City of New Berlin	Proposed	Yes	75	1	1	43	39	2	2	1	1	2	2	1	1
61	N. Moorland Road and IH 94	City of Brookfield	Proposed	Yes	45	2	2	30	26	10	8	1	1	10	8	1	1
62	USH 45 and W. National Avenue	City of West Allis	Proposed	Yes	110	1	4	24	--	3	3	--	--	5	5	--	--
63	N. 84th Street and IH 94	City of Milwaukee	Proposed	Yes	175	7	2	22	18	19	17	3	3	17	19	3	3
64	Cemetery Access Road and IH 94	City of Milwaukee	Proposed	Yes	--	1	--	20	--	2	2	--	--	2	2	--	--
65	S. 43rd Street and W. Morgan Avenue	City of Milwaukee	Proposed	Yes	25	1	2	31	--	1	--	--	--	--	1	--	--
66	S. 44th Street and W. National Avenue	Village of West Milwaukee	Proposed	Yes	--	1	2	20	--	1	--	--	--	--	1	--	--
67	S. 108th Street and STH 15	City of Greenfield	Existing	Yes	360	1	3	30	--	2	2	--	--	2	2	--	--
68	S. 76th Street and W. Cold Spring Road	City of Greenfield	Proposed	Yes	200	1	1	29	26	2	2	1	1	3	3	1	1
69	W. Loomis Road and W. Rawson Avenue	City of Franklin	Proposed	Yes	50	1	2	37	--	5	5	--	--	5	5	--	--
70	W. Loomis Road and W. Grange Avenue	Village of Greendale	Proposed	Yes	--	1	1	29	--	5	5	--	--	5	5	--	--
71	S. 27th Street and IH 894	City of Milwaukee	Proposed	Yes	125	1	1	25	--	5	5	--	--	5	5	--	--
72	14th Avenue and 54th Street	City of Kenosha	Existing	Yes	75	1	6	69	66	3	3	2	2	3	3	2	2
73	STH 31 and 52nd Avenue	City of Kenosha	Proposed	Yes	160	1	1	63	60	3	3	2	2	3	3	2	2
74	Memorial Drive and State Street	City of Racine	Proposed	Yes	25	1	8	74	71	3	3	2	2	3	3	2	2
75	STH 31 and STH 20	Town of Mt. Pleasant	Proposed	Yes	100	1	1	52	49	3	3	2	2	3	3	2	2
76	IH 94 and STH 20	Town of Mt. Pleasant	Proposed	Yes	75	1	--	42	39	3	3	2	2	3	3	2	2
77	IH 94 and Ryan Road	City of Oak Creek	Proposed	Yes	40	1	2	30	--	2	2	--	--	2	2	--	--
78	13th Avenue and E. Rawson Avenue	City of Oak Creek	Proposed	Yes	50	1	2	29	--	2	2	--	--	2	2	--	--
79	IH 94 and W. College Avenue	City of Milwaukee	Existing	Yes	530	3	2	26	23	6	6	2	2	7	7	2	2
80	General Mitchell Field	City of Milwaukee	Proposed	Yes	--	1	3	24	21	2	2	2	2	2	2	2	2
81	IH 94 and W. Holt Avenue	City of Milwaukee	Existing	Yes	240	1	2	21	--	4	4	--	--	4	4	--	--
82	S. Pennsylvania Avenue and E. Layton Avenue	City of Cudahy	Proposed	Yes	100	1	--	22	--	1	--	--	--	--	2	--	--

Source: SEWRPC.

Table 70

PRIMARY TRANSIT ROUTES FOR THE LOWER TIER OF THE FINAL RECOMMENDED PRIMARY TRANSIT SYSTEM PLAN

Route	Station Number	Station
Light Rail Transit Service		
Downtown Milwaukee-Northridge Shopping Center	1	Northridge Shopping Center
	2	N. 76th Street and W. Bradley Road
	3	N. 76th Street and W. Good Hope Road
	4	N. 60th Street and W. Mill Road
	5	N. Sherman Boulevard and W. Silver Spring Drive
	6	N. Sherman Boulevard and W. Villard Avenue
	7	N. Sherman Boulevard and W. Hampton Avenue
	8	N. Sherman Boulevard and W. Congress Street
	9	N. Sherman Boulevard and W. Capitol Drive
	10	N. Sherman Boulevard and W. Fond du Lac Avenue
	11	N. Sherman Boulevard and W. Burleigh Street
	12	N. Sherman Boulevard and W. Center Street
	13	N. Sherman Boulevard and W. North Avenue
	14	N. 40th Street and W. Lisbon Avenue
	15	W. Highland Boulevard and W. Vliet Street
	16	N. 44th Street and W. Wisconsin Avenue
	17	N. 35th Street and W. Wisconsin Avenue
	18	N. 27th Street and W. Wisconsin Avenue
	19	N. 21st Street and W. Wisconsin Avenue
	20	N. 16th Street and W. Wisconsin Avenue
	21	N. 12th Street and W. Wisconsin Avenue
	22	N. 9th Street and W. Wisconsin Avenue
	23	N. 6th Street and W. Wisconsin Avenue
	24	N. 2nd Street and W. Wisconsin Avenue
	25	N. Broadway and E. Wisconsin Avenue
	26	N. Jackson Street and E. Wisconsin Avenue
	27	N. Prospect Avenue and E. Wisconsin Avenue
Bus-on-Freeway Service		
1—Port Washington	28	IH 43 and STH 33
	29	IH 43 and CTH Q
	35	IH 43 and W. Silver Spring Drive
	36	IH 43 and W. North Avenue
	24	N. 2nd Street and W. Wisconsin Avenue
2—Cedarburg/Grafton	30	S. 1st Avenue and Wisconsin Avenue
	31	IH 43 and CTH C
	35	IH 43 and W. Silver Spring Drive
	36	IH 43 and W. North Avenue
	24	N. 2nd Street and W. Wisconsin Avenue
3—Mequon	32	Cedarburg Road and Highland Road
	33	IH 43 and Mequon Road
	35	IH 43 and W. Silver Spring Drive
	36	IH 43 and W. North Avenue
	24	N. 2nd Street and W. Wisconsin Avenue
4—River Hills	34	IH 43 and W. Brown Deer Road
	35	IH 43 and W. Silver Spring Drive
	36	IH 43 and W. North Avenue
	24	N. 2nd Street and W. Wisconsin Avenue
5—Wauwatosa	45	USH 45 and W. Watertown Plank Road
	64	Cemetery Access Road and IH 94
	24	N. 2nd Street and W. Wisconsin Avenue

Table 70 (continued)

Bus-on-Freeway Service (continued)		
Route	Station Number	Station
6—West Bend	37	S. Main Street and W. Washington Avenue
	38	S. Main Street and Paradise Avenue
	39	USH 45 and STH 60
	63	N. 84th Street and IH 94
	24	N. 2nd Street and W. Wisconsin Avenue
7—Germantown/Menomonee Falls	41	N. Pilgrim Road and W. Mequon Road
	42	N. 107th Street and W. Good Hope Road
	63	N. 84th Street and IH 94
	24	N. 2nd Street and W. Wisconsin Avenue
8—Brookfield	43	N. Calhoun Road and W. Capitol Drive
	44	N. 124th Street and W. Capitol Drive
	63	N. 84th Street and IH 94
	24	N. 2nd Street and W. Wisconsin Avenue
9—Oconomowoc via Pewaukee	46	S. Main Street and E. Wisconsin Avenue
	47	Lakeland Road and STH 16
	48	Merton Avenue and STH 16
	49	Main Street and STH 16
	61	N. Moorland Road and IH 94
	63	N. 84th Street and IH 94
	24	N. 2nd Street and W. Wisconsin Avenue
10—Waukesha-Grandview Boulevard	53	Grandview Boulevard and IH 94
	61	N. Moorland Road and IH 94
	63	N. 84th Street and IH 94
	24	N. 2nd Street and W. Wisconsin Avenue
10S—Oconomowoc via Delafield	50	E. Summit Avenue and Pabst Road
	51	Summit Avenue and Delafield Road
	52	STH 83 and IH 94
	53	Grandview Boulevard and IH 94
	61	N. Moorland Road and IH 94
	63	N. 84th Street and W. Wisconsin Avenue
	24	N. 2nd Street and W. Wisconsin Avenue
11—Waukesha-Downtown	54	N. Barstow Street and W. Main Street
	55	N. Barker Road and W. Blue Mound Road
	63	N. 84th Street and IH 94
	24	N. 2nd Street and W. Wisconsin Avenue
12—Mukwonago	57	STH 83 and STH 15
	58	CTH F and STH 15
	59	Racine Avenue and STH 15
	60	S. Moorland Road and STH 15
	61	N. Moorland Road and IH 94
	63	N. 84th Street and IH 94
	24	N. 2nd Street and W. Wisconsin Avenue
12S—East Troy	56	STH 20 and STH 15
	57	STH 83 and STH 15
	58	CTH F and STH 15
	59	Racine Avenue and STH 15
	60	S. Moorland Road and STH 15
	61	N. Moorland Road and IH 94
	63	N. 84th Street and IH 94
	24	N. 2nd Street and W. Wisconsin Avenue
13—Hales Corners	67	S. 108th Street and STH 15
	24	N. 2nd Street and W. Wisconsin Avenue

Table 70 (continued)

Bus-on-Freeway Service (continued)		
Route	Station Number	Station
14—Greenfield	68 24	S. 76th Street and W. Cold Spring Road N. 2nd Street and W. Wisconsin Avenue
15—West Allis	62 24	USH 45 and W. National Avenue N. 2nd Street and W. Wisconsin Avenue
16S—Stadium South	65 66 24	S. 43rd Street and W. Morgan Avenue S. 44th Street and W. National Avenue N. 2nd Street and W. Wisconsin Avenue
17—Franklin	69 70 71 24	W. Loomis Road and W. Rawson Avenue W. Loomis Road and W. Grange Avenue S. 27th Street and IH 94 N. 2nd Street and W. Wisconsin Avenue
18—Kenosha	72 73 79 80 24	14th Avenue and 54th Street STH 31 and 52nd Avenue IH 94 and W. College Avenue General Mitchell Field N. 2nd Street and W. Wisconsin Avenue
19—Racine	74 75 76 79 80 24	Memorial Drive and State Street STH 31 and STH 20 IH 94 and STH 20 IH 94 and W. College Avenue General Mitchell Field N. 2nd Street and W. Wisconsin Avenue
20—Oak Creek/Ryan Road	77 24	IH 94 and Ryan Road N. 2nd Street and W. Wisconsin Avenue
21—South Milwaukee	78 24	13th Avenue and E. Rawson Avenue N. 2nd Street and W. Wisconsin Avenue
22—South Side/College Avenue	79 24	IH 94 and W. College Avenue N. 2nd Street and W. Wisconsin Avenue
23—South Side/Holt Avenue	81 24	IH 94 and W. Holt Avenue N. 2nd Street and W. Wisconsin Avenue
24S—Cudahy	82 24	S. Pennsylvania Avenue and E. Layton Avenue N. 2nd Street and W. Wisconsin Avenue

Source: SEWRPC.

Bend, \$2.00 from Oconomowoc, \$2.00 from East Troy, and \$2.00 from Kenosha, all expressed in 1979 dollars. In 1982 dollars, these one-way fares would be equivalent to \$2.60 from Port Washington, \$3.15 from West Bend, and \$2.80 from Oconomowoc, East Troy, and Kenosha.

Also included as part of the lower tier is the option of operating one or more of three commuter rail routes on a trial, or demonstration, basis. Although the analyses indicated that the commuter rail mode could not be expected to be viable as an areawide primary transit system except under the most optimistic of future conditions for public transit need and use in the Milwaukee area, it was found that each of these three routes could be viable as a specialized, weekday-only, peak-period service since at least one-half of the operating and maintenance costs could be expected to be recovered from farebox revenues. The three routes are:

Milwaukee to Grafton, a distance of 23.2 miles; Milwaukee to Oconomowoc, a distance of 32.2 miles; and Milwaukee to Racine and Kenosha, a distance of 33.1 miles. If implemented, operation of these three commuter rail routes would initially be on a temporary demonstration basis. In order to adequately test the public response to such service, it is suggested that the trial period be maintained for a minimum of one year, and that provision be made for proper data collection procedures in order to evaluate the demonstration project.

Performance and Cost of the Lower Tier of the Two-Tier Recommended Plan

The recommended plan envisions substantial improvements in transit service within the greater Milwaukee area over both the existing system and the base system plan.[4] It proposes the expansion of primary transit service within Milwaukee County, and the extension of service to the south to the Cities of Racine and Kenosha; to the southwest to the Villages of Mukwonago and East Troy in Waukesha and Walworth Counties, respectively; to the northwest to the City of West Bend in Washington County; and to the north to the City of Port Washington in Ozaukee County. In addition, the recommended plan would expand primary transit service beyond operation during the weekday peak travel periods to all-day weekday service at maximum headways of 30 minutes in peak travel periods and 60 minutes in off-peak travel periods on most primary transit routes. The plan also recommends an increased level of primary transit service not only through priority for light rail vehicles operating over surface alignments, but also through the development of an operationally controlled freeway system which would provide extensive preferential treatment for transit vehicles using the freeway system.

Under the recommended plan there would be about 1,060 route miles of primary transit service under both the moderate growth scenario-centralized land use plan alternative future, and the stable or declining growth scenario-decentralized land use plan alternative future, as shown in Table 66.[5] Similarly, the number of vehicle miles of primary transit service under the recommended plan would range from about 14,800 under the most pessimistic future for transit use in the Milwaukee area, to about 43,200 under the most optimistic future.

[4] *The base system plan consists of the existing transit system together with planned short-term improvements as adopted by the Milwaukee County Board on September 10, 1980.*

The recommended plan also envisions complementary expansion and improvement of the express and local elements of the Milwaukee area transit system, operating in a coordinated manner with the expanded primary transit system. The local transit system element in the Milwaukee area would be expanded where cost-effective into contiguous areas of urban development, including such areas in northern and southern Milwaukee County and parts of southern Ozaukee County, southeastern Washington County, and eastern Waukesha County. Route miles of express and local service operated would increase to between 1,300 and 1,500 miles under the recommended plan—the lower total under the stable or declining growth scenario-decentralized land use plan alternative future, and the higher total under the moderate growth scenario-centralized land use plan alternative future. Vehicle miles of express and local service operated would increase only under the more optimistic future, and then only to about 87,000 bus miles under the recommended plan.

The cost and performance of the recommended primary transit system plan are summarized in Table 71. This table provides data on capital cost and investment, operating and maintenance cost and deficit, accessibility, level of service, energy consumption, and environmental impacts. Under the range of future conditions considered, the recommended plan was determined to perform better than the base system plan by providing service to more Milwaukee area residents and jobs, providing a higher level of service through faster transit speeds, attracting higher levels of total primary transit ridership, having higher energy efficiencies, and generating less air pollutant emissions. Therefore, the recommended two-tier system plan would represent a substantial improvement over the base system plan.

The level of transit accessibility provided to the Milwaukee central business district was measured by determining the overall travel time, including all

[5] *The light rail transit alignment described and utilized herein represents a preliminary alignment developed for systems planning purposes. During the preliminary engineering phase of plan implementation, this alignment, along with other possible alignments, would be evaluated and compared in detail in order to select the final alignment within the northwest corridor.*

Table 71

SUMMARY OF COST AND PERFORMANCE INFORMATION FOR THE FINAL RECOMMENDED PRIMARY TRANSIT SYSTEM PLAN UNDER THE MODERATE GROWTH SCENARIO-CENTRALIZED LAND USE PLAN AND THE STABLE OR DECLINING GROWTH SCENARIO-DECENTRALIZED LAND USE PLAN

Evaluative Measure	Lower Tier of the Two-Tier System Plan — Alternative Future: Optimistic Scenario—Moderate Growth-Centralized Land Use Plan	Lower Tier of the Two-Tier System Plan — Alternative Future: Pessimistic Scenario—Stable or Declining Growth-Decentralized Land Use Plan
Accessibility		
Average Overall Travel Time of Transit Trips to the Milwaukee Central Business District (minutes)	34	34
Cost		
Total Public Cost to Design Year (capital cost and operating and maintenance cost deficit)	$806,826,900	$623,567,000
Average Annual Total Public Cost	38,420,300	29,693,700
Capital Cost and Investment		
Capital Cost to Design Year	302,497,200	220,945,500
Average Annual Capital Cost	14,404,600	10,521,200
Capital Investment to Design Year	462,515,200	368,907,800
Average Annual Capital Investment	22,024,500	17,567,000
Operating and Maintenance Deficit (net cost)		
Deficit in Design Year	32,444,000	19,540,300
Deficit to Design Year	504,329,700	402,621,500
Average Annual Deficit	24,015,700	19,172,500
Cost-Effectiveness		
Total Public Cost to Design Year per Passenger	0.51	0.54
Capital Cost to Design Year per Passenger	0.19	0.19
Operating Deficit to Design Year per Passenger	0.32	0.35
Total Public Cost to Design Year per Passenger Mile	0.10	0.12
Capital Cost to Design Year per Passenger Mile	0.04	0.04
Operating Deficit to Design Year per Passenger Mile	0.06	0.08
Percent of Operating and Maintenance Cost Met by Farebox Revenue in Design Year		
Total Transit System	61	52
Primary Element	64	47
Energy		
Total Transit System Energy Use to Design Year (million BTU's)	23,211,800	16,576,500
Total Construction Energy Use to Design Year (million BTU's)	2,434,600	1,890,100
Total Transit Operating and Maintenance Energy Use to Design Year (million BTU's)	20,777,200	14,686,400
Total Transit System Energy Use per Passenger Mile Traveled to Design Year (BTU's)	2,830	3,540
Total Transit Passenger Miles per Gallon of Diesel Fuel to Design Year (BTU's)	48.1	39.4
Dependence on Petroleum-Based Fuel	8 percent of transit trips not dependent	8 percent of transit trips not dependent

Table 71 (continued)

Evaluative Measure	Lower Tier of the Two-Tier System Plan — Alternative Future: Optimistic Scenario—Moderate Growth-Centralized Land Use Plan	Lower Tier of the Two-Tier System Plan — Alternative Future: Pessimistic Scenario—Stable or Declining Growth-Decentralized Land Use Plan
Petroleum-Based Fuel Use by Transit to Design Year (gallons of diesel fuel)	124,342,200	112,530,300
Automobile Propulsion Energy Use in Design Year (gallons of gasoline)	395,169,000	332,800,000
Ridership		
Average Weekday Transit Trips in Design Year		
Total Transit System	371,700	176,300
Primary Element	95,200	35,200
Percent of Transit Trips Using Primary Element	26	20
Service Coverage		
Population Served Within a One-Half-Mile Walking Distance of Primary Transit Service	392,200	260,100
Population Served Within a Three-Mile Driving Distance of Primary Transit Service	1,300,000	930,600
Jobs Served Within a One-Half-Mile Walking Distance of Primary Transit Service	309,300	260,200
Level of Service		
Average Speed of Transit Vehicle (mph)		
Primary Element	28	27
Total System	18	17
Average Speed of Passenger Travel on Vehicle (mph)		
Primary Element	32	30
Total System	21	19
Environmental Impacts		
Community Disruption		
Homes, Businesses, or Industries Taken	None	None
Land Required (acres)	123	62
Air Pollutant Emissions—Total Transportation System (Highway and Transit) in design year (tons per year)		
Carbon Monoxide	167,300	163,100
Hydrocarbons	16,900	16,400
Nitrogen Oxides	30,000	29,200
Sulfur Oxides	2,600	2,400
Particulates	4,000	3,900

Source: SEWRPC.

access, wait, and transfer time, for transit trips to the Milwaukee central business district from all parts of the Milwaukee area. The overall travel time for transit trips to the central business district was determined to be about 34 minutes under the recommended plan. Transit speed and accessibility to the central business district would be significantly increased under the recommended plan, as shown on Map 49 in Chapter VI, which shows the overall transit travel time from each part of the Milwaukee area to the central business district through travel time contour lines.

The Milwaukee central business district is the singularly most important trip generator in the Milwaukee area[6] and would, under the range of alternative futures considered, be expected to remain so, accounting for over 6 percent of the approximately 4.4 million trips expected to be made within the Milwaukee area on an average weekday under the moderate growth scenario-centralized land use plan alternative future; and for 5 percent of the approximately 3.6 million trips expected to be made under the stable or declining growth scenario-decentralized land use plan alternative future. It would also be the singularly most important transit trip generator, accounting for about 25 percent of the average weekday transit trips made under the recommended plan. A comparative evaluation of the travel time contour lines shown on Map 49 in Chapter VI against the adopted regional land use plan indicates that the recommended plan would generally support implementation of the adopted regional land use plan through the provision of a good, related accessibility pattern.[7]

The total public cost of the recommended two-tier system plan, including all capital and net operating and maintenance costs, was estimated at $624 million, or about $30 million annually, under the stable or declining growth scenario-decentralized land use plan alternative future, and at about $807 million, or about $38 million annually, under the moderate growth scenario-centralized land use plan alternative future. A higher total public cost would be incurred under the latter future because of the need for more transit vehicles and transit vehicle miles to serve the larger transit demand which may be expected under that future. Capital and operating costs for just the light rail transit element of the lower tier of the recommended plan are summarized in Table 72. The recommended two-tier system plan was estimated to have a capital cost ranging from $221 million, or about $11 million annually, to $302 million, or about $14 million annually. The lowest capital cost was attendant to the most pessimistic future for transit needs and use—the stable or declining growth scenario-decentralized land use plan alternative future—and the highest capital cost was attendant to the most optimistic future for transit needs and use—the moderate growth scenario-centralized land use plan alternative future.

An important element of the total public cost of transit is the public subsidy required for the transit operating and maintenance costs over the plan design period. The subsidy requirement of the recommended plan was estimated to total $504 million over the plan design period, or about $24 million annually, under the moderate growth scenario-centralized land use plan alternative future, and about $403 million over the plan design period, or about $19 million annually, under the stable or declining growth scenario-decentralized land use plan alternative future. Thus, in terms of cost-effectiveness, the average total public cost per passenger trip over the 21-year plan design period for the recommended two-tier system plan would range between $0.51 and $0.54.

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[6] *The University of Wisconsin-Milwaukee campus, located on the City of Milwaukee's east side, is currently the second most important trip generator in the Milwaukee area. There is no reason to believe that this situation will change during the next two decades. Other important trip generators in the Milwaukee area include, among others, the Southridge and Northridge Shopping Centers and the Marquette University campus.*

[7] *The regional land use plan recommends a highly centralized land use development pattern. Population and jobs are proposed to be reconcentrated in central Milwaukee County, and new urban development is proposed to occur principally at medium urban densities along and contiguous to the periphery of existing urban centers (see SEWRPC Planning Report No. 25, A Regional Land Use Plan and a Regional Transportation Plan for Southeastern Wisconsin: 2000, Volume Two, Alternative and Recommended Plans).*

Table 72

CAPITAL AND OPERATING COSTS FOR THE LIGHT RAIL TRANSIT ELEMENT UNDER THE LOWER TIER OF THE FINAL RECOMMENDED PRIMARY TRANSIT SYSTEM PLAN

	Alternative Future	
Cost Category	Moderate Growth-Centralized Land Use Plan (millions of dollars)	Stable or Declining Growth-Decentralized Land Use Plan (millions of dollars)
Capital Investment to Design Year		
Fixed Guideway	$130.1	$130.1
Station Facilities	8.0	6.6
Vehicle Storage and Maintenance	6.1	3.6
Vehicle Acquisition	21.6	12.8
Total	$165.8	$153.1
Capital Cost to Design Year (based on remaining life after 21-year amortization period)	$ 84.5	$ 79.0
Annual Operating Cost	$ 1.6	$ 3.1

Source: SEWRPC.

Including system construction as well as system operation, energy consumption under the recommended two-tier plan would total 23,212 billion British Thermal Units (BTU's) under the moderate growth scenario-centralized land use plan alternative future, and 16,577 billion BTU's under the stable or declining growth scenario-decentralized land use plan alternative future. The recommended plan would require up to 7 percent less petroleum-based motor fuel than the base plan, since under the two-tier plan about 8 percent of the transit trips would be made on electrically propelled vehicles. However, this savings of petroleum-based motor fuel—ranging from 10 million to 20 million gallons over the 21-year plan implementation period—would represent less than a one-tenth of 1 percent savings in petroleum-based motor fuel used on the total transportation system in the Milwaukee area. This is because levels of automobile tripmaking and travel are expected to remain higher than levels of transit tripmaking and travel in the Milwaukee area. Consequently, any savings in petroleum-based motor fuels through use of electrically propelled transit vehicles will be dominated by the petroleum-based fuel used for automobile travel. With respect to the energy efficiency of the recommended two-tier plan, between 2,540 and 2,830 BTU's per passenger mile would be expended under the most pessimistic future and most optimistic future, respectively.

The level of transit ridership perhaps best represents the level of transit service provided by the recommended transit plan, as it indicates the extent to which trips have been attracted to the use of the transit system. Under the recommended two-tier system plan, between 176,300 and 371,700 trips may be expected to be made on public transit in the Milwaukee area on an average weekday in the plan design year. In addition, the two-tier plan would be expected to carry between 0.9 million and 2.5 million passenger miles on an average weekday, depending upon future conditions.

With respect to maximizing the number of jobs and resident population served, the primary transit element of the two-tier plan under the moderate growth scenario-centralized land use plan alternative future would serve about 1.3 million residents within a three-mile driving distance of primary transit service. Under this future, the two-tier plan would provide good accessibility to residents and jobs within walking distance of primary transit stations and stops, estimated at 392,000 residents and 309,000 jobs. Under the stable or declining growth scenario-decentralized land use plan alternative future, the two-tier plan would serve about 931,000 residents within a three-mile driving distance of primary transit service. The two-tier plan would also provide good accessibility to residents and jobs within walking distance of primary transit stations and stops under this future—estimated at 260,000 residents and 260,000 jobs.

With respect to the average speed provided by primary transit services under the two-tier plan, average vehicle speeds are expected to range between 27 and 28 mph. The average vehicle speed on all elements of the plans—primary, express, and local—could be expected to range between 17 and 18 mph. The average speed of passenger travel on the primary transit vehicles was estimated at 30 to 32 mph, while average speeds of passenger travel on vehicles of all service elements was estimated at 19 to 21 mph. Average speeds for passenger travel on vehicles are generally higher than vehicle speeds because passengers are typically concentrated on the transit facilities and services which operate at the highest speeds.

In terms of community disruption, the recommended two-tier system plan would not require the taking of any homes, businesses, or industries. The plan would, however, require the acquisition of right-of-way for the construction of fixed guideways, stations, park-ride lots, and maintenance and storage facilities. Under the most optimistic set of future conditions for transit needs and use in the Milwaukee area, the two-tier system plan would require the acquisition of about 123 acres of land, and under the most pessimistic set of future conditions, about 62 acres.

The levels of highway and transit air pollutant emissions anticipated under the recommended two-tier system plan are also summarized in Table 71. This table shows the level of total transportation system carbon monoxide, hydrocarbon, particulate matter, sulfer oxide, and nitrogen oxide pollutant emissions that would be expected under each of the extreme sets of alternative future conditions.

Description of the Upper Tier

The upper tier of the recommended primary transit system plan is shown on Map 54. No actions would be proposed to implement the upper tier of recommendations other than those required to ensure that the concerned facilities could be developed at some time in the future with a minimum of disruption and at minimal cost, and that any bus-on-freeway facilities and services implemented in the corridors concerned are adaptable to the possible eventual conversion to rail transit operation. Implementation of the upper-tier light rail transit and commuter rail recommendations would occur only following the implementation of light rail transit in the northwest corridor, and following a determination, based on that implementation, of the extent to which the intangible benefits of rail transit, particularly with respect to land development and redevelopment, were being achieved.

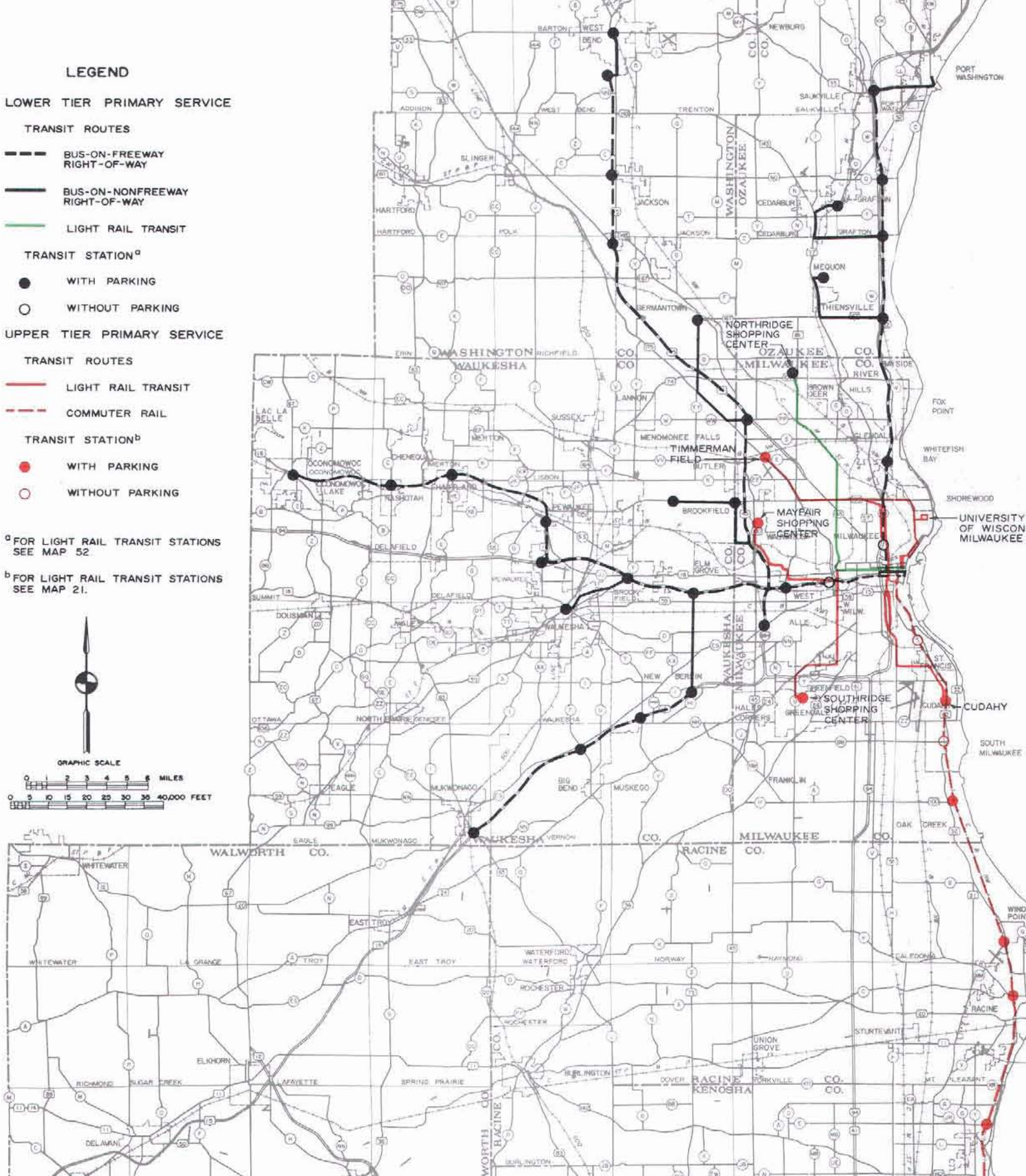
Under the upper tier of the plan, five additional light rail transit routes, or corridors, are planned, along with one commuter rail line. The light rail facilities and services could be located on the routes in five corridors extending from the Milwaukee central business district. One route would extend from the intersection of N. 6th Street and W. Wisconsin Avenue north along N. 6th Street and the one-way pair of N. 7th and N. 8th Streets through Milwaukee's near north side. The route would then proceed in a northwesterly direction along W. Atkinson Avenue, W. Capitol Drive, and W. Appleton Avenue, terminating at Timmerman Field.

A second route would extend from the intersection of N. 6th Street and W. Wisconsin Avenue south across the 6th Street viaduct and the one-way pair of S. 4th and S. 5th Streets. The route would then continue along S. Chase and S. Howell Avenues, turning in an easterly direction following the former Milwaukee Electric Lines Lakeside Belt Line right-of-way to S. Kinnickinnic Avenue. At S. Kinnickinnic Avenue, the route would proceed along the Chicago & North Western Railway right-of-way through the City of Cudahy, terminating at S. Whitnall Avenue.

The third route would, as the initial route, extend from downtown Milwaukee along W. Wisconsin Avenue to N. 44th Street, where it would turn in a southerly direction passing through the Milwaukee County Stadium area. The route would then proceed along the cleared right-of-way of the Stadium Freeway-South extension through the Village of West Milwaukee, continuing south along S. 43rd Street before proceeding southwesterly along the former electric interurban railway Lakeside Belt Line right-of-way, W. Forest Home Avenue, and S. 76th Street, and terminating at the Southridge Shopping Center in the Village of Greendale.

Map 54

UPPER TIER OF THE FINAL RECOMMENDED PRIMARY TRANSIT SYSTEM PLAN



Under the recommended two-tier plan for primary transit system development in the Milwaukee area, only the lower of the two tiers would be recommended for immediate implementation. Under the lower tier of this plan, a system of bus-on-metered freeway facilities and services would be developed except in the northwest corridor of Milwaukee County, within which a light rail facility would be developed. The lower-tier bus-on-freeway facilities and services would be developed so as to permit the ready eventual conversion to light rail operation in up to five additional corridors and to commuter rail operation between the Cities of Milwaukee, Racine, and Kenosha. Implementation of these routes would occur only following the development of the light rail transit line in the northwest corridor and a determination, based on the experience with that line, of the extent to which the intangible benefits of rail transit were being achieved, particularly with respect to the shaping of land development and redevelopment. The five light rail transit routes in the upper tier of the plan could entail an additional 42.2 miles of fixed guideway, all located within Milwaukee County. These facilities could include up to an additional 83 stations, of which 12 would have park-ride lots. The single commuter rail facility in the upper tier of the plan would consist of a route 33.1 miles in length and would have nine stations, seven of which have park-ride lots. Of these nine stations, five would be located within Milwaukee County, three of which would have park-ride lots.

Source: SEWRPC.

Table 73

CAPITAL INVESTMENT REQUIRED FOR IMPLEMENTATION OF THE LIGHT RAIL TRANSIT ELEMENT OF THE FINAL RECOMMENDED PRIMARY TRANSIT SYSTEM PLAN

Cost Category	Alternative Future					
	Moderate Growth-Centralized Land Use Plan			Stable or Declining Growth-Decentralized Land Use Plan		
	Lower-Tier Facilities[a] (millions of dollars)	Upper-Tier Facilities (millions of dollars)	Total (millions of dollars)	Lower-Tier Facilities[a] (millions of dollars)	Upper-Tier Facilities (millions of dollars)	Total (millions of dollars)
Fixed Guideway Development.	$130.1	$321.4	$451.5	$130.1	$321.4	$451.5
Station Facility Development.	8.0	28.5	36.5	6.6	13.1	19.7
Vehicle Storage and Maintenance	6.1	24.6	30.7	3.6	12.2	15.8
Vehicle Acquisition. . .	21.6	76.8	98.4	12.8	34.0	46.8
Total	$165.8	$451.3	$617.1	$153.1	$380.7	$533.8

[a]*Northwest corridor light rail transit facility.*

Source: SEWRPC.

The fourth route would extend from downtown Milwaukee along W. Wisconsin Avenue to S. 44th Street, as the route to the Southridge Shopping Center, would pass Milwaukee County Stadium, and would then continue in a westerly direction along the former electric interurban railway right-of-way as far west as N. Glenview Avenue. The route would then proceed in a northwesterly direction through the Milwaukee County Institutions grounds, terminating at the Mayfair Mall Shopping Center in the City of Wauwatosa.

The fifth route would extend from downtown Milwaukee in a northeasterly direction along the one-way pair of N. Jackson and N. Van Buren Streets, and the one-way pair of N. Prospect and N. Farwell Avenues to the former right-of-way of the Chicago & North Western Railway lakefront main line. The route would follow this former mainline right-of-way north to E. Capitol Drive, turning in a westerly direction on Capitol Drive, where a possible connection could be made with another light rail transit facility proposed under the upper tier in the vicinity of N. 20th Street. The fifth route would also include a spur from the former mainline right-of-way to the University of Wisconsin-Milwaukee campus.

These five light rail transit routes could entail up to an additional 45.8 miles of fixed guideway, of which 43.0 miles, or 90 percent, would be on surface alignments, and 2.8 miles, or 9 percent, would be on elevated structures. All of this additional fixed guideway mileage, except for about 3 miles, or about 6 percent, would be reserved for the exclusive use of public transit vehicles through the provision of an exclusive right-of-way over 17.7 miles of the line, and through the reservation of lanes or median areas of surface streets over 25.2 miles of line. The remaining 2.9 miles would be located in mixed traffic over surface streets. A total of up to 83 stations could be provided along the alignments of these fixed guideways, of which up to 12 could have park-ride lots. Station spacing would be the same as along the facility in the northwest corridor. Average speeds along these five additional corridors would, as in the northwest corridor line, be about 20 mph. Service headways during the peak periods would range from about 5 to 12 minutes, with some service being provided by two-car trains. Headways would range from about 8 to 20 minutes during both the midday and evening off-peak travel periods. Preliminary estimates of capital investment requirements for the upper-tier light rail transit facilities are presented in Table 73.

Commuter rail service from the Milwaukee central business district south to the City of Kenosha would be provided under the upper tier of the plan largely over track owned and operated by the Chicago & North Western Transportation Company. Commuter rail service would be provided to the communities of St. Francis, Cudahy, South Milwaukee, Oak Creek, Racine, and Kenosha. Under the two-tier system plan option, commuter rail service was concluded by the Advisory Committee to be preferable in the long term to bus-on-freeway service in this corridor for two principal reasons. First, the implementation of such service between Milwaukee and Kenosha could—through proper integration with the existing commuter rail service between Kenosha and Chicago—contribute to the development of improved interregional passenger transportation services in the Milwaukee-Chicago intercity corridor. Second, the individual corridor analysis performed for this corridor indicated that the operating cost-effectiveness of this commuter rail route was comparable to the combined operating cost-effectiveness of the bus-on-freeway routes serving this corridor. This consideration, plus the benefits attributable to the intangible advantages of a rail transit facility, was believed to be important enough to recommend commuter rail service under the upper tier of the two-tier system plan option. Upon implementation of such commuter rail service under the upper tier of the recommended plan, or important step prior to actual initiation of service would be preliminary engineering, which would address—among other areas of concern—the necessary railway track rehabilitation and attendant capital cost requirements, the impact that heavy freight trains and unit coal trains could have on the rehabilitated track structure, and schedule coordination between passenger, freight, and switching movements.

A total of nine stops could be made along this 33-mile route. Speeds on the route would average 32 mph, and headways would be every half-hour in the peak direction during the peak periods and every hour otherwise. Trains would consist of a locomotive and between two and five coaches during the peak periods, and a locomotive and between one and three coaches during the off-peak periods. Preliminary estimates of capital investment requirements for the upper-tier commuter rail facilities and equipment are presented in Table 74.

Table 74

CAPITAL INVESTMENT REQUIRED FOR IMPLEMENTATION OF THE COMMUTER RAIL ELEMENT IN THE UPPER TIER OF THE FINAL RECOMMENDED PRIMARY TRANSIT SYSTEM PLAN

Cost Category	Cost (millions of dollars)[a]
Guideway Improvements. .	$ 8.3
Station Facility Development.	5.0
Vehicle Storage and Maintenance	2.8
Vehicle Acquisition[b]	24.8
Total	$40.9

[a] *Costs reflect implementation under the most optimistic future conditions.*

[b] *Includes six diesel-electric locomotives and 30 bi-level gallery coaches.*

Source: SEWRPC.

SUMMARY

This chapter has described the recommended year 2000 primary transit system plan for the greater Milwaukee area as prepared by the Milwaukee Area Primary Transit System Alternatives Analysis Citizens Intergovernmental and Technical Coordinating and Advisory Committee. In this chapter, the recommended primary transit system plan was identified, an explanation was provided as to why this plan was chosen from among the alternatives considered, and the important characteristics of the recommended plan were described. The recommendations included within this plan represent the culmination of nearly three years of intensive effort on the part of the Advisory Committee and the Regional Planning Commission staff, an effort which has concluded with a set of major findings concerning future primary transit system development in the Milwaukee area.

The inventory phase of the alternatives analysis indicated that five public transit modes were potentially applicable to the provision of primary transit service in the Milwaukee area and warranted consideration in the systems analyses. These modes included motor bus on metered freeway, motor bus on busway, light rail transit, heavy rail rapid transit, and commuter rail. The inventories also indicated that there are numerous rights-of-way in the Milwaukee area which have potential for use as the location of primary transit facilities and services, thus offering the possibility of some reduction in implementation costs. Because of the great uncertainties that exist in the Region regarding the primary factors which affect the demand for primary transit service, an "alternative futures" approach was considered to be especially appropriate for this study. Under this approach, alternative primary transit systems are tested and evaluated under a range of future conditions in order to identify systems which may be expected to perform well under a wide range of future conditions in the Milwaukee area.

A number of important conclusions pertaining to the applicability of the various transit technologies in the Milwaukee area were drawn from the design, test, and evaluation phase of the alternatives analysis. Reconfirming the findings of earlier planning efforts in the Region, this phase of the study indicated that heavy rail rapid transit would be inapplicable to the greater Milwaukee area, the travel demand in the most heavily traveled corridors under even the most optimistic future for transit use being insufficient to permit utilization of the high capacities and efficiencies of this mode. As an areawide primary system, commuter rail may be expected to be viable only under the most optimistic future conditions for public transit need and use. This mode may, however, have applicability in special, limited service within certain corridors under the other futures considered. Three primary transit modes, including bus on metered freeway, bus on busway, and light rail transit, could be expected to perform well under a wide range of future conditions, with the only significant difference among these modes being the capital cost requirements. Finally, if consideration is given to the intangible benefits of primary transit system performance, the potential advantages of certain fixed guideway modes could outweigh any capital cost disadvantage.

Based on these findings and conclusions, the Advisory Committee determined that two preliminary recommended primary transit system plan options should be prepared and presented, together with a base—or status quo—plan, at a series of public informational meetings and at a public hearing. The first recommended plan option was a bus-on-freeway plan. The adoption of this plan would represent a continued public commitment to the provision of primary transit service in the Milwaukee area through the bus-on-freeway mode. The second recommended plan option would call for the immediate implementation of a single light rail transit facility in the northwest corridor of the Milwaukee area, as well as the possible future implementation of additional light rail transit and commuter rail facilities and services in other travel corridors of the greater Milwaukee area.

A series of public informational meetings and a public hearing were held on the findings and preliminary recommendations of the alternatives analysis. The record of these meetings and hearing indicated strong support for implementation of the two-tier system plan option, and, conversely, little support for either the base plan or the bus-on-metered freeway system plan option. With respect to the two-tier plan option, strong support was expressed for the proposed light rail transit facility in the northwest corridor, although it was suggested that consideration should be given to other alignments in addition to the preferred alignment presented in the plan. It was also indicated that consideration should be given to extending the light rail transit mode through the lower east side of Milwaukee to the University of Wisconsin-Milwaukee campus. Support was also expressed for the proposed commuter rail service between Milwaukee, Racine, and Kenosha, as well as for commuter rail services in other corridors, including the corridors between the Milwaukee central business district and the City of Oconomowoc. It was also suggested at the public meetings that General Mitchell Field be directly served by primary transit service.

The Advisory Committee met on April 23, 1982, to deliberate on the public reaction to the primary transit system plan options and the base system plan. After considerable discussion and debate, the Committee concluded that the two-tier system plan option should be recommended for adoption as the primary transit system plan for the greater Milwaukee area. Five reasons were cited in support of this determination: 1) the potential intangible benefits attendant to the development of rail transit technology which requires the use of a fixed guideway and permits the use of electrical propulsion over the long-term future; 2) the flexibility inherent in the two-tier plan option with respect to the evolutionary development of rail transit technology in the Milwaukee area, such flexibility being particularly desirable in view of the great uncertainties which exist concerning future conditions affecting transportation system need and use in the greater Milwaukee area; 3) the complexity and importance of the issue of the best means of providing a high level of transportation service in the greater Milwaukee area, and the need to provide ample time and adequate opportunity to fully and properly consider this issue within the area; 4) the need to provide a high level of transportation service in the northwest corridor of Milwaukee County in light of the removal of certain freeway segments from the long-range transportation system plan for the area; and 5) the public support for the two-tier plan option as evident from the testimony provided at the public informational meetings and public hearing.

The Advisory Committee therefore recommended a final primary transit system plan for the greater Milwaukee area which consists essentially of the two-tier plan option as originally presented for public review, but with three modifications. These modifications are: 1) the inclusion of direct bus-on-freeway primary transit service to General Mitchell

Field; 2) the inclusion of an option to operate specialized commuter rail service on an experimental, demonstration basis under the lower tier of the plan, should there exist substantial public interest and demand for such demonstration service; and 3) the inclusion of light rail transit service in the northeast corridor of the Milwaukee area under the upper tier of the plan.

The final recommended primary transit system plan consists of a lower tier and an upper tier. Under the lower tier of the recommended plan, a light rail transit facility would be constructed in the Milwaukee northwest corridor; the existing system of bus-on-freeway routes would be expanded into all other major travel corridors of the Milwaukee area; most primary transit service would be expanded from weekday peak-period service to all-day service at maximum headways of 30 minutes during peak travel periods and 60 minutes during off-peak travel periods; and preferential treatment would be provided for buses operating in primary transit service over a metered freeway system.

Several steps would need to be taken prior to the actual construction and operation of light rail transit service in the northwest corridor. Included in these steps is a detailed corridor analysis, including preliminary engineering and assessment of the environmental and land use development impacts of the several alternative alignments. While the initial phase of the alternatives analysis—the findings and recommendations of which are reported within this planning report—is not intended to result in the final recommendation of a specific alignment, it was necessary to select a preliminary alignment for purposes of testing and evaluation of the primary transit system plan. This preliminary light rail transit line would have a length of about 14.3 miles, and would include a total of 27 stations, 3 of which would have park-ride lots. Headways would range from 4 to 12 minutes during the weekday peak periods, and from 12 to 30 minutes during midday and evening travel periods, with service being provided by trains of one or two articulated light rail vehicles.

The bus-on-freeway facility services under the lower tier of the plan would consist of 24 bus-on-freeway routes totaling 1,057 route miles in length, and having a total of 55 stations, 50 of which would have park-ride lots. Bus-on-freeway primary transit service would be expanded from operation only during the weekday peak travel periods to all-day weekday service at maximum headways of 30 minutes during the peak travel periods and 60 minutes in off-peak travel periods, using articulated, high-capacity motor buses. The Milwaukee area freeways over which motor buses in primary transit service would operate would be operationally controlled during peak travel periods, requiring the expansion of the present limited freeway traffic management system serving central Milwaukee County to an areawide system. This system would restrain automobile and motor truck access to the freeways during peak travel periods at the freeway on-ramps to ensure uninterrupted freeway traffic flow and operating speeds of at least 40 miles per hour (mph) on all freeway segments, including otherwise congested segments. Motor buses would be able to bypass vehicle queues at the on-ramps to immediately take advantage of the high-speed freeway operation.

The recommended plan also envisions complementary expansion and improvement of the express and local elements of the Milwaukee area transit system. In order to accommodate the increased volume of transit vehicles anticipated, it is further proposed that Wisconsin Avenue in downtown Milwaukee be converted to a mall for the exclusive use of motor buses and light rail vehicles between N. 10th Street and N. Prospect Avenue, a distance of 1.3 miles. Finally, the lower tier of the recommended plan includes the option of operating up to three commuter rail routes on a temporary, demonstration basis. Such demonstration service could be considered for the routes between Milwaukee and Grafton, Milwaukee and Oconomowoc, and Milwaukee, Racine, and Kenosha.

The recommended plan provides substantial improvements and increases in transit service over the base system plan in terms of routes, coverage of the Milwaukee area, and overall system speeds. Under the recommended plan, there would be about 1,060 route miles of primary transit service under the full range of future conditions for transit need and use in the area, and route miles of express and local service operated would increase to between 1,300 and 1,500 miles under the recommended plan.

The primary transit element of the two-tier recommended plan under the moderate growth scenario-centralized land use plan alternative future would serve about 1.3 million residents within a three-mile driving distance of primary transit service, along with 392,000 residents and 309,000 jobs within walking distance of primary transit stations and stops. Under the stable or declining growth scenario-decentralized land use plan alternative future, the recommended plan would serve about 931,000 residents within a three-mile driving distance of primary transit service, along with 260,000 residents and 260,000 jobs within walking distance of primary transit stations and stops.

Average vehicle speeds could be expected to range from 27 to 28 mph, and average speeds of passenger travel on primary transit vehicles, from 30 to 32 mph. The average speeds on all elements of the recommended plan could be expected to range from 17 to 18 mph with respect to vehicles, and from 19 to 21 mph with respect to passenger travel.

The level of transit ridership under the recommended plan could be expected to range between 176,300 and 371,700 trips, and between 0.9 and 2.5 million passenger miles per average weekday, depending upon future conditions. The Milwaukee central business district could be expected to remain the most important trip generator in the Milwaukee area, accounting for over 6 percent of the approximately 4.4 million trips expected to be made within the Milwaukee area on an average weekday under the most optimistic future conditions. Downtown Milwaukee could also be expected to remain the singularly most important transit trip generator, accounting for about 25 percent of the average weekday transit trips made under the recommended plan.

The capital cost of the recommended plan would range from about $221 million, or about $11 million annually, to about $302 million, or about $14 million annually, depending upon the alternative future considered. The public subsidy required for operation and maintenance may be expected to total between $504 million, or about $24 million annually, and $403 million, or $19 million annually, depending upon the alternative future considered. The total public cost of the recommended plan, including all capital and net operating and maintenance costs, would therefore range from $624 million, or about $30 million annually, to about $807 million, or about $38 million annually. Higher total public costs would be incurred under the moderate growth scenario-centralized land use plan alternative future because of the need for more transit vehicles and transit vehicle miles of service to meet the higher transit demand under that future. In terms of cost-effectiveness, the average total public cost per passenger trip over the 21-year plan design period for the recommended plan would range between $0.51 and $0.54.

Under the recommended plan, total energy consumption would range from about 16,577 billion British Thermal Units (BTU's) to about 23,212 billion BTU's. Furthermore, under the alternative future most conducive to transit use, the recommended plan would require about 2,830 BTU's per passenger mile, and under the future least conducive to transit use, would require about 2,540 BTU's per passenger mile. The recommended two-tier plan would require up to 7 percent less petroleum-based motor fuel than the base plan, since under the recommended plan about 8 percent of the transit trips would be made on electrically propelled vehicles. However, this savings of motor fuel would represent less than a one-tenth of 1 percent savings in petroleum-based motor fuel used on the total transportation system in the Milwaukee area.

The recommended plan would not require the taking of any homes, businesses, or industries. The plan would, however, require the acquisition of some right-of-way for the construction of fixed guideway stations, park-ride lots, and maintenance and storage facilities.

The total levels of highway and transit air pollutant emissions would be about 2 percent less under the recommended plan than under the base plan, principally because of the decline in automobile travel anticipated under the recommended plan.

The final recommended primary transit system plan represents the unanimous recommendation of the 21-member Advisory Committee, which gave careful individual and collective consideration to the alternatives available and provided thoughtful review of the technical work, and openly considered the public response to the plan options presented at the public informational meetings and public hearing. The recommended plan combines the most attractive features of the many alternative plans considered. It provides for the development of an efficient primary transit system with expanded and improved service, and at the same time recognizes the real, but intangible, benefits of rail transit technology and provides the flexibility needed to exercise the option of implementing rail transit facilities. It was the considered opinion of the Advisory Committee that of the numerous alternative plans evaluated under this study, the final recommended plan provides the best means of proceeding with the provision of public transit service in the greater Milwaukee area in light of the uncertainty regarding future conditions in the area.

Chapter VIII

PLAN IMPLEMENTATION

INTRODUCTION

The recommended primary transit system plan as described in the previous chapter of this report provides a design for the attainment of the primary transit system objectives set forth in Chapter II of this report. The recommended plan consists of a number of elements, including the provision of motor bus primary transit service on the regional freeway system; the provision of light rail transit service in the northwest corridor of Milwaukee County; the possible undertaking of commuter rail demonstration service in up to three corridors emanating from the Milwaukee central business district; the preservation of rights-of-way for possible future rail transit use; the construction of transit stations and park-ride lots; the development of a transit mall in the Milwaukee central business district; the provision of reserved lanes for bus service along selected arterial streets in the Milwaukee area; and the implementation of a comprehensive freeway traffic management system to facilitate the provision of primary transit service on freeways. In a practical sense, however, the recommended primary transit system plan is not complete until the steps required to implement that plan—that is, to convert the plan into action policies and programs—are specified.

This chapter is, therefore, presented as a guide for use in the implementation of the recommended primary transit system plan. Basically, it outlines the actions which must be taken by the various levels and agencies of government concerned if the recommended plan is to be fully carried out over the next 20 years. Those units and agencies of government which have plan adoption and implementation powers applicable to the primary transit system plan are identified; necessary or desirable formal plan adoption, endorsement, and acknowledgement actions are specified; and specific implementation actions are recommended to each of the units and agencies of government and private parties concerned with respect to each of the plan elements. In addition, financial considerations pertaining to implementation of the plan are discussed.

The plan implementation recommendations contained in this chapter are, to the maximum extent practicable, based upon and related to the existing governmental structure and governmental programs, and are predicated upon the existing enabling legislation. However, because of the ever present possibility of changes in economic conditions, state and federal legislation, case law decisions, governmental organization, and tax and fiscal policies, it is not possible to declare once and for all time exactly how a process as complex as transit system plan implementation in the Region should be administered and financed. Under the continuing regional planning program for southeastern Wisconsin, therefore, it will be necessary to update periodically not only the elements of the transit plan and the data and forecasts on which that plan is based, but also the recommendations contained herein for implementation.

BASIC PRINCIPLES AND CONCEPTS

It is important to recognize that plan implementation measures should grow out of adopted plans. Thus, action policies and programs not only should be preceded by formal plan adoption, and, following such adoption, be consistent with the adopted plan, but also should emphasize the most important and essential elements of the plan and those areas of action which will have the greatest impact on guiding and shaping development in accordance with the objectives underlying the recommended plan.

Several particularly significant aspects of transit system plan implementation warrant emphasis here. First, it should be recognized that the recommended primary transit system plan is intended as a guide to primary transit system development in the Southeastern Wisconsin Region over the next two decades and, as such, is advisory to the local, state, and federal units and agencies of government concerned. The plan is intended to help such units and agencies of government in considering transit system and related development proposals. The plan is not to be considered as an inflexible mold to which all future primary transit system development within the Region must conform. Rather, the primary transit system plan is to be regarded as a point of departure against which transit system and related development proposals can be evaluated as they arise and in the light of which better development decisions can be made by all concerned. The primary transit recommendations contained in the plan constitute a refinement and amendment of primary transit decisions previously made by the Commission and documented in the currently adopted regional transportation plan.[1]

Second, the adoption or endorsement of the recommended primary transit system plan as a guide to the sound provision of primary transit services in the Region by the directly affected local units of government and by the state and federal agencies concerned is highly desirable and, in some cases, essential in order to ensure a common understanding of areawide public transit objectives and to permit the necessary plan implementation work to be cooperatively programmed and jointly executed.

Third, plan implementation policies and programs not only should be preceded by plan adoption or endorsement, but should emphasize the most important and essential elements of the plan and those areas of action which will have the greatest impact on guiding and shaping the development of primary transit service in accordance with the recommended plan. Thus, the major emphasis of this plan is on the provision of primary, or rapid, transit service throughout the greater Milwaukee area. The recommended primary transit network will serve the most heavily traveled corridors at the highest speeds, thereby attracting heavy volumes of relatively long trips. Implementation activities should focus on the attainment of the network of primary transit services identified in the plan, including the provision of the necessary station and terminal facilities along the network and, importantly, the attainment of a freeway traffic management system which can facilitate the provision of high-speed motor bus primary transit service in certain corridors.

Although the focus of the plan is on the primary element of the mass transportation system, the secondary, or express, service network and the tertiary, or local, service network are important means of supporting and supplementing the recommended primary transit network. Such services will need to be adjusted and restructured simultaneously with the expansion of the primary transit services in order to provide a logical and effective feeder system to the primary network, as well as to improve the connectivity between primary transit, express, and local service throughout the Milwaukee area.

Fourth, the importance of close coordination and cooperation among the local units of government, the transit agencies, and the various state and federal agencies concerned with respect to plan implementation cannot be over emphasized. As the metropolitan planning organization, the Commission should continue to serve as a center for such coordination. This will become particularly important given the recommendations in the plan to expand the present Milwaukee area primary transit service, which for the most part is confined to Milwaukee and Waukesha Counties, into a system which extends into portions of the remaining five counties in the Region.

Fifth, implementation of the primary transit system plan cannot be brought about by the actions of a single unit or agency of government. Rather, implementation of the plan will be brought about through a series of coordinated development decisions made on a day-to-day basis over a period of many years by many local, state, and federal units and agencies of government. Because urban transit service within the greater Milwaukee area is provided largely in the public domain, it should also be recognized that ultimately it will be the electorate of the area who, acting through their elected officials, will decide at what rate implementation will proceed. The general public will influence the day-to-day development decisions not only by partaking in any public participation process that develops with regard to primary transit plan implementation, but also by making their opinions, views, and concerns known to the various elected officials and public administrators responsible for the governance of the Region. It is important that the individuals and agencies making those decisions be aware of and understand the proposals set forth in the primary transit system plan so that the plan will receive proper consideration in the decision-making process.

[1] *See SEWRPC Planning Report No. 25, A Regional Land Use Plan and a Regional Transportation Plan for Southeastern Wisconsin: 2000, Volume One, Inventory Findings, and Volume Two, Alternative and Recommended Plans.*

Finally, primary transit system plan implementation can be achieved only within the context of a continuing, comprehensive, areawide planning effort through which the inventories and forecasts on which the regional transportation and land use plans are based are updated, monitored, and revised. The plans themselves should be subject to periodic reappraisal and, if necessary, revision to accommodate changing conditions.

PLAN IMPLEMENTATION ORGANIZATIONS

Although the Regional Planning Commission can promote and encourage plan implementation in various ways, the completely advisory role of the Commission makes actual implementation of the recommended primary transit system plan entirely dependent upon action by local, state, and federal units and agencies of government, as well as by certain private concerns. These agencies include general-purpose local units of government, including counties and cities; special agencies created at the local level to carry out transit functions; state agencies, particularly including the Wisconsin Department of Transportation; and federal agencies, particularly including the U. S. Department of Transportation, Urban Mass Transportation Administration and Federal Highway Administration. Because of the number of governmental agencies concerned with transit system development, it becomes important to identify the key agencies having the legal authority and financial capability to most effectively implement the recommended plan.

Accordingly, those agencies whose actions will have a significant effect either directly or indirectly upon the successful implementation of the recommended primary transit system plan, and whose full cooperation in plan implementation will be essential, are listed and discussed below. For convenience, the agencies are discussed by level of government; however, it is important to emphasize the interdependence between the various levels, as well as between agencies of government, and the need for close intergovernmental coordination in plan implementation.

Advisory Committee

The conduct of the Milwaukee area primary transit system alternatives analysis was guided by a 21-member Citizens Intergovernmental and Technical Coordinating and Advisory Committee created by the Regional Planning Commission for that purpose. Upon adoption of the recommended plan by the Regional Planning Commission, this Committee will have completed its work, and can accordingly be dissolved. The Regional Planning Commission itself will be available as needed to perform the continuing areawide comprehensive planning functions necessary for plan implementation as a part of the continuing regional transportation system planning program. To the extent required, participation by the local, state, and federal officials concerned with transportation system development in any comprehensive planning activities related to the implementation of the recommended primary transit system plan can be achieved through the Commission's standing advisory committee structure. In addition, it may be expected that the implementing agencies themselves will carry out, as a normal part of the plan implementation activities, more direct public official and citizen involvement programs in the day-to-day decision-making required for primary transit system development.

Local Level Agencies

While all local units of government in the Region are legally empowered to provide mass transit services, as a practical matter only a relatively few local level agencies become directly involved in the delivery of such services. Of particular importance to the implementation of the Milwaukee area primary transit system plan are certain of the counties and cities in the Region.

County Transit Agencies: Currently in the Southeastern Wisconsin Region, two of the seven counties—Milwaukee and Waukesha—directly provide urban transit services. In Milwaukee County, such services are provided under policy direction by the Milwaukee County Board of Supervisors acting primarily through the Board's Mass Transit Committee and, to a lesser extent, through the Board's Transportation and Public Works Committee, and are administered by the office of the County Executive acting primarily through the County Department of Public Works. All matters of policy relating to the development and operation of the Milwaukee County Transit System are considered by the Mass Transit Committee, the County Board, and the County Executive. The Transportation and Public Works Committee becomes involved with the transit operation primarily with respect to the construction and maintenance of park-ride lots. At the present time, Milwaukee County contracts with Milwaukee Transport Services, Inc. (MTS, Inc.), a private transportation firm operating within the County Department of Public Works, to provide the day-to-day management and operation of the County's public transit system. The President of MTS, Inc., and the Director of Transportation of the Milwaukee County Department of Public Works advise the Mass Transit Committee, the County Board, and the County Executive on all transit-related policy issues. Because they are responsible for the operation of the largest public transit system in the Region, the Mass Transit Committee, the Milwaukee County Board, and the Milwaukee County Executive will probably have the singularly most important responsibilities attendant to implementation of the recommended primary transit system plan.

In Waukesha County, matters relating to the provision of transit service are considered by the Highway and Transportation Committee, which reports directly to the County Board. At the present time, the Waukesha County Highway and Transportation Committee does not directly provide public transit services. Rather, this Committee contracts for such services both with the Milwaukee County Transit System and with Wisconsin Coach Lines—Waukesha, Inc. The Waukesha County Highway and Transportation Committee will also have plan implementation responsibilities with regard to the primary transit system plan.

None of the other five counties in the Region presently provide urban public transit service, although the Ozaukee County Board through its Highway Committee at one time provided commuter bus service to Milwaukee. Should they choose to do so, all remaining five counties could be involved in the provision of transit services in the manner envisioned in the recommended primary transit system plan. In order that the recommended primary transit system plan be implemented, it is recommended that the Ozaukee, Washington, and Walworth County Boards of Supervisors assign urban public transit responsibilities to their respective highway committees and direct those committees to work with Waukesha and Milwaukee Counties in the provision of the primary transit services set forth in the plan at such time as needs and demands may dictate. It should be noted in this respect that both Ozaukee and Washington Counties are already formally designated as recipients of available federal transit operating funds. Accordingly, it will be necessary for Walworth County to be so designated at such time as that county may desire to implement the commuter-oriented specialized service envisioned in the plan to extend from East Troy to Mukwonago.

It is not recommended that the Kenosha and Racine County Boards of Supervisors act to provide urban transit services at the present time. Rather, because the Common Councils of the Cities of Kenosha and Racine already provide such services within their respective urbanized areas, and because those cities are already designated as recipients of available federal transit operating funds,[2] it is recommended that the Cities of Kenosha and Racine assume the additional responsibility of implementing over time, as needs and demands may dictate, the primary transit system plan recommendations that would provide for service between Kenosha, Racine, and Milwaukee.

Local Transit Agencies: Three cities currently provide urban transit service in the Region—Kenosha, Racine, and Waukesha. In Kenosha, the Common Council has created a Transit Commission to oversee the provision of mass transit services. The Director of the City of Kenosha Department of Transportation serves as staff to the Transit and Parking Commission. Mass transit services are provided directly by city employees of the Department of Transportation. In Racine, mass transit services are provided under the direction of the Racine Transit and Parking Commission, created by the Common Council. The Transit Planner in the City's Department of Public Works serves as staff to the Transit and Parking Commission. Actual public transit services in the Racine urbanized area are provided by Taylor Enterprises, Inc., a private transportation firm providing services on a contract basis to the City of Racine.

Transit service in the City of Waukesha is provided under the guidance of the Transit System Utility Board created by the Common Council. The Transit Coordinator in the Department of Public Works serves as staff to the Transit System Utility Board. The actual provision of transit services in the City of Waukesha is provided by Transit Management of Waukesha, Inc., a management firm under a contract with the City.

[2] *The Cities of Racine and Kenosha are designated as recipients of available transit operating funds on an annual basis through the Governor's delegation of that responsibility to the Secretary of the Wisconsin Department of Transportation.*

All three of the city transit agencies in the Region have primary transit system plan implementation responsibilities. As already noted, it is recommended that the Cities of Kenosha and Racine, in addition to providing the basic tertiary level of transit service within the Kenosha and Racine urbanized areas—coordinating such service as necessary with the primary transit system as that system is developed—assume the responsibility of implementing the primary transit elements of the plan that provide for service in the Milwaukee to Racine and Kenosha corridor. It is recommended that the City of Waukesha continue to provide the basic tertiary level transit service while coordinating such service with the primary transit service provided by Waukesha County.

Other Local Agencies: One other local unit of government will be particularly important in terms of implementing the recommended primary transit system plan. The City of Milwaukee, while it does not itself directly provide urban public transit services, has a number of important functions that indirectly support, and relate to, implementation of the primary transit system plan. In particular, the Departments of Public Works and City Development, working through appropriate committees of the Common Council of the City of Milwaukee, as discussed in greater detail below, carry a significant level of responsibility in facilitating the implementation of a number of important elements of the primary transit system plan.

In addition, it is important to recognize that implementation of the recommended primary transit system plan will affect other communities that may be concerned with the final locations of park-ride lots and scheduling of bus-on-freeway services, as well as modifications to existing or new feeder bus routes for these primary services. Accordingly, the Regional Planning Commission, upon adoption of this plan, will formally certify the plan to all municipalities in the expanded transit service area.

This certification will be addressed to the Mayor and Common Council or Village President and Village Board in care of the Municipal Clerk, along with a request that the municipalities concerned act to adopt the recommended plan.

Areawide Agencies

At the present time, there are no areawide agencies providing public transit service in the Southeastern Wisconsin Region. Although not recommended herein, it would be possible to create an areawide agency to provide not only primary but secondary and tertiary public transit services throughout the Region.

Regional Transit Authority: Section 66.94 of the Wisconsin Statutes provides for the creation of a metropolitan transit authority in the Milwaukee area. Such an authority would have the power to acquire, construct, and operate a public transportation system, including the power of eminent domain within a jurisdictional area that would include all of Milwaukee County and such local units of government located in adjacent counties into which and through the transportation system operated by the authority would extend. Such an authority would not have powers of taxation. It would, however, be able to issue revenue bonds. No such authority has to date been created within the Region.

An alternative approach to providing for transit services on an areawide basis would involve use of Section 66.30 of the Wisconsin Statutes. Under this section of the Statutes, counties and municipalities are able to contract with each other to jointly provide, among other facilities and services, transit facilities and services. Under such an approach, a cooperative contract commission would be created and be given powers for the purposes of acquiring, constructing, and operating an areawide public transportation system. A number of such cooperative contract commissions have been created in the Region for other purposes, with particular respect to sanitary sewer and public water supply services. However, no such commission has to date been created for providing transit service within the Region.

While not presently provided for under the Wisconsin Statutes, legislation could be enacted that would permit the creation of a multi-modal areawide transportation authority that would be assigned responsibility not only for areawide transit system development but for the development and operation of other areawide transportation systems within the metropolitan region. Such a multi-modal transportation authority could be made responsible for developing and operating, in addition to an areawide transit system, the airports, seaports, and automobile parking areas and structures within the greater Milwaukee area. The creation of such a multi-modal transportation authority would offer the potential for highly coordinated and effective total transportation system development and operation, and would provide means of cross funding transportation system improvements not now possible. The creation of such an authority was, however, considered by the Advisory Committee to be politically impractical at this time. Only at such time as the importance of such an authority to the sound economic development of the area becomes evident and acceptable will consideration be given to its creation.

Accordingly, it was not intended to provide herein an examination of the advantages and disadvantages of providing transit service through some form of areawide transit authority, either single- or multi-purpose in nature. Rather, as a matter of political practicality, it was recommended that the primary transit system plan be implemented in a cooperative manner by the various counties and cities involved in the provision of transit service. There is reason to believe that such a cooperative approach to the provision of areawide transit services is feasible. At the present time, for example, there is a contract between the Waukesha and Milwaukee County Boards of Supervisors providing for the extension of Milwaukee County transit service to certain portions of Waukesha County. There is no reason to believe that this approach cannot be followed in other areas of the Region and that through such cooperative contract action taken within the overall framework of an advisory plan, the entire primary transit system plan cannot be substantially implemented. Only if such a cooperative approach to plan implementation should fail in any significant way is it recommended that consideration be given to the creation of a single- or multi-purpose transportation authority to provide for implementation of the recommended primary transit system.

Regional Planning Commission: Although the Regional Planning Commission is not a plan implementation agency per se, it warrants discussion herein. While the Commission has no statutory plan implementation powers, it may in its role as coordinating agency for planning and development activities in the Region promote implementation of the primary transit system plan. In addition, the Commission provides a resource to be used in carrying out some of the detailed planning and engineering activities necessary for implementation of some of the plan elements, particularly with respect to the proposed light rail transit service in the northwest corridor of Milwaukee County and the freeway traffic management system. Finally, the Commission provides the basis for the continued functioning of land use and transportation-related advisory committees which may be helpful in providing the continuing comprehensive public planning function needed not only to promote sound primary transit plan implementation but to reappraise and revise as may be necessary the primary transit system plan itself.

State Level Agencies

At the state level, there are two agencies that are particularly important to implementation of the primary transit system plan: the Wisconsin Departments of Transportation and Natural Resources.

Wisconsin Department of Transportation: Responsibility for the planning and development of all modes of transportation in Wisconsin is centered in the Wisconsin Department of Transportation. The Department is authorized to preserve and improve transportation in the State and to provide the State with a highly integrated transportation system. The Department is responsible for administering all state and federal aids for highway improvements; for the planning, design, construction, and maintenance of all state trunk highways; and for planning, laying out, revising, constructing, reconstructing, and maintaining a national system of interstate and defense highways, the federal aid primary system, the federal aid secondary system, and the federal aid urban system, the latter four functions all being subject to federal review and regulation. The Department further administers state and federal aid programs for mass transit, airports, railroads, harbors, and local streets.

The Wisconsin Department of Transportation also has authority to administer urban rail transit system programs within the State, pursuant to Section 85.063(2) of the Wisconsin Statutes. This Statute, enacted in 1979, specifically authorizes the Department to plan, design, and engineer urban rail transit systems for any area that includes a city or village having a population of 50,000 or more, and wherein the provision of rail transit is appropriate, in the judgment of the Department. To date, no state appropriations have been made under this authority.

Wisconsin Department of Natural Resources: As the state agency responsible for ensuring compliance with the requirements of the federal Clean Air Act, the Wisconsin Department of Natural Resources becomes indirectly concerned with mass transit planning and development. The Department is responsible for preparing and submitting to the U. S. Environmental Protection Agency the Wisconsin State Implementation Plan for achieving the federally prescribed air quality standards. An important part of that plan consists of transportation-related maintenance, including in southeastern Wisconsin the development and implementation of mass transit systems.

Federal Level Agencies

The following agencies at the federal level administer programs that can have important effects upon implementation of the primary transit system plan.

U. S. Department of Transportation: Two administrations within the U. S. Department of Transportation—the Federal Highway Administration and the Urban Mass Transportation Administration—represent key agencies for implementation of the primary transit system plan. The Urban Mass Transportation Administration in particular provides capital grants and operating subsidies to local agencies providing urban mass transit. The Federal Highway Administration provides financial support for the development of highways, including support through the federal interstate primary, secondary, and urban systems for the development of arterial highways. Such support can be important in the development of park-ride lots attendant to such highways and in the development of the recommended freeway traffic management system.

U. S. Environmental Protection Agency: The U. S. Environmental Protection Agency administers the federal programs relative to achievement of the objectives sought in the federal Clean Air Act. As such, the U. S. Environmental Protection Agency is interested in, and concerned with, matters relating to the provision of mass transit in southeastern Wisconsin since the regional air quality management plan and the State Implementation Plan identify mass transit as one way in which to help reduce the amount of harmful pollutant emissions that contribute to nonattainment of air quality standards. The U. S. Environmental Protection Agency therefore must review and approve the State Implementation Plan relative to air quality submitted by the Wisconsin Department of Natural Resources.

Private Agencies

The development and implementation of the primary transit system plan also involves a number of private agencies and corporations in southeastern Wisconsin. In particular, it should be noted that Wisconsin Coach Lines, Inc., a private corporation providing suburban and intercity motor bus service in the Region, is directly involved in some of the primary transit service proposals contained in the plan. Wisconsin Coach Lines, Inc., already provides subsidized primary transit service from certain locations in Waukesha County to the Milwaukee central business district through funds provided by Waukesha County. Some of the routes currently being subsidized by Waukesha County represent routes for which franchises historically were held by Wisconsin Coach Lines, Inc. In addition, Wisconsin Coach Lines, Inc., currently provides unsubsidized transit service in the Milwaukee-to-Racine and Kenosha corridor, a factor that will have to be recognized and dealt with at the time that the proposed primary transit service in that corridor is implemented.

The lower tier of the recommended plan allows for the possible operation of demonstration commuter rail service in up to three corridors, while the upper tier of the plan includes commuter rail service in the Milwaukee-Racine-Kenosha corridor. The cooperation of both the Chicago, Milwaukee, St. Paul & Pacific Railroad Company (the Milwaukee Road) and the Chicago & North Western Transportation Company will be required if such commuter rail services are to be demonstrated and operated. It is also possible that the National Railroad Passenger Corporation (Amtrak), the quasi-public passenger rail corporation created by the U. S. Congress, could be involved in the provision of the commuter rail service. Accordingly, each of these private or quasi-public entities should be kept abreast of, and become involved in, matters dealing with implementation of the commuter rail aspects of the recommended plan.

In addition, it should be noted that a number of private agencies and corporations hold land that some day may be needed if the rail transit recommendations contained in either the lower or upper tier of the primary transit plan are to be implemented. Of particular importance in this respect are the Wisconsin Electric Power Company, the Chicago & North Western Transportation Company, and the Chicago, Milwaukee, St. Paul & Pacific Railroad Company. Each of these private concerns owns or controls rights-of-way, portions of which may some day be desired for use in the provision of rail transit service. The State of Wisconsin, although not a private agency or corporation, also owns right-of-way within the City of Milwaukee as a result of acquisition for the purpose of railway freight service preservation. This right-of-way was identified as possibly being useful for the implementation of primary transit fixed guideways. This right-of-way was formerly owned and operated by the Chicago, Milwaukee, St. Paul & Pacific Railroad Company, and is currently operated by the Wisconsin & Southern Railroad Company.

Finally, it is important to note that implementation of the recommended light rail transit facility could, under certain circumstances, be substantially aided by one or more private concerns that may be willing to partially or fully advance the capital required to provide light rail transit service. Recently, a consortium of private concerns submitted a proposal in the Minneapolis-St. Paul (Minnesota) metropolitan area under which the consortium would design and construct a light rail transit line in return for participation in land development and redevelopment along the line. The required return on the private investment involved could come from favorable tax treatment, as well as from land development and redevelopment and revenues derived over the long-term operation of the facility itself.

PLAN ADOPTION AND INTEGRATION

The primary transit system plan set forth in this report is intended to constitute an amendment to and refinement of the regional transportation system plan previously adopted by the Commission in accordance with Section 66.945(10) of the Wisconsin Statutes. Accordingly, the Commission, upon adoption of the primary transit system plan, will transmit a certified copy of the resolution adopting the plan, together with a copy of the report documenting the plan, to all local legislative bodies within the Southeastern Wisconsin Region and to all of the aforenoted local, areawide, state, and federal agencies and private concerns that have significant plan implementation functions.

Adoption, endorsement, or formal acknowledgment of the primary transit system plan by the local legislative bodies and the aforenoted local, areawide, state, and federal level agencies and private parties concerned is highly desirable in order to help ensure a common understanding between the public and private sector and between the several levels of units and agencies of government involved, and to enable the programming of the necessary plan implementation work. Formal plan adoption may also be required to ensure eligibility for state and federal financial aid. It is important to understand that adoption of the recommended primary transit system plan by any unit or agency of government pertains only to the statutory duties and functions of the adopting agencies, and such adoption does not and cannot in any way preempt or commit action by another unit or agency of government acting within its own area of functional and geographical jurisdiction.

Upon adoption, endorsement, or acknowledgment of the primary transit system plan by a unit or agency of government, it is recommended that the policy-making body of the unit or agency of government direct its staff to review in detail the elements of the plan. Once such review is completed, the staff can propose to the policy-making body for its consideration and approval the steps necessary to fully integrate the primary transit system plan elements into the plans and programs of the unit or agency of government.

Local Level Agencies

1. It is recommended that the County Boards of Supervisors of the Counties of Milwaukee, Ozaukee, Walworth, Washington, and Waukesha formally adopt the primary transit system plan by resolution as an amendment to the regional transportation plan pursuant to Section 66.945(12) of the Wisconsin Statutes after review and recommendation by appropriate committees and commissions.

2. It is recommended that the City of Kenosha Transit Commission, the City of Racine Transit and Parking Commission, and the City of Waukesha Transit System Utility Board formally adopt the primary transit system plan by resolution pursuant to Section 66.945 (12) of the Wisconsin Statutes.

3. It is recommended that the Common Councils of the Cities of Kenosha, Milwaukee, Racine, and Waukesha formally adopt the primary transit system plan by resolution pursuant to Section 66.945(12) of the Wisconsin Statutes after review and recommendation by appropriate committees, boards, and commissions.

State Level Agencies

1. It is recommended that the Wisconsin Department of Transportation, acting through its Secretary, endorse the recommended primary transit system plan and integrate the plan element into its broad range of transportation planning and development responsibilities, as well as assist in coordinating plan implementation activities.

2. It is recommended that the Wisconsin Natural Resources Board acknowledge the primary transit system plan as a refinement of and amendment to the regional transportation and regional air quality management plans for southeastern Wisconsin as those plans may impact upon and affect the State Implementation Plan for air quality.

Federal Level Agencies

1. It is recommended that the U. S. Department of Transportation, Urban Mass Transportation Administration, formally acknowledge the primary transit system plan as an amendment to the regional transportation plan, and consider and give due weight to the plan recommendations in the administration and granting of federal aids in transportation system development and operations in the Region.

2. It is recommended that the U. S. Department of Transportation, Federal Highway Administration, formally acknowledge the primary transit system plan as an amendment to the regional transportation plan, and consider and give due weight to the plan recommendations in the administration and granting of federal aids for highway-related construction and management in the Region.

3. It is recommended that the U. S. Environmental Protection Agency formally acknowledge the primary transit system plan as an amendment to the regional transportation and air quality management plans, and consider and give due weight to the recommended plan in the exercise of its air quality management programs.

Subsequent Adjustment of the Plan

No plan can be permanent in all of its aspects or precise in all of its elements. The very definition and characteristics of "regional planning" suggest that a regional plan, to be viable and of use to local, state, and federal units and agencies of government, should be continually adjusted through formal amendments, extensions, additions, and refinements to reflect changing conditions. Indeed, this effort to prepare a primary transit system plan represents an amendment to the regional transportation plan completed in 1978. It may be expected that additional amendments, extensions, and changes to the regional transportation plan will be forthcoming not only from the work of the Commission but from the work of the key implementing agencies. In particular, it is to be expected that implementation activities with respect to the light rail transit element contained in the primary transit system plan will result in a further amendment to the regional transportation plan.

All plan adjustments and refinements will require close cooperation among local, state, and federal agencies, as well as coordination by the Southeastern Wisconsin Regional Planning Commission, which is empowered under Section 66.945(8) of the Wisconsin Statutes to act as a coordinating agency for the programs and activities of its constituent local units of government. To most effectively and efficiently achieve this coordination between local, state, and federal programs, and, therefore, ensure the timely adjustment of the regional plans, it is recommended that the aforenoted agencies having various plan and plan implementation powers transmit all subsequent planning studies, plan proposals, and plan amendments to the Southeastern Wisconsin Regional Planning Commission for consideration for integration into, and adjustment of, the regional plans.

PRIMARY TRANSIT PLAN IMPLEMENTATION

The recommended primary transit system plan consists of the following eight basic elements: bus-on-metered freeway transit service, light rail transit service, commuter rail demonstration service, right-of-way protection and preservation for possible future rail transit use, transit stations and park-ride lots, transit mall, reserved bus lanes on surface arterials, and freeway traffic management. The following discussion identifies the specific plan implementation activities and assignment of transit agency implementation responsibilities attendant to each of these eight elements.

Bus-on-Metered Freeway Transit Service

The recommended plan calls for the operation of 22 bus-on-metered freeway transit routes that could ultimately provide not only peak-period service but also midday and evening off-peak-period service as well. In addition, the plan calls for the operation of four bus-on-metered freeway routes that would provide for peak-period service only. These routes are identified by number and name in Table 75. Also identified in the table are the transit agencies designated to be responsible for implementation of these routes; an indication of the route status in terms of whether it is an existing

Table 75

RECOMMENDED JURISDICTIONAL RESPONSIBILITY FOR IMPLEMENTATION OF BUS-ON-FREEWAY SERVICE BY ROUTE: LOWER TIER OF RECOMMENDED PRIMARY TRANSIT SYSTEM PLAN

Bus-on-Freeway Route		Transit Agency(ies) Responsible for Implementation	Route Status			Implementation Timing[a]		
Number	Name		Existing to be Retained	Existing to be Modified	New	Stage 1	Stage 2	Stage 3
1	Port Washington.	Ozaukee County/ Milwaukee County	--	--	X	--	X	--
2	Cedarburg/Grafton	Ozaukee County/ Milwaukee County	--	--	X	--	--	X
3	Mequon	Ozaukee County/ Milwaukee County	--	--	X	--	--	X
4	River Hills	Milwaukee County	--	X	--	X	--	--
5	Wauwatosa.	Milwaukee County	X	--	--	--	--	X
6	West Bend	Washington County	--	--	X	--	--	X
7	Germantown/Menomonee Falls. . . .	Washington County/ Waukesha County/ Milwaukee County	--	X	--	X	--	--
8	Brookfield	Waukesha County	--	X	--	--	--	X
9	Oconomowoc via Pewaukee	Waukesha County	--	X	--	--	X	--
10	Waukesha-Grandview Boulevard. . . .	Waukesha County	--	--	X	--	X	--
10S	Oconomowoc via Delafield	Waukesha County	--	X	--	X	--	--
11	Waukesha-Downtown.	Waukesha County	--	X	--	X	--	--
12	Mukwonago	Waukesha County	--	X	--	--	--	X
12S	East Troy	Walworth County/ Waukesha County	--	--	X	X	--	--
13	Hales Corners	Milwaukee County	X	--	--	--	--	X
14	Greenfield	Milwaukee County	X	--	--	X	--	--
15	West Allis	Milwaukee County	X	--	--	--	X	--
16S	Stadium South	Milwaukee County	--	--	X	X	--	--
17	Franklin	Milwaukee County	--	--	X	--	--	X
18	Kenosha	City of Kenosha/ Milwaukee County	--	--	X	X	--	--
19	Racine	City of Racine/ Milwaukee County	--	--	X	X	--	--
20	Oak Creek-Ryan Road	Milwaukee County	--	--	X	--	X	--
21	South Milwaukee	Milwaukee County	--	--	X	--	--	X
22	South Side/College Avenue	Milwaukee County	X	--	--	X	--	--
23	South Side/Holt Avenue	Milwaukee County	X	--	--	--	X	--
24S	Cudahy.	Milwaukee County	--	--	X	X	--	--

[a]*With the exception of the four routes designated with the suffix "S" where only peak-period service is envisioned, this column refers only to the timing of the institution of primary transit service beyond peak-period service.*

Source: SEWRPC.

route to be maintained, an existing route to be modified, or a completely new route; and an indication as to the staging of implementation of the route recommendations.

It is recommended that Ozaukee County, acting in cooperation with Milwaukee County, implement Route Numbers 1, 2, and 3 from Port Washington, Cedarburg/Grafton, and Mequon, respectively, to the Milwaukee central business district. All three of these routes would be totally new. It would be feasible to consider initiation of peak-period service on these routes as need and demand may warrant in the early stages of plan implementation. Service beyond peak-period service, however, would be warranted only if it appears that future conditions in the Milwaukee area are progressing toward those considered under this study to be intermediate (Route 1) or optimistic (Routes 2 and 3) with respect to future transit needs and use.

It is recommended that Washington County, acting in cooperation with Waukesha and Milwaukee Counties, implement Route Numbers 6 and 7 from West Bend and Germantown/Menomonee Falls, respectively, to the Milwaukee central business district. The West Bend route would be totally new. The Germantown/Menomonee Falls route would be a modification of a route already provided by Waukesha County. It would be feasible to consider initiation of peak-period service on the West Bend route (Route 6) as need and demand may warrant in the early stages of plan implementation. Service beyond peak-period service can also be considered in the early stages of plan implementation for the Germantown/Menomonee Falls route (Route 7). Service beyond peak-period service for the West Bend route (Route 6), however, should be considered only if it appears that future conditions in the Milwaukee area are progressing toward those considered under this study to be optimistic with respect to future transit needs and use.

It is recommended that Waukesha County, in addition to cooperating with Washington and Milwaukee Counties in implementation of the Germantown/ Menomonee Falls route (Route 7), implement Route Numbers 8, 9, 10, 11, and 12 from Brookfield, Oconomowoc via Pewaukee, Waukesha-Grandview Boulevard, Waukesha-Downtown, and Mukwonago, respectively, to the Milwaukee central business district. Of these five routes, only the Waukesha-Grandview Boulevard route would be new; the remaining four would represent existing routes to be continued and modified as necessary in terms of hours of operation to meet changing conditions. It would be feasible to consider initiation of service beyond peak-period service in the early stages of plan implementation only for the Waukesha-Downtown route (Route 11). Such additional service on the other routes would warrant consideration only if it appeared that future conditions in the Milwaukee area are progressing toward those considered under this study to be intermediate (Routes 9 and 10) or optimistic (Routes 8 and 12) with respect to future transit needs and use. Finally, it is recommended that Waukesha County continue to operate Route 10S, a peak-period-only service from Oconomowoc via Delafield.

It is recommended that Walworth County, acting in cooperation with Waukesha County, implement Route 12S from East Troy to the Milwaukee central business district. This would be an extension of Route 12 operated by Waukesha County to Mukwonago. Consideration could be given to implementing this particular recommendation by Walworth County at any time during the plan implementation period.

It is recommended that the Cities of Kenosha and Racine, acting in cooperation with Milwaukee County, implement Routes 18 and 19 from Kenosha and Racine, respectively, to the Milwaukee central business district. In terms of providing through primary transit service over freeways, both of these routes would be new. Wisconsin Coach Lines, Inc., however, currently operates bus service between Kenosha, Racine, and Milwaukee over nonfreeway routes. Accordingly, it is recommended that the Cities of Kenosha and Racine and Milwaukee County cooperatively examine the relationship between the proposed primary transit service on Routes 18 and 19 and Wisconsin Coach Lines, Inc., to determine how best to proceed with plan implementation. It may be feasible, for example, for Wisconsin Coach Lines, Inc., to reduce or eliminate its service along STH 38 and STH 32 in favor of providing such service over the freeway system as recommended in the plan.

All of the remaining motor bus primary transit routes identified in Table 75—Route 4-River Hills, Route 5-Wauwatosa, Route 13-Hales Corners, Route 14-Greenfield, Route 15-West Allis, Route 16S-Stadium South, Route 17-Franklin, Route 20-Oak Creek-Ryan Road, Route 21-South Milwaukee, Route 22-South Side-College Avenue, Route 23-South Side-Holt Avenue, and Route 24S-Cudahy—are routes that are located totally within Milwaukee County. Accordingly, implementation would be the responsibility of Milwaukee County. Of these routes, only Routes 16S, 17, 20, 21, and 24S are new routes. All of the other routes identified for Milwaukee County currently exist and are to be retained and/or modified as necessary to meet changing needs and demands. It would appear that Routes 4, 14, and 22 hold the greatest potential for service beyond peak-period service during the early stages of plan implementation.

The foregoing recommendations for the operation of bus-on-metered freeway primary transit routes will, in certain cases, require that intergovernmental agreements be executed between two and sometimes three of the transit agencies involved. Such agreements should be negotiated and executed in much the same manner as the purchase-of-service agreement for transit service currently in effect between Waukesha and Milwaukee Counties. In negotiating such agreements, it will be necessary to determine fair and equitable cost-sharing arrangements for each of the routes, including a determination regarding the division of available state and federal funds for capital investment and operating assistance.

In addition to undertaking the foregoing basic plan implementation responsibilities, it is important that each of the transit agencies involved in the operation of motor bus primary transit service take steps to ensure full coordination between any new primary transit service and other public transit services in the Region. In particular, it is recommended that the Cities of Kenosha, Racine, and Waukesha periodically review the local transit services being provided in those Cities to ensure that the routing and timing of such service facilitates transfers to and from primary transit service oriented to the Milwaukee area. Similarly, it is recommended that Ozaukee, Walworth, Washington, and Waukesha Counties and the Cities of Kenosha and Racine take appropriate steps to ensure coordination of any new primary transit with various types of specialized transportation services, including demand-responsive services, that are currently being provided in their respective areas either to special population subgroups, such as the elderly or handicapped, or, in some cases, to the general public, for instance in rural areas. Such coordination will facilitate transfers to and from the primary transit service and thereby enhance the mobility of all residents of the Region.

Light Rail Transit Service

The recommended primary transit system plan proposes the construction and operation of a light rail transit facility in the northwest corridor of the City and County of Milwaukee. The first phase of the primary transit alternatives analysis—the findings and recommendations of which are herein reported—is not intended to result in the recommendation of a specific alignment for such a facility. Rather, it is envisioned that, as discussed below, the selection of such an alignment properly would be the subject of preliminary engineering work to be conducted as the second phase of the alternatives analysis and the first step in plan implementation. It was, however, necessary in conducting the first phase of the alternatives analysis to select a single alignment for the purposes of testing and evaluating the facility. It is proposed that this tested alignment, together with two other specific alignments suggested during and after the public informational meetings and public hearing, be explicitly considered in the preliminary engineering effort, together with any other specific alignments that may become evident as plan implementation proceeds. These three alignments may be described as follows:

1. The alignment tested in the first phase of the study, under which the light rail facility would extend from N. Prospect Avenue in the Milwaukee central business district westerly along W. Wisconsin Avenue to N. 44th Street and then north across the Menomonee River Valley to N. Sherman Boulevard; thence northerly along N. Sherman Boulevard to W. Silver Spring Drive; thence northwesterly along the Wisconsin & Southern Railroad line to N. 76th Street; and thence north on N. 76th Street to the Northridge Shopping Center.

2. An alignment suggested by Milwaukee County Board Supervisor Paul F. Mathews at the public hearing similar in nature to the alternative that was tested and described above, except that it would extend along the N. 33rd Street railroad corridor instead of N. Sherman Boulevard.

3. An alignment offered by Congressman Henry S. Reuss after the public hearing record was closed extending from the Amtrak Station in downtown Milwaukee westerly along the Milwaukee Road right-of-way to County Stadium; thence northerly along the Milwaukee Road right-of-way past the Miller Brewery, Harley-Davidson, Master Lock, Koehring, A. O. Smith, Outboard Marine, Cutler-Hammer, and other industrial establishments to the North Milwaukee railroad station at N. 33rd Street and W. Hampton Avenue; thence northerly along the Milwaukee Road's Fifth Subdivision to the Chicago & North Western's Airline Subdivision right-of-way; and thence northwesterly past Graceland Cemetery, Tripoli Country Club, and Brynwood Country Club, terminating at N. 76th Street near Servite Woods and the Northridge Shopping Center—with a possible extension for about two more miles to Granville Station. Under examination of this alignment, primary transit service alternatives which use either the existing railway trackage or a separate fixed guideway located on the right-of-way would be considered. The above alignments are shown on Map 53 on page 280 of this report.

Proceeding with implemention of this particular plan recommendation will represent the most difficult and challenging aspect of the entire primary transit system plan. The proposed light rail transit facility is located entirely within Milwaukee County and, indeed, within the City of Milwaukee. Consequently, while the implementation of this facility could ultimately have important implications for many local units of government in the greater Milwaukee area should it lead to implementation of the light rail transit system envisioned in the upper tier of the plan, initial responsibilities for plan implementation can be expected to fall primarily upon Milwaukee County and the City of Milwaukee.

Accordingly, it is recommended that responsibility for implementation of the light rail transit element of the lower tier of the recommended plan be assigned directly to Milwaukee County, acting through the Department of Public Works, as the primary agency responsible for the provision of public transit service in Milwaukee County. While Milwaukee County is thus envisioned as the lead agency in this entire matter, the City of Milwaukee, acting through the staffs of the Departments of Public Works and City Development, would have important implementation responsibilities. In addition, it may be expected that the Regional Planning Commission, as the metropolitan planning organization, would provide technical assistance toward implementation of the light rail transit facility. The Wisconsin Department of Transportation will also have to be involved in this aspect of plan implementation, particularly as it affects financing of the necessary engineering studies, of the construction of the fixed guideway and other necessary facilities, and of its ultimate operation.

It is recommended that Milwaukee County proceed to develop the proposed light rail transit facility in the manner envisioned in the federal guidance promulgated by the Urban Mass Transportation Administration.[3] Under this guidance, the following steps would be taken:

1. Concurrence with the findings and recommendations of the initial phase of the primary transit system alternatives analysis for the greater Milwaukee area would be obtained from the Urban Mass Transportation Administration. Approval by the Urban Mass Transportation Administration of the plan set forth in this report should constitute such concurrence. The plan would include, but not be limited to, the three alternative light rail transit alignments set forth above.

2. Milwaukee County should then proceed with what has been herein termed the preliminary engineering phase of the work. In order to meet Urban Mass Transportation Administration guidelines and thereby preserve federal funding possibilities, this portion of the work should result in the preparation of the following two documents:

   a. A draft and, following public hearing, a final environmental impact statement pertaining to both phases of the alternatives analysis leading to the selection of a recommended transit facility or facilities.

   b. A technical report describing the recommended light rail transit facility in terms of its corridor location, length of initial segment, transit technology, horizontal and vertical alignment, grade separation, station location, and aesthetic character. This report should include a reexamination of the route of the proposed light rail facility in the northwest corridor in light of the comments made at the public informational meetings and public hearing on the plan referenced in the preceding chapter of this report. This work effort must also include an in-depth analysis of the potential for light rail transit to induce sound land development and redevelopment within the corridor to be served by the facility. This is a particularly important aspect of the work, for the extent to which a light rail transit facility will be successful, not only performing in the manner envisioned in the plan but accruing the envisioned intangible benefits, will depend in large part on the imaginative development and redevelopment of the land uses along the light rail line. If indeed the light rail facility in the north-

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[3] *See "Major Urban Mass Transportation Investments: Statement of Policy,"* Federal Register, *Volume 41, No. 185, September 22, 1976, pp. 41511-41514, and reproduced in Appendix B of this report.*

west corridor is to become a reality, it must be shown to have a high probability of inducing sound land development and redevelopment along the line. This particular portion of the preliminary engineering effort will require the utmost cooperation between the City of Milwaukee and, in particular, the staffs of the Departments of Public Works and City Development and the County.

After approval of these two documents by Milwaukee County and the federal Urban Mass Transportation Administration, Milwaukee County would be in a position to complete the preliminary engineering work phase as envisioned by the Administration. The preliminary engineering phase must conclude with a showing of a firm commitment of the nonfederal capital funds required for the project, a showing of state and local government consensus on the financing of operating deficits attendant to the facility, and a showing of planning for and financial commitment to any necessary supportive actions as, for example, land use development and redevelopment, that would promote effective utilization of the proposed transit facility.

3. After completion of the preliminary engineering phase as described above, Milwaukee County would be in a position to proceed with the construction of the proposed facility, including final design, engineering, and right-of-way acquisition. Following its completion, the facility would be operated by Milwaukee County as an integral part of the Milwaukee County Transit System.

From the foregoing, it is clear that the preliminary engineering phase of the implementation effort should be a highly coordinated intergovernmental effort. The decision as to whether or not to proceed with preliminary engineering properly rests with the Milwaukee County Board of Supervisors and the Milwaukee County Executive, and while Milwaukee County represents the logical lead agency in the conduct of such engineering, provision must be made to actively involve the other concerned parties in this matter—in particular, the City of Milwaukee.

Milwaukee County could approach the conduct of the preliminary engineering studies in a number of ways, including conducting such studies with its own staff, conducting such studies using consultants, contracting with the Regional Planning Commission and the City of Milwaukee for the conduct of such studies, or some combination of the foregoing. In this respect, it is suggested that consideration be given to a cooperative, intergovernmental approach to the conduct of the preliminary engineering studies, under which certain work would be done by the county staff, certain work by the Commission staff, certain work by the city staffs, and certain work by one or more private consultants.

Regardless of the manner in which Milwaukee County may determine to undertake the preliminary engineering, it is important that the County seek a letter of "no prejudice" from the federal Urban Mass Transportation Administration with respect to the conduct of such studies. Such a waiver is necessary at this time because of the position of the current federal administration that, temporarily, no federal monies are to be used for further engineering, design, or construction of rail transit facilities for new rail systems. The granting of such a waiver would ensure that reimbursement could be sought from the federal government for the costs of conducting any studies and building any facilities should the position of the federal government change and federal monies once again become available for funding new rail transit system studies and facilities.

Perhaps the best way to approach the preliminary engineering and related studies that are needed to begin implementation of the light rail transit facility would be for Milwaukee County to request the Regional Planning Commission, as the metropolitan planning organization with coordinative responsibilities, to prepare a prospectus for the necessary studies. This prospectus would set forth the scope and content of the work required to be undertaken for proper completion of the preliminary engineering, including all of the documentation required under the federal Urban Mass Transportation Administration guidelines noted above. The prospectus would also address the means by which the preliminary engineering and related environmental impact, land use, and land marketability studies could be funded. It is important that agreement on the scope and content of the work be reached in this manner if the letter of "no prejudice" is to be obtained from the Urban Mass Transportation Administration. It is proposed that the preparation of such a prospectus be guided by an ad hoc technical advisory committee that would include representatives from the Urban Mass

Transportation Administration, Federal Highway Administration; Wisconsin Department of Transportation; Milwaukee County; Milwaukee Transport Services, Inc.; and the City of Milwaukee, including both the Department of Public Works and Department of City Development. Because of the funding implications for such studies, particularly given the current federal position, it would also be desirable to include nontechnical elected representatives from Milwaukee County and the State Legislature on the ad hoc committee.

Finally, as noted earlier, the possibility of private investment in light rail transit in the northwest corridor should not be overlooked. Given the recent proposal by a consortium of private concerns in the Minneapolis-St. Paul (Minnesota) metropolitan area, it may be possible to generate private interest in light rail facility design and construction in the Milwaukee area.

Commuter Rail Service

The recommended plan holds open the possibility of operating one or more of three commuter rail routes on a trial, or demonstration, basis. These three routes would emanate from the Milwaukee central business district along the Chicago, Milwaukee, St. Paul & Pacific Railroad Company (Milwaukee Road) trackage to Grafton, a distance of 23.2 miles; along the Milwaukee Road trackage to Oconomowoc, a distance of 32.2 miles; and along a combination of the Milwaukee Road and Chicago & North Western Transportation Company trackage to Racine and Kenosha, a distance of 33.1 miles. The plan envisions that an adequate test of such commuter rail service would require a commitment for at least one year, and that proper surveys would be conducted to help evaluate these demonstration projects. Whether or not such demonstrations would be undertaken would be dependent upon the extent of public interest in and concern for the possible reestablishment of commuter rail service in the Region.

The undertaking of such demonstration efforts would require cooperative efforts on the part of the counties and railroads involved, as well as the possible inclusion of Amtrak, the national quasi-public rail passenger corporation. Accordingly, should sufficient interest develop in evaluating commuter rail service along the Milwaukee-to-Grafton line, it is recommended that Ozaukee County and Milwaukee County cooperatively with the Chicago, Milwaukee, St. Paul & Pacific Railroad Company seek to initiate such a demonstration service. Similarly, should sufficient interest develop concerning commuter rail service to Oconomowoc, it is recommended that Waukesha County and Milwaukee County cooperatively work with the Chicago, Milwaukee, St. Paul & Pacific Railroad Company to conduct such a demonstration. Finally, should sufficient interest be generated for a commuter rail demonstration project to Racine and Kenosha, it is recommended that the Cities of Racine and Kenosha, together with Milwaukee County, cooperatively work with both of the affected railroads in undertaking such a project. If any commuter rail demonstration projects are undertaken, it is recommended that the local transit agencies desiring to undertake the project ask the Regional Planning Commission, as the metropolitan planning organization, to prepare a prospectus for the project outlining the scope and duration of the demonstration effort, the means by which the effort is to be organized and financed, and the criteria by which the project is to be judged a success or failure.

Right-of-Way Protection and Preservation

The upper tier of the recommended plan includes five potential additional light rail transit routes extending from the Milwaukee central business district. Because the plan does not recommend immediate implementation of these additional facilities, it is important that, to the greatest extent possible, the rights-of-way along the preferred alignments for these facilities be protected and preserved. To the extent possible, steps should be taken to ensure that where the land is currently open, it is kept open and that options for future light rail transit service are not unnecessarily and unknowingly foreclosed.

The first of the five routes would extend north and northwest from the intersection of N. 6th Street and W. Wisconsin Avenue north along N. 6th Street and the one-way pair of N. 7th and N. 8th Streets through Milwaukee's near north side. The route would then proceed in a northwesterly direction along W. Atkinson Avenue, W. Capitol Drive, and W. Appleton Avenue, terminating at Timmerman Field. This route would include a total of 11.3 miles of fixed guideway, all of which would lie in current public street rights-of-way. Accordingly, no special efforts need to be taken either by the City of Milwaukee or Milwaukee County other than to be aware of the possible future use of such street rights-of-way along this alignment for light rail transit purposes and to take such possibility into account in matters attendant to future street reconstruction proposals.

The second of the five routes would extend from the intersection of N. 6th Street and W. Wisconsin Avenue south across the 6th Street viaduct and the one-way pair of S. 4th and S. 5th Streets. The route would then continue along S. Chase and S. Howell Avenues, turning in an easterly direction following the former Milwaukee Electric Lines Lakeside Belt Line right-of-way to S. Kinnickinnic Avenue. At S. Kinnickinnic Avenue, the route would proceed along the Chicago & North Western Railway right-of-way through the City of Cudahy, terminating at S. Whitnall Avenue. This route would consist of 10.5 miles of fixed guideway, of which 6.6 miles would be in public streets, 1.8 miles would be on right-of-way currently owned by the Wisconsin Electric Power Company, and the remaining 2.1 miles would be located on or along the Chicago & North Western Railway right-of-way. Since there is no public authority to regulate or oversee the decisions made by private utilities and railroads, it will be necessary to rely on the good will of the Chicago & North Western Transportation Company and the Wisconsin Electric Power Company to hold open the subject rights-of-way for possible future public use.

A third route would extend from a junction with the light rail transit facility proposed in the lower tier of the plan located at N. 44th Street and N. Blue Mound Road through the Milwaukee County Stadium area and along the cleared right-of-way of the Stadium Freeway-South and S. 43rd Street before proceeding southwesterly along the former Milwaukee Electric Lines Lakeside Belt Line right-of-way, W. Forest Home Avenue, and S. 76th Street to a terminal at the Southridge Shopping Center. This route would involve a total of 8.6 miles of fixed guideway. Of this total, only 3.3 miles would be located in current public street rights-of-way, while another 1.2 miles would be located on lands cleared for the Stadium Freeway-South. A total of 0.3 mile of right-of-way would be required through current public parklands, while 1.9 miles of alignment would be located on the right-of-way owned by the Wisconsin Electric Power Company. The remaining 1.9 miles of fixed guideway would be located on lands that are currently privately owned and used for miscellaneous urban purposes. Again, the good will of the Wisconsin Electric Power Company will be required to hold open its right-of-way for possible future public transit purposes. In addition, it is recommended that should construction of that portion of the future right-of-way located on lands cleared for the Stadium Freeway-South proceed, the design take into account the possible construction of a future light rail transit facility. Should construction not proceed with this particular freeway, it is recommended that sufficient land be reserved for possible future public transit use.

The fourth route would extend from the junction with the northwest corridor light rail transit facility included in the upper tier of the plan—and located at the intersection of N. 44th Street and the northerly access road to Milwaukee County Stadium—through the Milwaukee County Stadium area to and along the former electric interurban railway right-of-way as far west as N. Glenview Avenue. The route would then proceed in a northwesterly direction through the Milwaukee County Institutions grounds and terminate at the Mayfair Mall Shopping Center. The total fixed guideway required for this facility approximates 5.8 miles. Of this total, 1.4 miles would be located on public street rights-of-way, 1.6 miles on right-of-way owned by the Wisconsin Electric Power Company, and 2.6 miles on Milwaukee County-owned lands at the County Institutions site. The remaining 0.2 mile would constitute lands privately owned for miscellaneous urban purposes. The good will of the Wisconsin Electric Power Company will be required to hold open its right-of-way in this location for possible future public transit purposes. In addition, it is recommended that in its planning and construction activities on the County Institutions grounds, Milwaukee County take into account the possible need to ultimately provide a right-of-way for a light rail transit facility through those grounds.

A fifth route would extend from downtown Milwaukee in a northeasterly direction along the one-way pair of N. Jackson and N. Van Buren Streets, and the one-way pair of N. Prospect and N. Farwell Avenues, to the former right-of-way of the Chicago & North Western railway lakefront main line—a right-of-way owned by Milwaukee County. The route would follow this former mainline railway right-of-way north to E. Capitol Drive, turning west on Capitol Drive to a connection with another light rail transit facility in the vicinity of N. 20th Street. In addition, a spur would be provided from the former mainline right-of-way to the University of Wisconsin-Milwaukee campus. This entire route would require fixed guideway totaling 9.6 miles, of which 6.8 miles would be located on public street rights-of-way. An additional 2.4 miles would be located on the former mainline railway right-of-way owned by Milwaukee County, while the remaining 0.4 mile would be located along lands previously cleared for the Park Freeway-East. Accordingly, it is recommended that Milwaukee County retain the former railway mainline right-of-way in its entirety for possible use for public transit purposes and that, should the Park Freeway-East not be constructed, consideration be given in the redevelopment planning for the cleared land to preserving a right-of-way for a possible future light rail transit facility, although it would also be possible to accommodate that facility on adjacent public street rights-of-way.

Transit Stations and Park-Ride Lots

In addition to the establishment of 27 transit stations, including 3 park-ride lots, in the proposed northwest corridor light rail transit facility, the recommended plan calls for the establishment of 55 transit stations throughout the Region, of which 50 would include park-ride lots. The number, location, status, and timing of implementation of each of these stations and lots is identified in Table 76, together with the agency designated as being responsible for implementation.

It is recommended that the Wisconsin Department of Transportation (WisDOT) be the agency primarily responsible for implementing this element of the plan. Of the 55 transit stations and park-ride lots identified in the plan, it is proposed that WisDOT be responsible for implementing 47, all of which lie along, or in proximity to, the state trunk highway and connecting street system. It is further recommended that WisDOT utilize federal and state highway funds to the greatest extent possible in the construction of these lots. Of the 47 transit stations and park-ride lots assigned to the Wisconsin Department of Transportation, 6 currently exist and need not be modified, 8 currently exist but may require some modification during the plan implementation period, and 33 represent new facilities. Four of the 14 existing lots are currently operated by Ozaukee, Milwaukee (two lots), and Waukesha Counties, respectively, and are herein proposed to be transferred to the Wisconsin Department of Transportation.

Of the remaining 8 transit stations and park-ride lots, development of 5 would be the responsibility of Milwaukee County. All 5 constitute transit stations without park-ride facilities. Development of the remaining 3 transit stations would be the responsibility of the Cities of Kenosha, Racine, and Waukesha, respectively; these would constitute downtown station facilities in those 3 communities.

Transit Mall

The recommended plan calls for the development of a transit mall in the Milwaukee central business district extending along Wisconsin Avenue from N. 10th Street on the west to N. Prospect Avenue on the east, a distance of 1.3 miles. This facility would serve both motor buses and light rail vehicles, assuming implementation of the light rail transit facility occurs in the northwest corridor in Milwaukee County.

It is recommended that primary responsibility for the development of this downtown transit mall be placed with the City of Milwaukee. Close coordination will be required with Milwaukee County in order to ensure that the mall is designed and built to properly accommodate and meet the needs of the Milwaukee County Transit System. The design of the mall should be an element of the preliminary engineering study for the light rail transit facility discussed earlier in this chapter, and funding for the mall could, although it would not necessarily have to be, be accommodated as part of the construction of the light rail transit facility.

Reserved Bus Lanes

The recommended primary transit system plan includes proposals to establish reserved lanes on surface arterial streets for the exclusive use of transit vehicles. Such recommendations are in addition to the transit mall proposal for Wisconsin Avenue.

The two reserved lane proposals included in the recommended plan are identified in Table 77. These include a reserved lane on Kenwood Boulevard from N. Downer Avenue to N. Oakland Avenue in the westbound direction during peak periods, and a lane on E. and W. Wells Street from N. 10th Street to N. Prospect Avenue which is proposed as a contraflow lane for westbound buses all day. It is recommended that these lanes be constructed by the City of Milwaukee with the cooperation of Milwaukee County.

Freeway Traffic Management

The lower tier of the recommended primary transit system plan includes a recommendation to complete the design, construction, and implementation of a freeway operational control system in the Milwaukee area. This will require the expansion of the present limited freeway traffic management system installed by the Wisconsin Department of Transportation in central Milwaukee County to an

Table 76

RECOMMENDED JURISDICTIONAL RESPONSIBILITY FOR IMPLEMENTATION OF TRANSIT STATIONS/PARK-RIDE LOTS ASSOCIATED WITH BUS-ON-FREEWAY SERVICE: LOWER TIER OF PRIMARY TRANSIT SYSTEM

Transit Station/Park-Ride Lot[a]			Transit Agency Responsible for Implementation	Station Status			Implementation Timing[b]		
	Location								
Number	Intersection	Civil Division		Existing to be Retained	Existing to be Modified	New	Stage 1	Stage 2	Stage 3
28	IH 43 and STH 33	Village of Saukville	WisDOT	--	--	X	--	X	--
29	IH 43 and CTH Q	Town of Grafton	WisDOT	--	--	X	--	X	--
30	S. 1st Avenue and Wisconsin Avenue	Village of Grafton	WisDOT	--	--	X	--	--	X
31	IH 43 and CTH C	Town of Grafton	WisDOT[c]	--	X	--	--	--	X
32	Cedarburg Road and Highland Road	City of Mequon	WisDOT	X	--	--	--	--	X
33	IH 43 and Mequon Road	City of Mequon	WisDOT	--	--	X	--	--	X
34	IH 43 and W. Brown Deer Road	Village of River Hills	WisDOT[d]	X	--	--	--	X	--
35	IH 43 and W. Silver Spring Drive	City of Glendale	WisDOT	--	X	--	--	X	--
36	IH 43 and W. North Avenue	City of Milwaukee	Milwaukee County	--	--	X	--	X	--
37	N. Main Street and W. Washington Street	City of West Bend	WisDOT	--	--	X	--	--	X
38	S. Main Street and W. Paradise Drive	City of West Bend	WisDOT	--	--	X	--	--	X
39	USH 45 and STH 60	Town of Polk	WisDOT	--	--	X	--	--	X
40	USH 45 and STH 145	Village of Polk	WisDOT	--	--	X	--	--	X
41	Pilgrim Road and Mequon Road	Village of Germantown	WisDOT	--	--	X	X	--	--
42	N. 107th Street and W. Good Hope Road	City of Milwaukee	WisDOT	--	--	X	X	--	--
43	N. Calhoun Road and W. Capitol Drive	City of Brookfield	WisDOT	--	--	X	--	--	X
44	N. 124th Street and W. Capitol Drive	City of Brookfield	WisDOT	--	--	X	--	--	X
45	USH 45 and W. Watertown Plank Road	City of Wauwatosa	WisDOT[d]	--	X	--	--	--	X
46	S. Main Street and E. Wisconsin Avenue	City of Oconomowoc	WisDOT	--	--	X	--	X	--
47	Lakeland Road and STH 16	Village of Nashotah	WisDOT	--	X	--	--	X	--
48	Merton Avenue and STH 16	Village of Hartland	WisDOT	--	--	X	--	X	--
49	Main Street and STH 16	Village of Pewaukee	WisDOT	--	--	X	--	X	--
50	E. Summit Avenue and Pabst Road	City of Oconomowoc	WisDOT	--	--	X	X	--	--
51	Summit Avenue and Delafield Road	Town of Summit	WisDOT	X	--	--	X	--	--
52	STH 83 and IH 94	City of Delafield	WisDOT	--	--	X	X	--	--
53	Grandview Boulevard and IH 94	City of Waukesha	WisDOT	--	--	X	--	X	--
54	N. Barstow Street and W. Main Street	City of Waukesha	City of Waukesha	--	X	--	X	--	--
55	N. Barker Road and W. Blue Mound Road	Town of Brookfield	WisDOT	--	X	--	X	--	--
56	STH 15 and STH 20	Town of East Troy	WisDOT	--	--	X	X	--	--
57	STH 83 and STH 15	Town of Mukwonago	WisDOT	--	X	--	--	--	X
58	CTH F and STH 15	Town of Vernon	WisDOT	X	--	--	--	--	X
59	Racine Avenue and STH 15	City of New Berlin	WisDOT[e]	--	X	--	--	--	X
60	S. Moorland Road and STH 15	City of New Berlin	WisDOT	--	--	X	--	--	X
61	N. Moorland Road and IH 94	City of Brookfield	WisDOT	--	--	X	--	X	--
62	USH 45 and W. National Avenue	City of West Allis	WisDOT	--	--	X	--	X	--
63	N. 84th Street and IH 94	City of Milwaukee	WisDOT	--	--	X	X	--	--
64	Cemetery Access Road and IH 94	City of Milwaukee	Milwaukee County	--	--	X	--	--	X
65	S. 43rd Street and W. Morgan Street	City of Milwaukee	WisDOT	--	--	X	X	--	--
66	S. 44th Street and W. National Avenue	City of West Milwaukee	Milwaukee County	--	--	X	X	--	--
67	S. 108th Street and STH 15	City of Greenfield	WisDOT	--	X	--	--	--	X
68	S. 76th Street and W. Cold Spring Drive	City of Greenfield	WisDOT	--	--	X	X	--	--
69	W. Loomis Road and W. Rawson Avenue	City of Franklin	WisDOT	--	--	X	--	--	X
70	W. Loomis Road and W. Grange Avenue	Village of Greendale	Milwaukee County	--	--	X	--	--	X
71	S. 27th Street and IH 894	City of Milwaukee	WisDOT	--	--	X	--	--	X
72	14th Avenue and 54th Street	City of Kenosha	City of Kenosha	--	X	--	X	--	--

Table 76 (continued)

Transit Station/Park-Ride Lot[a]			Transit Agency Responsible for Implementation	Station Status			Implementation Timing[b]		
	Location								
Number	Intersection	Civil Division		Existing to be Retained	Existing to be Modified	New	Stage 1	Stage 2	Stage 3
73	STH 31 and 52nd Street	City of Kenosha	WisDOT	--	--	X	X	--	--
74	Memorial Drive and State Street	City of Racine	City of Racine	--	X	--	X	--	--
75	STH 31 and 12th Street	Town of Mt. Pleasant	WisDOT	--	--	X	X	--	--
76	IH 94 and STH 20	Town of Mt. Pleasant	WisDOT	--	--	X	X	--	--
77	IH 94 and Ryan Road	City of Oak Creek	WisDOT	--	--	X	--	X	--
78	13th Avenue and E. Rawson Avenue . .	City of South Milwaukee	WisDOT	--	--	X	--	--	X
79	IH 94 and W. College Avenue	City of Milwaukee	WisDOT	X	--	--	X	--	--
80	General Mitchell Field	City of Milwaukee	Milwaukee County	--	--	X	X	--	--
81	IH 94 and W. Holt Avenue.	City of Milwaukee	WisDOT	X	--	--	--	X	--
82	E. Layton Avenue and S. Pennsylvania Avenue.	City of Cudahy	WisDOT	--	--	X	X	--	--

[a]*The transit stations and park-ride lots identified in this table represent those facilities necessary to serve the primary transit routes recommended in the lower tier of the primary transit plan. It should be noted that at the present time Milwaukee County and WisDOT are in the process of developing two additional park-ride lots: one along W. Appleton Avenue at Timmerman Field and one along S. Lake Drive at E. Lunham Avenue in the City of Cudahy. If the light rail transit facility recommended in the plan is implemented, primary transit service to the Timmerman Field lot would be discontinued; the lot, however, would still be served by express transit. In addition, the Timmerman Field lot would be used for primary transit service again should the additional light rail transit facilities set forth in the upper tier of the plan ever be constructed. The E. Lunham Avenue lot is considered in the plan to be an interim facility to be discontinued at such time as the proposed lake arterial highway is constructed along with a new park-ride lot near the intersection of E. Layton Avenue and S. Pennsylvania Avenue.*

[b]*This column refers only to the timing of the provision of the total parking capacity envisioned in the plan at each site, that capacity required to support primary transit service beyond peak-period service. It will be necessary to provide at least a portion of the parking capacity at each site at the time of institution of peak-period service.*

[c]*This station is currently operated by Ozaukee County and is proposed to be transferred to WisDOT.*

[d]*This station is currently operated by Milwaukee County and is proposed to be transferred to WisDOT.*

[e]*This station is currently operated by Waukesha County and is proposed to be transferred to WisDOT.*

Source: SEWRPC.

Table 77

RECOMMENDED RESERVED LANES FOR EXCLUSIVE USE OF TRANSIT VEHICLES ON STANDARD ARTERIAL STREETS IN THE MILWAUKEE AREA: LOWER TIER OF PRIMARY TRANSIT SYSTEM PLAN

Arterial Street			Exclusive Transit Lane			Remarks
	Limits					
Name	From	To	Type	Direction	Duration	
Kenwood Boulevard	N. Downer Avenue	N. Oakland Avenue	Curb lane	Westbound	6:00 a.m.-9:00 a.m. 3:00 p.m.-6:00 p.m.	Requires removal of curb parking
E. and W. Wells Street	N. Prospect Avenue	N. 10th Street	Contraflow curb lane	Westbound	All day	Requires removal of curb parking, median construction, and replacement of Wells Street bridge over Milwaukee River

Source: SEWRPC.

areawide system. Under the proposal, all freeway ramps in the Milwaukee urbanized area would need to be ramp-metered to restrain automobile and truck access to the freeways during peak travel periods. The ramp meters would be operated through a central control system which would continuously measure traffic volumes on those portions of the freeway system needed for transit service through an interconnected series of traffic-sensing devices. As freeway traffic volumes approached the levels beyond which freeway operating speeds may be expected to deteriorate, fewer automobiles and trucks would be permitted to enter the freeway system. Buses, however, would have free access to the system through preferential ramps. Sufficient constraint would be exercised in the operation of the system to ensure uninterrupted traffic flow and, accordingly, relatively high operating speeds of at least 40 miles per hour, thus greatly facilitating primary transit service.

It is recommended that the Wisconsin Department of Transportation proceed with implementation of the proposed areawide freeway traffic management system. The first step toward implementation of this proposal consists of the conduct of a detailed planning and preliminary engineering study. It should be noted that this study, which is to be conducted cooperatively by the Regional Planning Commission and WisDOT, has recently been jointly funded by the Urban Mass Transportation Administration, the Federal Highway Administration, the Wisconsin Department of Transportation, and the Regional Planning Commission. It is expected that the study will begin in mid-1982 and will be completed in about two years. Accordingly, by mid-1984 WisDOT should be in a position to begin programming the improvements necessary to complete installation of the proposed freeway traffic management system.

FINANCIAL CONSIDERATIONS IN PLAN IMPLEMENTATION

The costs of implementing the recommended transit system plan, including the primary element which is the focus of this plan and its supporting secondary and tertiary elements in the Milwaukee urbanized area, were set forth in the preceding chapter of this report. It is estimated that the total operation and maintenance costs on an average annual basis over the entire 21-year plan implementation period would range from about $34.4 million under the stable or declining growth scenario-decentralized land use plan future to about $55.5 million under the moderate growth scenario-centralized land use plan future. Under present State legislation, state aids would be available—assuming continuing sufficient appropriations—to cover 30 percent of such operating costs. Thus, average annual state aid requirements would range from $11.8 million to $16.7 million. The remaining monies necessary to operate the transit system would have to be obtained through a combination of farebox revenues, federal aids, and local tax monies.

Given the assumptions underlying implementation of the plan, farebox revenues could be expected to range from $20.2 million to $31.5 million. This assumes that action will be taken, should general price inflation continue, to maintain fares at the relative level envisioned in the plan. Thus, the farebox recovery rate would range from 51 percent to 57 percent.

The future of federal transit operating aids is uncertain. The present federal administration has proposed phasing out the federal aid program for transit operating assistance by the end of 1984. Thus, should Congress concur in the administration proposal, it is possible that no federal operating aids will be available beyond that time and that the difference between the total operating costs and the amounts received from farebox revenues and state aids would have to be made up entirely by local funding. On an average annual basis over the entire plan implementation period, this would result in the need for local funds of about $7.4 million. The local monies budgeted in the Milwaukee area for transit operations in 1980 totaled about $4.8 million.

The total capital investment required to implement the recommended plan is expected to range from $17.6 million to $22.0 million on an average annual basis over the plan implementation period. To date, all major capital projects attendant to transit system development in the Milwaukee area have been funded on an 80 percent federal-20 percent local basis, although some state aids have been made available for motor bus vehicle purchases. As noted earlier, at the present time the federal government is temporarily not funding new rail transit development proposals; therefore, whether or not the 80 percent-20 percent funding ratio can be maintained for the entire plan over the plan implementation period is uncertain. If federal aids were to become available for rail capital investment purposes, then the 20 percent local share required to implement the plan could be expected to range from \$3.5 million to \$4.4 million annually. By comparison, \$1.7 million was spent in 1980 for transit capital investment. On the other hand, if federal funds remain unavailable for rail transit investment, then the necessary local share of plan implementation capital costs could be expected to range from \$9.3 million to \$10.7 million annually.

From the foregoing, it is apparent that many uncertainties are entailed in transit system development in the greater Milwaukee area. Accordingly, the situation will require careful monitoring by all parties concerned as the process of plan implementation proceeds. Depending upon the future federal position concerning transit system operating aids and the funding of investments in rail transit facilities, and depending upon the ability of the local transit agencies concerned to raise sufficient revenues to carry on the transit function, it may be necessary—as was suggested at the public meetings on the plan—to give consideration at the state level to other means of financing public transit systems. It has been suggested, for example, that consideration be given to the use of a sales tax, increased driver and motor vehicle license fees, a lubricating oil tax, an increased motor fuel tax, or the use of parking meter and parking surcharge monies to fund transit system development and operations. This issue is deserving of attention at the state level. Accordingly, it is recommended that the Wisconsin Department of Transportation and the legislative delegation from southeastern Wisconsin carefully monitor the public transit funding issue over the next several years, and, if transit system development and operation as envisioned in the plan begins to lag for lack of proper resources, that the State Legislature sponsor the conduct of a study of the entire transit funding situation with a view toward finding the best way in which to assure the long-term development and stability of transit operations in the greater Milwaukee area.

SUMMARY

This chapter has described the various means available and recommended specific procedures for implementation of the recommended primary transit system plan for the greater Milwaukee area. The most important recommended plan implementation actions are summarized in the following paragraphs by level and responsible agency or unit of government.

Local Level

Only nine local units of government in the Region are involved in a significant way in implementation of the recommended plan. The following are the specific plan implementation responsibilities for each of these nine units of government.

Milwaukee County: It is recommended that Milwaukee County:

1. Adopt the recommended primary transit system plan as an amendment to the regional transportation system plan.

2. Implement those motor bus primary transit routes identified in the lower tier of the plan that lie wholly within Milwaukee County.

3. Cooperate with Ozaukee, Washington, and Waukesha Counties and the Cities of Kenosha and Racine in implementing those motor bus primary transit routes identified in the lower tier of the plan that originate in outlying counties and terminate in Milwaukee County.

4. Implement the light rail transit facility in the northwest corridor of Milwaukee County included in the lower tier of the plan, including the conduct of appropriate preliminary engineering studies in conjunction with the City of Milwaukee, the Regional Planning Commission, and the Wisconsin Department of Transportation.

5. With respect to the planning for, and design and construction of, the proposed light rail transit facility, seek a waiver of "no prejudice" from the federal Urban Mass Transportation Administration so that federal reimbursement may be sought for any funds advanced toward implementation of this facility in the event that the federal government again agrees to fund new rail transit projects.

6. If sufficient public demand is shown, cooperate with Ozaukee and Waukesha Counties, the Cities of Kenosha and Racine, the Chicago & North Western Transportation Company, the Chicago, Milwaukee, St. Paul & Pacific Railroad Company, and the National Railroad Passenger Corporation (Amtrak) in projects designed to demonstrate the effectiveness of commuter rail transit in the Milwaukee area.

7. Help protect right-of-way possibly needed for additional light rail transit lines included in the upper tier of the plan, including the following county-owned lands: the cleared path for the Stadium Freeway-South, the County Institutions grounds, the former mainline railway right-of-way along the lakefront, and the lands cleared for the Park Freeway-East.

8. Cooperate with the Wisconsin Department of Transportation in the development by that Department of transit stations and park-ride lots included in the lower tier of the plan in Milwaukee County, and in the jurisdictional transfer of the existing Brown Deer Road and Watertown Plank Road park-ride lots to that Department.

9. Construct five transit stations without parking facilities in Milwaukee County as recommended in the lower tier of the plan.

10. Cooperate with the City of Milwaukee in the design and construction of the downtown Milwaukee transit mall included in the lower tier of the plan following completion and approval of the preliminary engineering study for the light rail transit facility in the northwest corridor of Milwaukee County.

11. Cooperate with the City of Milwaukee in the design and construction of the reserved bus lanes included in the lower tier of the plan along selected arterial streets.

Waukesha County: It is recommended that Waukesha County:

1. Adopt the recommended primary transit system plan as an amendment to the regional transportation system plan.

2. Implement those motor bus primary transit routes identified in the lower tier of the plan that originate in Waukesha County and terminate in Milwaukee County.

3. Cooperate with Walworth and Washington Counties in implementing those motor bus primary transit routes identified in the lower tier of the plan that originate in those counties and serve Waukesha County before terminating in Milwaukee County.

4. If sufficient public demand is shown, cooperate with Milwaukee County, the Chicago, Milwaukee, St. Paul & Pacific Railroad Company, and Amtrak in a project designed to demonstrate the effectiveness of providing commuter rail transit service along the railroad line from Oconomowoc to Milwaukee.

5. Cooperate with the Wisconsin Department of Transportation in the development by that Department of transit stations and park-ride lots in Waukesha County, and in the jurisdictional transfer of the existing Racine Avenue park-ride lot to that Department, as included in the lower tier of the plan.

6. Coordinate the motor bus primary transit service provided between Waukesha and Milwaukee Counties with the specialized transportation services provided in Waukesha County to population subgroups to facilitate transfers to and from the primary transit service.

7. Cooperate with the City of Waukesha Transit System Utility Board in the selection of a downtown transit station to serve as a local transit transfer point, as well as a transfer point to the motor bus primary transit system.

Ozaukee County: It is recommended that Ozaukee County:

1. Adopt the recommended primary transit system plan as an amendment to the regional transportation system plan.

2. Assign mass transit plan implementation responsibilities to the Ozaukee County Highway Committee.

3. Implement those motor bus primary transit routes identified in the lower tier of the plan that originate in Ozaukee County and terminate in Milwaukee County.

4. If sufficient public demand is shown, cooperate with Milwaukee County, the Chicago, Milwaukee, St. Paul & Pacific Railroad Company, and Amtrak in a project designed to demonstrate the effectiveness of providing commuter rail transit service along the railroad line from Grafton to Milwaukee.

5. Cooperate with the Wisconsin Department of Transportation in the development by that Department of transit stations and park-ride lots in Ozaukee County, and in the jurisdictional transfer of the existing CTH C park-and-pool lot to that Department, as included in the lower tier of the plan.

6. Coordinate the motor bus primary transit service provided between Ozaukee and Milwaukee Counties with the specialized transportation services provided in Ozaukee County to population subgroups to facilitate transfers to and from the primary transit service.

Washington County: It is recommended that Washington County:

1. Adopt the recommended primary transit system plan as an amendment to the regional transportation system plan.

2. Assign mass transit plan implementation responsibilities to the Washington County Highway Committee.

3. Implement those motor bus primary transit routes identified in the lower tier of the plan that originate in Washington County and terminate in Milwaukee County, including a route that also serves Waukesha County, as included in the lower tier of the plan.

4. Cooperate with the Wisconsin Department of Transportation in the development by that Department of transit stations and park-ride lots in Washington County.

5. Coordinate the motor bus primary transit service provided between Washington and Milwaukee Counties with the specialized transportation services provided in Washington County to population subgroups to facilitate transfers to and from the primary transit service.

Walworth County: It is recommended that Walworth County:

1. Adopt the recommended primary transit system plan as an amendment to the regional transportation system plan.

2. Assign mass transit plan implementation responsibilities to the Walworth County Highway Committee.

3. In cooperation with Waukesha County, implement the specialized peak-period motor bus primary transit service extension from Mukwonago to East Troy, as included in the lower tier of the plan.

4. Cooperate with the Wisconsin Department of Transportation in the development by that Department of a park-ride lot at East Troy, as included in the lower tier of the plan.

5. Coordinate the motor bus primary transit service provided from East Troy through Waukesha County to Milwaukee County with the specialized transportation services provided in Walworth County to population subgroups to facilitate transfers to and from the primary transit service.

City of Kenosha: It is recommended that the City of Kenosha:

1. Adopt the recommended primary transit system plan as an amendment to the regional transportation system plan (Common Council and Transit Commission).

2. Implement the motor bus primary transit route identified in the lower tier of the plan that originates in the City of Kenosha and terminates in Milwaukee County, coordinating that effort with Milwaukee County and Wisconsin Coach Lines, Inc.

3. If sufficient public demand is shown, cooperate with the City of Racine, Milwaukee County, the Chicago & North Western Transportation Company, the Chicago, Milwaukee, St. Paul & Pacific Railroad Company, and Amtrak in a project designed to demonstrate the effectiveness of commuter rail transit in the corridor extending from Kenosha through Racine to Milwaukee.

4. Cooperate with the Wisconsin Department of Transportation in the development by that Department of a park-ride lot near the intersection of STH 31 and STH 158, as included in the lower tier of the plan.

5. Maintain and modify as necessary the downtown transit station now serving Chicago-oriented commuter rail traffic, coordinating local transit service with primary transit service at that transfer point.

6. Coordinate the motor bus primary transit service provided between the City of Kenosha and Milwaukee County with the specialized transportation services provided in Kenosha County to population subgroups to facilitate transfers to and from the primary transit service.

City of Racine: It is recommended that the City of Racine:

1. Adopt the recommended primary transit system plan as an amendment to the regional transportation system plan (Common Council and Transit and Parking Commission).

2. Implement the motor bus primary transit route identified in the lower tier of the plan that originates in the City of Racine and terminates in Milwaukee County, coordinating that effort with Milwaukee County and Wisconsin Coach Lines, Inc.

3. If sufficient public demand is shown, cooperate with the City of Kenosha, Milwaukee County, the Chicago & North Western Transportation Company, the Chicago, Milwaukee, St. Paul & Pacific Railroad Company, and Amtrak in a project designed to demonstrate the effectiveness of commuter rail transit in the corridor extending from Kenosha through Racine to Milwaukee.

4. Establish a downtown transit station to serve the recommended motor bus primary transit route to Milwaukee and coordinate local transit service with primary transit service at that transfer point.

5. Coordinate the motor bus primary transit service provided between the City of Racine and Milwaukee County with the specialized transportation services provided in Racine County to population subgroups to facilitate transfers to and from the primary transit service.

City of Waukesha: It is recommended that the City of Waukesha:

1. Adopt the recommended primary transit system plan as an amendment to the regional transportation system plan (Common Council and the Transit System Utility Board).

2. Select a downtown transit station to serve as a local transit transfer point, as well as a transfer point to the motor bus primary transit system operated by Waukesha County.

City of Milwaukee: It is recommended that the City of Milwaukee:

1. Adopt the recommended primary transit system plan as an amendment to the regional transportation system plan.

2. Cooperate with Milwaukee County in the conduct of preliminary engineering studies for the light rail transit facility in the northwest corridor, with particular emphasis on the land use development and redevelopment and the traffic engineering aspects of those studies.

3. Design and construct the downtown Milwaukee transit mall after completion and approval of the preliminary engineering study for the light rail transit facility in the northwest corridor of Milwaukee County.

4. Design and construct the reserved bus lanes recommended on Wells Street and on Kenwood Boulevard.

Areawide Level

Regional Planning Commission: It is recommended that the Southeastern Wisconsin Regional Planning Commission:

1. Adopt the recommended primary transit system plan as an amendment to the regional transportation system plan and certify the plan amendment to the affected units and agencies of government.

2. Maintain a continuing regional transportation study to serve as a basis for coordinating the various primary transit system plan imple-

mentation efforts, including supporting an appropriate advisory committee structure.

3. Upon request by Milwaukee County, cooperate in the conduct of a preliminary engineering study for the proposed light rail facility in the northwest corridor of Milwaukee County, including the preparation of a prospectus for such a study.

4. Upon appropriate request by an implementing agency, prepare prospectuses for one or more demonstration efforts geared toward possible establishment of commuter rail service in the Milwaukee area.

5. Assist the Wisconsin Department of Transportation in implementing the proposed freeway traffic management system, including the conduct of detailed planning and engineering studies attendant to implementation of that system.

State Level

Wisconsin Department of Transportation: It is recommended that the Wisconsin Department of Transportation:

1. Endorse the recommended primary transit system plan as an amendment to the regional transportation system plan.

2. Cooperate with Milwaukee County in the conduct of a preliminary engineering study attendant to the implementation of the proposed light rail transit facility in the northwest corridor of Milwaukee County, and in the funding of such studies in a manner to be determined in the preparation of a prospectus for such study.

3. Design, construct, and maintain 47 transit stations and park-ride lots, and assume jurisdictional responsibility for four park-ride lots currently operated by Ozaukee, Milwaukee, and Waukesha Counties.

4. Implement the freeway traffic management system upon completion of the detailed planning and preliminary engineering studies for that system.

5. Carefully monitor, in cooperation with the Regional Planning Commission, the situation pertaining to public funding for urban transit systems and advise the State Legislature of any need to comprehensively reexamine the sources of funding for such systems.

6. Continue to provide appropriate financing for the continuing regional transportation system planning effort.

Wisconsin Department of Natural Resources: It is recommended that the Wisconsin Natural Resources Board:

1. Acknowledge the recommended primary transit system plan as an amendment to the regional transportation system plan.

2. Direct its staff in the Wisconsin Department of Natural Resources to recognize the primary transit system plan recommendations as appropriate in revisions to the State Implementation Plan for the attainment of air quality standards.

Federal Level

U. S. Department of Transportation, Urban Mass Transportation Administration: It is recommended that the U. S. Department of Transportation, Urban Mass Transportation Administration:

1. Formally acknowledge the recommended primary transit system plan as an amendment to the regional transportation system plan.

2. Use the primary transit system plan as a guide in the administration and granting of federal aids for transit system development and operation within the Region.

3. Cooperate with Milwaukee County, the Regional Planning Commission, and the other agencies concerned in the preparation of a prospectus on the scope of work for the preliminary engineering study for the proposed light rail transit facility in the northwest corridor of Milwaukee County, and grant a waiver of "no prejudice" to Milwaukee County that could provide for ultimate federal reimbursement of funds

expended for such study and any light rail transit construction that may follow such study.

4. Provide appropriate funding for the detailed planning and preliminary engineering studies attendant to the proposed freeway traffic management system.

U. S. Department of Transportation, Federal Highway Administration: It is recommended that the U. S. Department of Transportation, Federal Highway Administration:

1. Formally acknowledge the recommended primary transit system plan as an amendment to the regional transportation system plan.

2. Use the primary transit system plan as a guide in the administration and granting of federal aids for the development of park-ride lots and the freeway traffic management system.

U. S. Environmental Protection Agency: It is recommended that the U. S. Environmental Protection Agency:

1. Formally acknowledge the recommended primary transit system plan as an amendment to the regional transportation system plan.

2. Utilize the plan recommendations as appropriate in matters dealing with review and oversight of the State Implementation Plan for the attainment and maintenance of air quality standards.

Private Concerns

With respect to the various quasi-public and private concerns, it is recommended that:

1. Wisconsin Coach Lines, Inc., cooperate with the various transit operators in the Region in the provision and coordination of motor bus primary transit service.

2. The Chicago, Milwaukee, St. Paul & Pacific Railroad Company and the Chicago & North Western Transportation Company, as well as Amtrak, upon request cooperate with the transit operators in the Region in the conduct of demonstration studies pertaining to commuter rail service.

3. The Wisconsin Electric Power Company and the Chicago & North Western Transportation Company review the proposals contained in the upper tier of the plan for the possible future provision of light rail transit service and, to the extent possible, help hold open necessary rights-of-way for such service.

Chapter IX

SUMMARY AND CONCLUSIONS

INTRODUCTION

An important component of the public transportation system of any urbanized area is the primary transit system; that is, that system which provides the highest operating speeds and serves the longer trips within the most heavily traveled corridors of the urbanized area. In the greater Milwaukee area, such service is presently provided by diesel motor buses operating in mixed traffic over freeways. In some other urbanized areas, motor buses are also used, but operate over exclusive busways. Yet other urbanized areas use various forms of rail transit to provide primary service, including light rail transit, heavy rail rapid transit, and commuter rail. The determination of which transit technology can best serve the public transit needs of an area deserves periodic reexamination. A primary transit alternatives analysis study, the findings and recommendations of which are the subject of this report, is intended to provide the basis for such reexamination. The primary transit system alternatives analysis for the greater Milwaukee area was undertaken by the Commission at the request of Milwaukee County Executive William F. O'Donnell, who was particularly interested in determining whether or not it would be feasible to establish some form of light rail transit in the greater Milwaukee area. To meet federal planning guidelines, and to meet a specific request from Congressman Henry S. Reuss, the scope of the analysis was expanded to also consider the feasibility of providing primary transit service by bus on freeway, bus on metered freeway, bus on reserved freeway lanes, bus on busway, heavy rail rapid transit, and commuter rail transit, as well as by light rail transit. The objectives of the analysis were, first, to identify those corridors within the area which can best support primary transit facility development; and, second, to identify those transit modes which can best provide the primary transit service in those corridors.

In recent years, much attention has been focused in the United States on strengthening existing and establishing new primary transit systems. Motor bus primary transit service has been initiated in several metropolitan areas, including Boston, Houston, Los Angeles, Miami, Pittsburgh, San Francisco, Washington, D. C., and, in modified form, Milwaukee. New heavy rail rapid transit systems have been developed in the Atlanta, Baltimore, Miami, San Francisco, and Washington, D. C., metropolitan areas. New light rail transit systems are in various stages of development in the Buffalo, Portland, and San Diego metropolitan areas, as well as the Canadian cities of Edmonton and Calgary. Existing light rail transit systems are being refurbished in Boston, Cleveland, Philadelphia, Pittsburgh, and San Francisco. Commuter rail primary transit systems are being refurbished and upgraded in several major metropolitan areas, including Chicago and New York.

In addition to the growing interest in rail transit at the national and local levels, other factors led the Commission to conclude that a major study of primary transit in the Region would be timely. Failure to complete the Milwaukee area freeway system as originally planned, which was to provide the basis for the provision of areawide motor bus primary transit service, raised the question of whether primary transit service to certain sectors of the Milwaukee area not well served by freeways, and in particular to the northwest sector of Milwaukee County, might not better be provided by light rail transit or other fixed guideway modes. In addition, the Commission noted that certain rights-of-way which may be suitable for the development of fixed guideway facilities existed in the Milwaukee area, including portions of the former Chicago & North Western Railway lakefront right-of-way; portions of the rights-of-way for a former extensive electric interurban railway network; certain lands cleared for freeway construction; and certain power transmission line corridors. Also, total reliance on the motor bus for primary transit service under the current plans means total dependence on petroleum-based motor fuels. Light and heavy rail systems with electrical propulsion are not dependent upon such fuels. Hence, a reexamination of the energy impacts and financial feasibility of nonbus primary transit systems was considered warranted. Finally, the Commission noted that there were several potential but as yet uncertain impacts relating to rail primary transit system development that should be explored. These include the ability to increase transit ridership by providing an intrinsically more attractive service than motor bus service; the ability to concentrate and direct land use development and redevelopment; and the ability to minimize the environmental impacts of such service within certain travel corridors.

Work on the Milwaukee area primary transit system alternatives analysis study began in March 1979. The study was cooperatively funded by Milwaukee County, the Wisconsin Department of Transportation, and the U. S. Department of Transportation, Urban Mass Transportation Administration. All of the technical work was performed by the Commission staff.

To provide overall guidance to the study, the Commission established a 21-member Advisory Committee chaired by former Milwaukee Mayor Frank P. Zeidler. Membership on this Committee, the Milwaukee Area Primary Transit System Alternatives Analysis Citizens Intergovernmental and Technical Coordinating and Advisory Committee, was broadly drawn to include elected and appointed public officials at the local, county, and state levels of government, as well as knowledgeable and concerned citizen members. The membership of the Committee is listed on the inside of the front cover of this report.

The findings and recommendations of the reevaluation of the best means of providing primary transit service in the greater Milwaukee area are documented in a series of four Commission technical reports and in this planning report, which summarizes all of the information assembled, and the conclusions reached, in this extensive and complex study.

Much of the basic data and the analytical results are documented in the four technical reports. Two of these four reports present the findings of the inventories conducted under the study. The first, SEWRPC Technical Report No. 23, Transit-Related Socioeconomic, Land Use, and Transportation Conditions and Trends in the Milwaukee Area, 407 pages, presents data pertinent to sound primary transit system planning in the greater Milwaukee area. Included are data on the demographic and economic characteristics, on land use development, on travel habits and patterns, on public financial resources, on the location, capacity, and utilization of existing and proposed transportation facilities, and on the potential for existing rights-of-way in the area to readily accommodate the development of primary transit facilities.

The second of the two inventory technical reports, SEWRPC Technical Report No. 24, State-of-the-Art of Primary Transit System Technology, 273 pages, identifies those transit technologies which can be considered to be proven and available for potential application in the provision of primary transit service in the greater Milwaukee area within the next 20 years, and summarizes and compares their geometric design, performance, and operational and economic characteristics.

The third technical report, SEWRPC Technical Report No. 25, Alternative Futures for Southeastern Wisconsin, 149 pages, describes the range of future development conditions that may be expected in the greater Milwaukee area over the next 20 years, with emphasis upon those aspects that affect the need for and use of primary transit facilities. This range of future development conditions was used as a basis for the design, test, and evaluation of those primary transit technology alternatives determined to be proven and available for potential application in the greater Milwaukee area.

The fourth technical report, SEWRPC Technical Report No. 26, Milwaukee Area Alternative Primary Transit System Plan Preparation, Test, and Evaluation, 724 pages, documents the procedures used in, and the results of, the design, test, and evaluation of alternative primary transit systems under the study. This report also summarizes the decisions and recommendations of the Advisory Committee with respect to primary transit system development in the Region up to the point where public review and comment was sought.

PRIMARY TRANSIT SYSTEM DEVELOPMENT OBJECTIVES

The first step in the alternatives analysis was to identify the objectives that should be met by a primary transit system serving the greater Milwaukee area. These objectives were identified to provide overall direction to the study, to guide the conduct of the inventories and analyses, to guide the design of alternative primary transit system plans, and to permit the quantitative test and evaluation of such alternative system plans. The following objectives were identified by the Advisory Committee:

1. A primary transit system which, through its location, capacity, and design, serves to promote sound land use development, meeting the travel demand generated by desirable

future land use patterns, as well as by the existing land use pattern.

2. A primary transit system which is economical and efficient, satisfying all other objectives at the lowest possible cost.

3. A primary transit system which provides the appropriate service needed by all residents of the planning area.

4. A primary transit system which minimizes disruption of existing neighborhood and community development, including adverse effects upon the property tax base, and which minimizes the deterioration and/or destruction of the natural resource base.

5. A primary transit system which facilitates quick and convenient travel between component parts of the urbanized area, offering an effective and attractive alternative to travel by private automobile.

6. A primary transit system which reduces accident exposure and provides for increased travel safety.

7. A primary transit system with a high aesthetic quality whose major facilities have proper visual relation to the landscape and cityscape.

These seven objectives are supported by 37 specific standards. These standards serve to quantitatively relate the objectives to alternative primary transit system designs for the greater Milwaukee area. These standards are set forth in Chapter II of this report.

INVENTORY FINDINGS AND CONCLUSIONS

Three major inventories were conducted under the primary transit system alternatives analysis. The first was an inventory of socioeconomic, land use, natural resource base, transportation, and travel conditions in the Region. This inventory involved the collation of data from the Commission's files pertinent to primary transit system planning. The results are documented in SEWRPC Technical Report No. 23. The second inventory involved the collection of data on the potential of existing transportation facilities and rights-of-way in the greater Milwaukee area to readily accommodate rapid transit system development. The findings of this new inventory are also presented in SEWRPC Technical Report No. 23. The third inventory was also entirely new, and involved the collection of data on the state-of-the-art of primary transit technology. The findings of this inventory are presented in SEWRPC Technical Report No. 24.

Inventory of Transit-Related Socioeconomic, Land Use, and Transportation Conditions and Trends

Some of the more important inventory findings and conclusions resulting from the collation of existing Commission data pertinent to primary transit system development in the greater Milwaukee area are:

- After several decades of rapid growth, the population level of the Region remained virtually constant during the 1970's. A modest increase of about 8,800 residents in the regional population, bringing the regional total to 1,764,900 residents, represents the smallest 10-year population increase in the Region since 1850, thus signaling an end to 120 years of continuous rapid population growth. A virtual balance now exists between natural increase and net migration at the regional level. During the 1970's, the level of natural increase—births minus deaths—was about 113,800 persons. This was nearly offset by an estimated 105,000 more out-migrants than in-migrants over the same decade. This recent stabilization of the population size of the Region indicates possible stagnation in regional transit needs and use as well. It is one of the reasons why an "alternative futures" approach to transit planning was developed for this study.

- While the population level of the Region has remained virtually unchanged since 1970, significant geographic shifts in the distribution of the population in the Region have continued to occur, as shown in Table 78. Milwaukee County lost about 89,300 residents during the 1970's, a decrease of about 8 percent. At the same time, the three suburban counties surrounding the Milwaukee area, Ozaukee, Washington, and Waukesha Counties, continued to grow, collectively adding about 82,500 residents. The Region's three southern counties—Kenosha, Racine, and Walworth—also continued to grow but experienced lesser rates of population increase than the other three growing counties. During the 1970's, then, the regional population, while remaining at a virtually constant level, continued to decentralize,

Table 78

POPULATION DISTRIBUTION IN THE SOUTHEASTERN WISCONSIN REGION BY COUNTY: 1970-1980

County	Population		Difference: 1970-1980	
	1970	1980	Number	Percent
Kenosha	117,917	123,137	5,220	4.43
Milwaukee	1,054,249	964,988	- 89,261	- 8.47
Ozaukee	54,461	66,981	12,520	22.99
Racine.	170,838	173,132	2,294	1.34
Walworth.	63,444	71,507	8,063	12.71
Washington	63,839	84,848	21,009	32.91
Waukesha.	231,335	280,326	48,991	21.18
Region	1,756,083	1,764,919	8,836	0.50

Source: SEWRPC.

with the result being that fewer persons now reside in the Region's historic transit service areas.

- In another reversal of past trends, the regional population is becoming older, with the median age estimated to be about 29.6 in 1980 as compared with 31.4 in 1950, 28.5 in 1960, and 27.6 in 1970. The racial composition of the population has also been changing, with nonwhites comprising about 2.1 percent of the population in 1950, 4.7 percent in 1960, 7.4 percent in 1970, and about 11.7 percent in 1980.

- The average household size has decreased from 3.36 persons per household in 1950 to 3.30 in 1960, 3.20 in 1970, and 2.75 in 1980. While the regional population remained virtually unchanged during the 1970's, the total number of households increased by 91,500, or about 17 percent—from about 536,500 in 1970 to about 628,000 in 1980.

- The rate of increase in personal income in the Region is declining, although regional per capita incomes still remain above state and national per capita incomes. Per capita income within the Region increased from $2,505 in 1960 to $2,954 in 1970—the latest data available—measured in constant 1967 dollars, representing an 18 percent increase. The per capita income increased nationally from $2,087 to $2,692, or 29 percent, over the same period, and within the State from $2,081 to $2,621, or by 26 percent. A declining rate of personal income increase points toward greater transit needs and use within the Milwaukee area.

- Another important factor affecting transit needs and use in the Region is employment. The number of jobs in the Region increased by about 133,100 during the 1970's, from about 741,600 in 1970 to about 874,700 in 1980, representing an 18 percent increase, as shown in Table 79. Since the population level remained virtually unchanged, it is evident that more individuals—and particularly females—are participating in the regional labor force. Manufacturing jobs in the Region—while increasing in absolute number—have decreased in relative importance, constituting about 45 percent of total jobs in 1950 but about 30 percent of total jobs in 1980. Private and governmental services, education, and wholesale and retail trade have grown in relative importance in the regional economy, mirroring changes in the national economy.

- Geographic shifts in the distribution of employment have continued to occur, although the shifts have not been as dramatic as the shifts in the distribution of the population, with all seven of the Region's counties experiencing employment growth during the 1970's. Proportionately less employment growth occurred in Milwaukee

Table 79

EMPLOYMENT IN THE SOUTHEASTERN WISCONSIN REGION BY MAJOR CATEGORY: 1970-1980

Employment Category	Employment (in thousands)		Difference	
	1970	1980	Number	Percent
Agriculture	10.6	9.4	- 1.2	- 11.3
Construction and Mining	24.0	26.6	2.6	10.8
Manufacturing				
Food and Kindred Products	18.9	20.2	1.3	6.9
Printing and Publishing	14.9	15.7	0.8	5.4
Primary Metals	22.5	17.1	- 5.4	- 24.0
Fabricated Metals	24.6	31.7	7.1	28.9
Nonelectrical Machinery	68.1	74.8	6.7	9.8
Electrical Machinery	36.5	39.3	2.8	7.7
Transportation Equipment	22.0	20.8	- 1.2	- 5.5
Other Manufacturing	43.5	42.9	- 0.6	- 1.4
Manufacturing Subtotal	251.0	262.5	11.5	4.6
Wholesale Trade	32.0	44.4	12.4	38.8
Retail Trade	111.2	137.1	25.9	23.3
Transportation, Communication, and Utilities	36.0	38.5	2.5	6.9
Finance, Insurance, and Real Estate	31.2	43.4	12.2	39.1
Private Services, Except Education[a]	166.9	211.9	45.0	27.0
Government Services and Education	78.7	100.9	22.2	28.2
Total Employment	741.6	874.7	133.1	18.0

[a]*Includes the self-employed and domestic household workers.*

Source: SEWRPC.

County, however, with the result being that the proportion of total regional jobs in Milwaukee County decreased by about 3 percentage points—from 69 to 66 percent—over the decade.

- Air pollution problems exist in much of the Region, but particularly in the central areas of the Cities of Kenosha, Milwaukee, and Racine. Such problems relate to excessive levels of carbon monoxide, particulate matter, sulfur dioxide, and hydrocarbons and ozone. Nitrogen dioxide historically has not been, and is not anticipated to be, a problem. The adopted regional air quality plan recommends, among many other actions, that public transit service in the Region be improved to reduce travel in low-occupancy vehicles and thereby help reduce harmful emissions and achieve standards for carbon monoxide and hydrocarbons/ozone.

- Like many other urban facilities and services, public transit can be economically and effectively provided only in contiguous urban areas developed at relatively high densities. Prior to 1950, urban development in the Region was fairly dense and compact, with new urban development occurring in concentric rings contiguous to and outward from the established urban centers. Since 1950, however, urban development has occurred at relatively low densities and in a highly diffused pattern often far removed from existing urban centers, as shown on Map 2 on page 34 in Chapter III of this report. In addition, out-migration of the regional population from areas developed prior to 1950 began to occur after that year. Urban population density, which peaked within the Region at about 11,300 persons per square mile in 1920, has declined to about 4,300 persons per square mile.

- Personal travel is an orderly, regular, and measurable occurrence evidenced by recognizable travel patterns. In 1972—the last year in which the Commission has been able to conduct a comprehensive inventory of travel—nearly 4.5 million person trips and 3.3 million vehicle trips were made by residents of the Region on an average weekday. This represents about 2.5 trips per capita and 7.9 trips per household per day. Comparable data for 1963 are 3.6 million person trips, 2.5 million vehicle trips, 2.2 trips per capita, and 7.3 trips per household. Trips made by public transit accounted for only 4 percent of total travel in 1972, as compared with 13 percent in 1963. About 22 percent of all trips to, from, and within the Milwaukee central business district were made on public transit in 1972, as compared with 37 percent in 1963.

- The number of automobiles in the Region increased from 634,100 in 1970 to 842,500 in 1980, a 33 percent increase. The number of persons per automobile is estimated to have decreased from 2.77 in 1970 to 2.09 in 1980. The amount of travel increases with increased household automobile availability. There were an average of 1.18 autos per household in 1970; by 1980, this figure had increased to 1.34 autos per household.

- While sharp declines in transit use have occurred since the end of World War II, there are indications that this decline has stabilized and perhaps reversed. Transit ridership in the Milwaukee urbanized area declined from 90 million revenue passengers per year in 1963, to 52 million in 1972, or from 84 to 50 rides per capita per year. Transit ridership has since increased to about 58.1 million trips in 1980, or about 60 rides per capita per year. Similar reversals in the pattern of transit ridership decline have been observed in the Kenosha and Racine urbanized areas.

- Meeting the demand for trips to and from work is one of the primary transportation problems in the Region, and increasing the efficiency of the movement of peak-hour work trips is one of the key purposes of providing public transit. Trips to and from work represent about 33 percent of total regional trips on an average weekday, and about 42 percent of morning and evening peak-hour trips.

- The arterial street and highway system in the Region consists of about 3,290 miles of facilities. Freeways, while comprising about 7 percent of this arterial mileage, carry about one-third of the total travel on the arterial network. About 5 percent of the arterial street mileage is operating over design capacity, and, as a result, experiencing speed and maneuvering restrictions, momentary stoppages, necessary speed changes, and backups and delays behind turning vehicles.

- Milwaukee and Waukesha Counties provide transit service in the Milwaukee urbanized area. With a combined fleet of about 635 buses, these two public transit systems carried about 200,400 trips per average weekday in 1980, or about 58.1 million trips annually. Together, the two systems operate 14 "Freeway Flyer" bus routes, connecting 17 outlying park-ride lots by nonstop service to either downtown Milwaukee or the University of Wisconsin-Milwaukee campus. Ridership on this Freeway Flyer service totaled about 2.1 million annual revenue passengers in 1980, nearly 4 percent of the total transit ridership.

- The currently adopted regional transportation plan recommends substantial expansion and improvement of the public transit systems in the Region. The primary, or rapid transit, element of that plan—that part of the plan which is being reevaluated under the current study—calls for primary transit service provided by diesel motor buses operating in mixed traffic over 80 miles of freeway and 27 miles of surface arterial streets. The plan envisions that the buses used in line-haul service will also provide for the collection and distribution of passengers at the ends of each route. This primary transit service would be supported by a comprehensive freeway traffic management system. This system would meter access to the freeway system in order to maintain a balance between freeway operating speeds and capacity. Preferential access to the system would be provided for transit vehicles. The system would be operated to ensure that transit vehicles could bypass queued vehicles at freeway ramps and, when on the freeway system, could maintain operating speeds ranging from 40 to 45 miles per hour (mph).

Inventory of Existing Rights-of-Way Having Potential for the Location of Primary Transit Facilities

The cost and practicality of alternative primary transit systems can be significantly affected by the availability of rights-of-way for primary transit lines. One of the major new inventories conducted by the Commission as a part of the current study involved a determination of the extent, location, and physical characteristics of all existing rights-of-way in the greater Milwaukee area having potential for primary transit use. This effort included an analysis of the physical suitability of abandoned electric interurban railway rights-of-way, electric power transmission line rights-of-way, freeway rights-of-way, and active and abandoned railway rights-of-way for primary transit purposes. The following is a summary of the findings of these inventories and analyses:

Electric Interurban Railway Rights-of-Way

- From 1895 to 1963, the Milwaukee area was served by an extensive network of electric interurban railway lines. The Milwaukee Electric Railway & Light Company (Milwaukee Electric Lines) operated a 202-mile system over combinations of public streets and private rights-of-way from downtown Milwaukee north to Port Washington and Sheboygan, west to Oconomowoc and Watertown, southwest to East Troy and Burlington, and south to Racine and Kenosha. Within the immediate Milwaukee area, the Milwaukee Electric Lines operated 90 miles of electric interurban railway, of which 78 miles, or 86 percent, was operated over private rights-of-way. The Milwaukee Electric Lines also operated a 130-mile street railway system, of which 10 miles was on private rights-of-way in 10 sections ranging from 0.2 mile to 3.6 miles in length.

- Nearly all the electric interurban railway rights-of-way that comprised the Milwaukee Electric Lines system in the Milwaukee area have at least some segments with good potential for primary transit development, as shown on Map 8 on page 48 in Chapter III of this report. The rights-of-way are largely intact and owned by the Wisconsin Electric Power Company, being used for electric power transmission line location. The railway grades on these rights-of-way are only partially intact, however, most fills having been leveled and many cuts having been filled. Nearly all bridges at former grade separations with highways and other railways have been removed. About 60 miles, or 76 percent, of the 78 miles of railway operated by the Milwaukee Electric Lines on private rights-of-way in the Milwaukee area were found to have good potential for the location of primary transit facilities. Most of the 10 miles of former street railway private rights-of-way were found to have poor potential for primary transit use, having largely been converted to other urban uses.

- The right-of-way of a second electric interurban system formerly serving the Milwaukee area—the Chicago, North Shore & Milwaukee Railway Company (North Shore Line)—was found to be largely intact, being owned primarily by Milwaukee County. This right-of-way, which extends south from Milwaukee to Racine, Kenosha, and Chicago, was found to have poor potential for primary transit development south to nearly E. Rawson Avenue, and good potential for primary transit development south of there to the Racine County line. The railway grade, however, is only partially intact, as many fills have been leveled and many cuts filled. Nearly all bridges at former grade separations have been removed.

Electric Power Transmission Line Rights-of-Way

- There are nearly 2,000 miles of electric power transmission trunk lines in the Milwaukee area. These trunk lines are located on 57 miles of rights-of-way owned by the Wisconsin Electric Power Company (WEPCo) and 174 miles of easement obtained by WEPCo. The 57 miles of rights-of-way owned by WEPCo are the same rights-of-way that were formerly used for electric interurban railway purposes as discussed above. All other electric power transmission trunk lines in the Milwaukee area are on easements and have little or no potential for the development of primary transit systems. The easements generally consist only of small areas of land for the location of electric power transmission line supports connected by corridors over which WEPCo holds only aerial rights. The lands underneath the transmission lines between the support structures are usually developed and used in conjunction with abutting land uses. Other problems attendant to the use of such corridors include the limited legal rights held by WEPCo, which would make the use of the easement for a purpose other than the transmission of electric power subject to the approval of individual landowners; and the fact that the support structures and other facilities constructed on the easements generally are situated on existing topography without regard for the horizontal and vertical alignment needs of primary transit facilities. Consequently, it was concluded that the only electric power transmission rights-of-way having any potential for primary transit use are those formerly used for that purpose. Any attempt to construct primary transit facilities over the WEPCo corridors established through easements would be troublesome and costly.

Freeway Rights-of-Way

- The Milwaukee area freeway system has significant potential for use in providing primary transit service. Without any changes, it can be used to provide the modified primary transit, freeway flyer type of service currently provided. With modest changes, including the institution of an areawide operational control system and attendant ramp meters and preferential access lanes for buses, a higher level of primary transit service could be provided over the freeway system. In some cases, freeway lanes can be reserved for the exclusive use of motor buses either in a normal flow direction or in a contraflow direction. In addition, parts of freeway rights-of-way other than traffic-carrying lanes—particularly medians and shoulders—may be usable as rights-of-way for busway, light rail transit, or heavy rail rapid transit facilities.

- In order to properly assess the feasibility of using freeway rights-of-way for primary transit in the form of reserved lanes, busways, and light and heavy rail rapid transit guideway facilities, an inventory of the physical characteristics and current use of the 103-mile Milwaukee area freeway system was conducted. This inventory included pertinent data on the right-of-way, median, and shoulder width of each segment of the freeway system, on critical vertical clearances, and on current directional traffic volumes during peak weekday travel hours. Rural-type freeway segments generally have a right-of-way width of from 300 to 330 feet. Urban-type freeway segments are characterized by a maximum width of 230 feet. Rural freeway segments generally have median widths greater than 40 feet, while urban freeway segments generally have median widths less than 30 feet. Outside shoulders are provided on virtually the entire freeway system, although such shoulders are not continuous across every structure. There are a total of 350 structures that separate the Milwaukee freeways from arterial streets, freeways, railroads, and watercourses. These structures restrict the physical size of vehicles that can operate on the system. Generally, structures in freeway-to-freeway interchanges impose the most stringent restrictions with respect to both vertical and horizontal clearances. The detailed data collected are presented for each Milwaukee area freeway segment in SEWRPC Technical Report No. 23.

- The most critical obstacles to the accommodation of primary transit guideways on and along the Milwaukee area freeway system are the constraints imposed by the characteristics of the freeway-to-freeway interchanges; freeway-to-arterial street interchanges; freeway overpasses of streets, railways, and watercourses; and freeway underpasses of streets and railways. Freeway medians and outside shoulders are often not provided through under- and overpasses, or if provided are generally narrower than the medians or shoulders of freeway segments between such under- or overpasses. Even more importantly, medians or shoulders cannot be physically continued through interchanges because either the medians or the shoulders must cross freeway-to-freeway ramps or freeway entrance and exit ramps at the interchange. The number and location of these ramps—which exist on both the right- and left-hand sides—would generally make it difficult and costly to use the freeway system for primary transit facility location since elevated or tunneled fixed guideway construction would likely be necessary at most interchange and ramp locations.

- The medians, outside shoulders, and nonroadway portions of the Milwaukee area freeway system cannot readily be used for single or dual busways or railways. Only elevated busways or railways appear feasible, particularly on those freeways in the central portion of Milwaukee County. This feasibility conclusion was reached not only because of the limited horizontal clearance available in the medians, shoulders, and nonroadway portions of the freeway rights-of-way, but also because of the need to separate a busway or railway from freeway-to-freeway ramps and freeway entrance and exit ramps which cross the potential busway or railway alignments. The construction of elevated busways or railways would be particularly difficult and costly because of the need to go through, over, or around freeway-to-freeway interchanges and to go over other overpasses to the freeway. Much of the freeway system in Milwaukee County is unsuited for such use because the freeway medians—particularly at freeway underpasses—are too narrow to accommodate an at-grade light rail fixed guideway. Based on this and similar analyses of freeway shoulders and nonroadway areas, no further consideration was given in the study to the extensive construction of busways or railways on developed freeway rights-of-way in the Milwaukee area.

- The reservation of an existing freeway lane for the exclusive use of motor buses is often suggested as a means of providing primary transit service on the Milwaukee area freeway system. In concept, such reservation would need to be provided only during peak travel periods and in the peak direction of travel because at other times of the day, or in the contraflow direction during the peak travel period, buses can generally travel in mixed traffic on freeways at speeds equal to or approaching those achieved on reserved lanes. There are two ways of providing such a reserved lane. Either a lane can be reserved from those lanes which serve vehicles headed in the peak direction, creating a "normal flow" reserved lane, or a lane can be reserved from the lanes which serve the nonpeak direction, creating a "contraflow" reserved lane. In concept, such reserved lanes can be either the lane adjacent to the median or the lane adjacent to the outside shoulder of the freeway.

- The greatest obstacle to creating reserved lanes for buses on the Milwaukee area freeway system is the design of the freeway-to-freeway and freeway-to-arterial street interchanges. Such interchanges have entrance and exit ramps which connect to either the right-hand or left-hand lanes of the freeway, and sometimes to both. This variety of freeway ramp locations results in freeway traffic being required to cross potential reserved lanes located either along the shoulder or along the median. Accordingly, reserved lanes could be provided over segments of the freeway system shoulder or median lanes only if interchanges were closed or reconstructed, or if an elevated or tunneled busway between reserved lane segments were constructed. In concept, normal flow reserved lanes could be provided in discontinuous segments. Such an approach, however, is considered impractical and undesirable because of safety considerations involved in merging freeway traffic into and out of a normal flow reserved bus lane.

- Given the large number of freeway ramps connecting to the right-hand side of the freeway, it was concluded that only median lanes should be considered for use as either normal flow or contraflow reserve bus lanes in the Milwaukee area. A combined total of about 90 miles, or 88 percent, of the Milwaukee freeway system leading to the Milwaukee downtown area could physically accommodate normal flow reserved median lanes. The stretches in which median lanes could physically be used for contraflow bus lanes are limited to a combined total of about 80 miles, or 78 percent of the freeway system. Unfortunately, those portions of the Milwaukee County freeway system that are the most heavily congested and that approach the Milwaukee downtown area—and where reserved bus lanes are most needed—do not lend themselves to development as reserved contraflow bus lanes. Normal flow reserved lanes, however, could be physically provided over much of the East-West and North-South Freeways leading to the Milwaukee downtown area.

- Besides the physical problems involved in creating reserved bus lanes on the Milwaukee area freeway system, the traffic congestion which would be caused by removing an existing lane must be considered. This obstacle is more severe with normal flow bus lanes than with contraflow bus lanes. About 65 miles, or 58 percent, of the Milwaukee area freeway system is now carrying traffic volumes that would exceed the peak-hour design capacity of the freeway facilities concerned if reserved bus lanes in the peak flow direction were implemented. The central portions of the Milwaukee area freeway system, which total about 40 miles and which lead to the downtown area, would not have sufficient capacity with a reduced number of traffic lanes to accommodate the existing freeway traffic volumes, as shown on Map 9 on page 51 in Chapter III of this report. Accordingly, during the morning and evening peak hours between 1,000 and 1,900 vehicles would need to be diverted on parts of all central Milwaukee freeways in order to accommodate the reservation of a normal flow bus lane. In addition, operating conditions on the unreserved freeway lanes would deteriorate, with drivers experiencing severe congestion, continuous stop and go driving, and operating speeds below 30 miles per hour. The traffic congestion problems that would be caused by reserving existing freeway lanes in the contraflow manner were determined to be less severe, as shown on Map 10 on page 52 in Chapter III of this report.

- Given the physical design and construction problems and traffic operation and congestion problems attendant to the development of a system of reserved bus lanes either in the normal flow or contraflow direction, it was concluded that no further consideration should be given in the analysis to the use of reserved bus lanes in the provision of primary transit service. Attention was instead to be directed to those alternatives that would use the Milwaukee area freeway system for modified primary transit purposes, including an alternative that would continue to provide the Freeway Flyer bus service in its present form and an alternative that would control access to and traffic flow on the metropolitan Milwaukee freeway system through ramp metering and preferential bus ramps in order to provide relatively free-flowing traffic conditions and enable buses to provide primary transit service in mixed traffic at relatively high speeds.

- Several corridors in the Milwaukee area that had been cleared for future freeway construction have potential for accommodating primary transit fixed guideways for either busway or railway purposes. These corridors include the Stadium Freeway-South and Park Freeway-East, both of which are retained in the regional transportation plan for possible future freeway construction, and the Park Freeway-West, which is no longer recommended for any future freeway construction. Each of these cleared corridors could physically accommodate primary transit facilities. To date, however, redevelopment planning for the Park Freeway-West corridor does not include an accommodation for locating primary transit fixed guideways.

Active and Abandoned Railway Rights-of-Way

- An inventory of the railway system rights-of-way within the Milwaukee area was conducted to determine the potential for placing primary transit fixed guideways on such rights-of-way. The results of this effort are summarized on Map 13 on page 63 in Chapter III of this report. Many of the active railway lines in the Milwaukee area have segments with good potential for the location of at-grade primary transit guideways. This assessment was based upon the existence of adequate horizontal and vertical clearances for guideways on the right-of-way on either side of the existing railway trackage, the absence of lengthy portions of the right-of-way located on fill or in cut, the absence of major obstructions in the right-of-way, and the absence of extensive industrial siding or lead tracks or additional railway trackage or station facilities on the right-of-way. Of the abandoned railway rights-of-way in the Milwaukee area, only one—the former Chicago & North Western Railway Company main line extending north from downtown Milwaukee—has good potential for primary transit development.

- Six railway routes in the Region were identified as having the operational potential to be used for commuter rail service, as shown on Map 14 on page 64 in Chapter III of this report. These six routes radiate from downtown Milwaukee to Port Washington, Saukville, West Bend, Oconomowoc, Kenosha, and Waukesha. Of the six routes, the route between Milwaukee and Oconomowoc—which is now used for Amtrak intercity rail passenger service—appears to have excellent physical potential for commuter rail service, requiring relatively little cost per mile in rehabilitation costs to permit commuter train use. The other five potential commuter rail routes would require more capital investment to permit commuter rail operation, with expenditures being required for track rehabilitation, the construction of storage and servicing facilities for trains at the outermost station on each route, the installation of automatic crossing gates at all public at-grade street and highway crossings, and, in some cases, the construction of a connecting track between the trackage of the Chicago & North Western Railway Company and the Chicago, Milwaukee, St. Paul & Pacific Railroad Company lines. Track rehabilitation and related costs attendant to each of the six potential commuter rail routes are summarized in Tables 14 and 15 in Chapter III of this report. The cost of track rehabilitation for the entire commuter rail system as envisioned on Map 14 on page 64 of Chapter III is estimated at $35.7 million.

Inventory of Primary Transit Technology State-of-the-Art

In order to provide a sound basis for the design, test, and evaluation of alternative primary transit system plans for the Milwaukee area, it was necessary to conduct an inventory of the state-of-the-art of primary transit technology. In this effort, the full range of urban transit technologies which may be suitable for primary transit service was surveyed, and those technologies considered to have application in the provision of primary transit service over the next two decades in the Milwaukee area identified. The following summarizes the results of this major inventory effort, the findings of the inventory being presented in greater detail in SEWRPC Technical Report No. 24 as well as in Chapter III of this report.

- Of the transit technologies surveyed, it was determined that three would be practically capable of providing primary transit service in the Milwaukee area over the next 20-year period: motor bus transit, electric trolley bus transit, and rail transit. These three technologies are manifested in eight urban public transit modes, including four motor bus modes, three rail modes, and one electric trolley bus mode. Of the four motor bus modes, three—motor bus operation on freeways in mixed traffic, motor bus operation on freeways over reserved lanes, and express bus operation on arterial streets—make use of existing freeways and surface arterial streets and highways. The fourth motor bus mode—motor bus operation on busways—and two of the three rail transit modes—light rail transit and heavy rail rapid transit—require the construction of new fixed guideways. Fixed guideways for light rail transit and busway systems can be located on existing surface street rights-of-way and need not be fully grade-separated. Fixed guideways for heavy rail rapid transit systems must be fully grade-separated. The seventh mode—commuter rail—makes use of existing railway mainline trackage, sharing such trackage with intercity freight and passenger train traffic. The eighth mode—electric trolley bus transit—can provide rapid transit service only if special hardware design provisions are included.

- The four motor bus modes were further reduced for systems planning purposes to two modes: motor bus operation on freeways in mixed traffic and motor bus operation on busways. Motor bus operation on freeways was defined to include an operationally controlled freeway system. The Wisconsin Department of Transportation has already put in place a partial freeway operational control system through the installation of a series of ramp meters. The adopted regional transportation system plan calls for the provision of additional ramp meters and the interconnection of all such meters into a centrally controlled system. By controlling access to the freeway system through ramp meters, traffic flow and operating speeds on the most congested segments of the Milwaukee area freeway system can be significantly improved. In addition, by providing preferential access for motor buses, primary transit service can be provided over a free-flowing freeway system at relatively low cost.

The mode of motor bus operation on freeways over reserved lanes was, as already noted, given no further consideration in the analyses both because of the problems attendant to creating reserved lanes for buses on freeways in the Milwaukee area owing to the frequency of right- and left- hand ramps, and because of the increased amount of traffic congestion that would be attendant to the establishment of reserved lanes. Motor bus primary transit service on operationally controlled freeways was thus considered superior in every respect to buses operating on a reserved lane freeway system. The express bus operation over arterial street mode and busway mode were considered together since they have similar cost and performance characteristics, particularly with respect to a busway that would not be fully grade-separated.

- Electric trolley buses require a system of twin overhead contact power wires. Except for this distinction, the electric trolley bus differs little from the diesel motor bus in terms of performance. In order to provide primary transit service at vehicle speeds above 40 mph, however, a special electric overhead power distribution system would be required, as well as lower gear ratios on electric trolley buses. It was concluded that the diesel motor bus and the electric trolley bus have quite similar performance characteristics in both local and surface express transit service and, given the special provisions noted above in the design of the vehicles and in the power distribution system, could provide similar primary transit service, particularly over busways. Accordingly, it was determined not to test separate alternatives involving the electric trolley bus in primary transit service. Rather, it was determined that the electric trolley bus constitutes a special variation of the motor bus mode to be considered further as may be necessary only after full development and evaluation of the diesel motor bus and the rail transit alternatives.

- Based upon the foregoing conclusions, five primary transit modes were selected for use in the preparation of alternative primary transit systems for the greater Milwaukee area. These five modes are: motor buses on operationally controlled freeways, bus on busways, light rail transit, heavy rail rapid transit, and commuter rail. Of the two modes involving buses, it was assumed that an articulated vehicle would be used for primary transit service, since such a bus could carry about 40 percent more seated passengers and about 50 percent more standees than a conventional bus, thus having lower operating costs per passenger mile. It was further assumed in the design of the alternatives that the use of a motor bus on either an operationally controlled freeway or a busway system would include a passenger collection function at one end and a passenger distribution function at the other end, thus offering the passenger a "one-seat, no-transfer" ride, an important advantage of the motor bus modes over the rail modes. For the light rail transit alternatives, a single articulated vehicle that could be coupled into trains of up to two cars was assumed in order to provide operating efficiencies. For the heavy rail rapid transit alternatives, it was assumed that a semi-permanently coupled pair of single-unit vehicles would be employed that could be coupled into trains of up to six cars. Finally, for the commuter rail alternatives, it was assumed that a diesel-electric locomotive and bi-level gallery coaches would be employed as opposed to single-level, self-propelled vehicles. Given the type of primary transit service envisioned under this alternative analysis study—namely, a high level of handling heavy passenger loads during peak periods—self-propelled commuter rail coaches would be less cost-effective than bi-level gallery coaches propelled by diesel-electric locomotives. This, however, does not preclude the consideration of self-propelled coaches for special-purpose service and light traffic-density purposes, such as within a single corridor where light passenger loads could be expected, especially for a service which would operate only during peak periods.

- The five primary transit modes selected for use in the study provide a broad range of possibilities for the establishment of primary transit service in the Milwaukee area with respect to travel speed, capital and operating costs, and energy requirements. The major differences between these modes can be identified by the salient physical, economic, performance, and energy characteristics of each mode, as shown in Table 31 in Chapter IV of this report. These five modes are illustrated in Figures 22 and 23.

- Of the five modes, three would require new fixed guideway construction, while two would be able to use existing facilities as guideways. The motor bus-on-freeway mode would use the existing freeway system, operationally controlled, as noted above, and with the provision of preferential bus ramps. The commuter rail mode would use existing mainline railways, requiring some track rehabilitation and grade-crossing protection. Since both of these modes would use existing facilities, they would have lower capital costs than would the three modes requiring new fixed guideway construction. However, primary transit service could not be provided by these two modes where freeways or mainline rail facilities do not exist. In addition, the freeway and mainline railway facilities would have to be shared with other traffic.

- There are some important distinctions among the guideway characteristics of the three modes that would require new fixed guideways. The motor bus-on-busway mode and the light rail transit mode can use either a guideway that is exclusive and fully grade-separated or a lesser guideway that would be semi-exclusive with little or no grade separation. For example, motor buses and light rail vehicles can run on reserved lanes, or in the median areas of surface arterial streets on which preferential treatment is provided at intersections with cross streets. Heavy rail rapid transit, however, requires—in large part because of safety considerations attendant to the third rail source of power, high operating speeds, and semi-automated control—fully grade-separated, exclusive rights-of-way over the entire length of the fixed guideways.

- Vehicle performance and station spacing are important considerations in determining the average speeds attainable by the various primary transit technologies. Most primary transit vehicles can attain relatively high average speeds with stations located from one-half mile to one mile apart. Among the five selected primary transit modes, the motor bus-on-freeway mode has the highest average speed—about 35 to 45 mph—because it usually provides nonstop, line-haul service. If time is added for collection and distribution functions at the origin and destination ends of a motor bus-on-freeway route, however, that average speed is lowered, bringing it into the range of average speeds of other modes of between 20 and 30 mph. Because of low acceleration and deceleration rates, commuter rail can provide high-speed transit service only if stations are a minimum of two to three miles apart, a factor which reduces accessibility to the system. Consequently, commuter rail can be expected to be the most effective when accommodating the longest transit trips in the Region, and cannot be expected to function efficiently if station spacings are similar to those required for the light and heavy rail and motor bus modes.

- There is little difference in the unit costs of at-grade, elevated, and subway guideway segments for the busway, light rail transit, and heavy rail rapid transit modes. At-grade fixed guideways can be expected to cost from \$1 million to \$7 million a mile, depending upon the mode and abutting land uses.[1] Regardless of the mode, elevated guideway segments can be expected to cost from \$4 million to \$25 million per mile, or up to four times as much as an at-grade guideway. Subway segments may be expected to cost from \$38 million to \$47 million per mile, or from 5 to 15 times as much as at-grade guideway segments. Because heavy rail rapid transit requires a fully grade-separated fixed guideway, its capital costs will greatly exceed those of the motor bus-on-busway and light rail transit modes. For any primary transit systems that require new fixed guideways, guideway construction can be expected to be the most costly element of the total system. The motor bus-on-freeway and commuter rail modes therefore have a significant capital cost advantage.

- Other important elements of the costs of providing primary transit service are vehicles, stations, and maintenance and storage facilities. Motor buses cost substantially less than rail vehicles. However, more motor buses would be necessary to carry an equivalent number of passengers, and buses have an estimated useful life of less than half that

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[1] *All capital and operating costs presented within this report are given in 1979 dollars.*

Figure 22

EXAMPLES OF MOTOR BUS PRIMARY TRANSIT TECHNOLOGY

Photo courtesy of Milwaukee County Transit System.

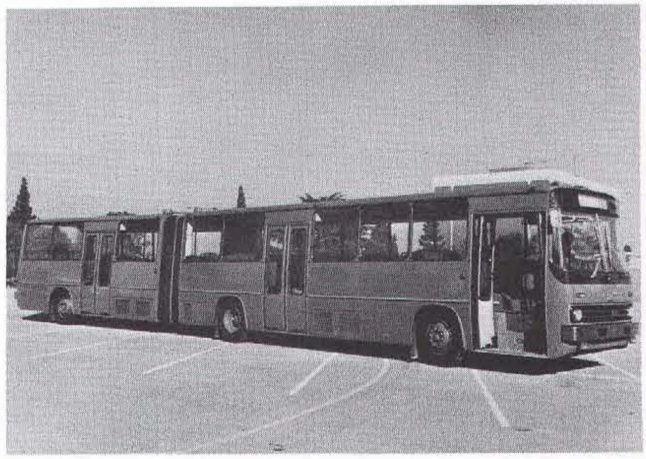
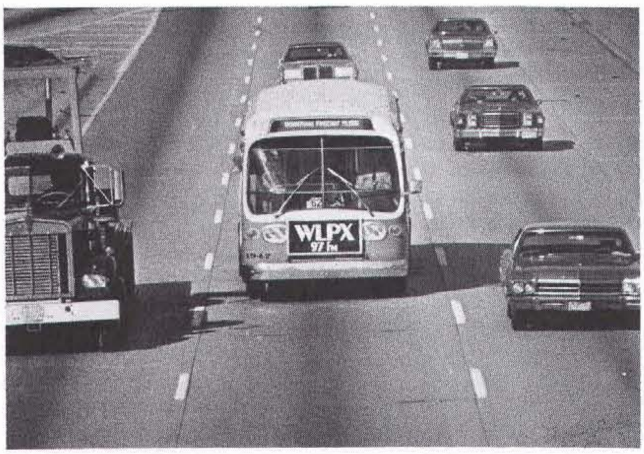


Photo courtesy of Crown Coach Corporation.



SEWRPC Photo.

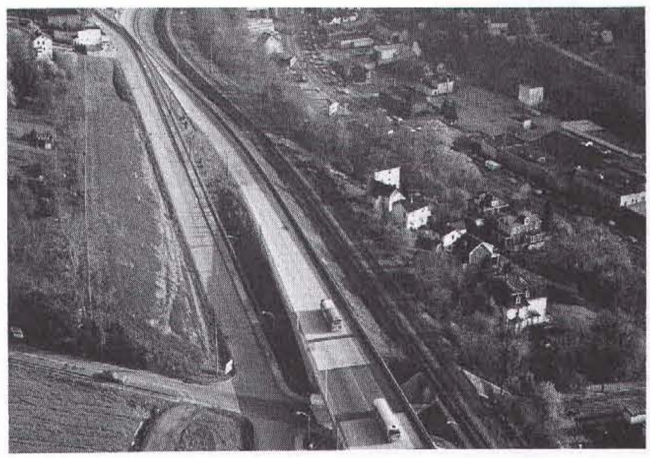


Photo courtesy of Port Authority of Alleghany County.

There were two modes of motor bus technology found to be applicable for the provision of primary transit service in the Milwaukee area: operation on operationally controlled freeways in mixed traffic, and operation on busways. The same motor bus vehicles can be used for either of these two modes, the most common vehicles being a conventional configuration (upper left), or an articulated design (upper right). Operation in mixed traffic on freeways makes predominant use of existing facilities without major modifications (lower left), unlike motor bus operation on busways, which requires the construction of a separate guideway (lower right). Motor bus technology offers the potential for a no-transfer ride between origins and destinations because of the ability to operate the vehicles both on exclusive guideways or freeways and on arterial or local streets.

of rail vehicles. In the Milwaukee area, the motor bus modes have a capital cost advantage over the heavy rail rapid transit and light rail transit modes in that existing maintenance facilities, equipment, and procedures could be used. The light rail transit and heavy rail rapid transit modes, however, have the advantage over the motor bus modes of not requiring indoor storage during cold weather, since they are electrically propelled and heated. The costs of stations may be expected to be lowest for the motor bus-on-freeway and commuter rail modes. Individual station costs are quite similar for the motor bus-on-busway, light rail transit, and heavy rail rapid transit modes. Overall station costs are generally much higher for heavy rail rapid transit than for the other

Figure 23

EXAMPLES OF RAIL PRIMARY TRANSIT TECHNOLOGY

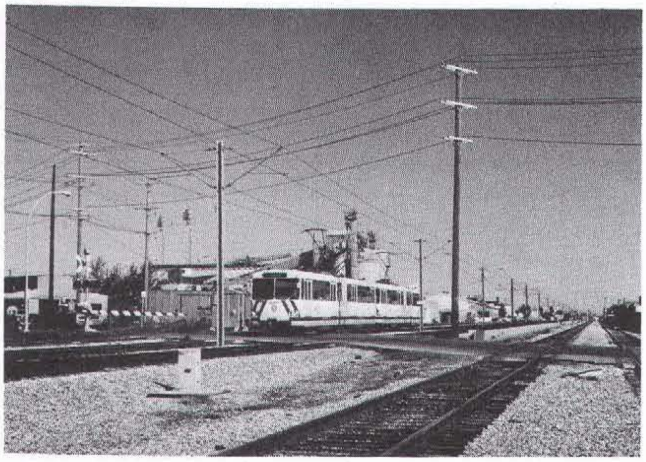


Photo by Russell E. Schultz.

Photo by Russell E. Schultz.

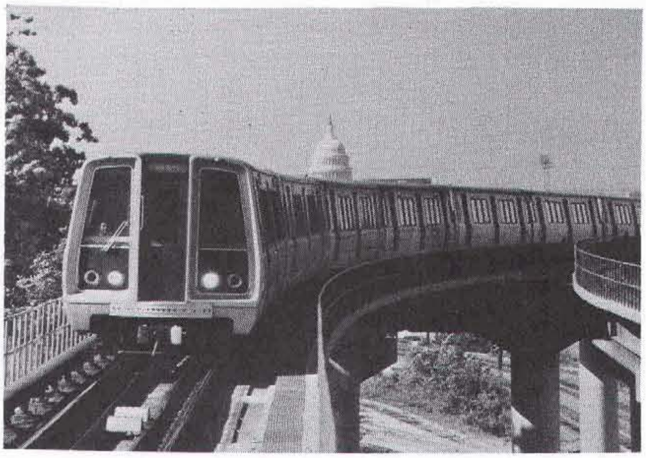


Photo courtesy of Washington Area Metropolitan Transit Authority.

SEWRPC Photo.

There were three modes of rail transit technology found to be applicable for the provision of primary transit service in the Milwaukee area: light rail transit, heavy rail rapid transit, and commuter rail. Because its electric power supply is provided by an overhead wire system, light rail transit can utilize a wide variety of surface configurations, such as exclusive railway rights-of-way (upper left) or shared public street rights-of-way in reserved median areas (upper right), thus minimizing the capital investments in comparison to those that would be necessary with a fully grade-separated alignment. Modern heavy rail rapid transit systems are typified by lengthy segments of elevated alignments (lower left), as well as by expensive subways, since this mode can operate only over an exclusive, fully grade-separated guideway because of the use of a side-running third rail for power collection and because of high vehicle operating speeds and semi-automated train operation. The operation of commuter trains involves the use of rolling stock manufactured to mainline railway standards operated over railway trackage shared with intercity freight and passenger train traffic (lower right).

modes because of the need for an exclusive, fully grade-separated guideway along the entire system length.

- Operating costs per vehicle mile for the five modes range from a low of $1.87 for the two motor bus modes to a high of $5.40 for the commuter rail mode. In terms of costs per passenger mile at maximum design capacity, however, the bus-on-busway mode has the lowest operating cost, 1.7¢; followed by heavy rail rapid transit, 1.9¢; light rail transit, 2.2¢; bus on freeway, 2.8¢; and commuter rail, 3.4¢. No primary transit system will, of course, operate at maximum design load factors except for relatively short periods of peak travel demand. Consequently, only through the preparation, test, and evaluation of alternative primary transit system plans can the actual operating cost for each mode in the Milwaukee area be determined.

- The two motor bus modes are by far the most efficient in terms of the amount of energy used per vehicle mile. Diesel motor buses require about 38,000 British Thermal Units (BTU's—equivalent to about 0.28 gallon of diesel fuel) per vehicle mile, while heavy rail rapid transit requires about 74,000 (0.54 gallon), light rail transit about 84,000 (0.62 gallon), and commuter rail about 113,000 (0.83 gallon). This determination is based not only on the energy actually consumed in propelling the vehicle but also on the energy lost in the conversion of other sources of power to electrical power, and the energy lost in the transmission and distribution of that power. The heavy rail rapid transit and motor bus-on-busway modes are by far the most efficient in terms of the amount of energy used per passenger mile when loaded to maximum design capacity, requiring 330 BTU's and 350 BTU's, respectively, equivalent to 0.002 and 0.003 gallon of diesel fuel. The motor bus-on-freeway and light rail transit modes both require 560 BTU's per passenger mile, and commuter rail requires 720 BTU's per passenger mile, equivalent to 0.004 and 0.005 gallon of diesel fuel, respectively. A significant amount of energy would also be required in the construction of new fixed guideways, ranging from 25 million BTU's to 234 million BTU's per mile, depending upon the type of guideway being constructed.

- There are a number of additional transit technologies which, while having certain potential advantages over the proven and readily available technologies, cannot realistically be expected to become practically available for the provision of primary transit service within the next two decades. These technologies, which must be termed "futuristic," are in various stages of development and require extensive research, experimentation, testing, and demonstration prior to practical application in regular service. Included in this group are personal rapid transit and group rapid transit, referred to collectively as light guideway or automated guideway transit systems, dual-mode transit systems, the intermediate capacity transit system (ICTS), and the O-Bahn. Other exotic forms of transit technology cannot reasonably be considered for the provision of primary transit service in the Milwaukee area because demonstrations and application of these technologies to date have not established their superiority in any way over proven primary transit technologies. Such technologies include monorail, rubber-tired duorail, and moving way systems. Yet other transit technologies, including the street railway, the electric interurban railway, and older forms of conventional heavy rail rapid transit systems, also cannot be considered to be reasonable alternatives in the Milwaukee area since they are obsolete and have evolved into more advanced forms of rail transit technology. These technologies are discussed in more detail in Chapter IV of this summary report and in Chapter V of SEWRPC Technical Report No. 24, State-of-the-Art of Primary Transit System Technology.

ALTERNATIVE FUTURES—DETERMINATION OF FUTURE NEED

Traditionally, transportation system planning has involved the preparation of a single forecast of those conditions which lie beyond the scope of the plan but which affect plan design and implementation. The future demand for transportation will depend, in part, upon the future size and distribution of the population of the planning area, on the future nature and distribution of economic activity, and on the cost of motor fuel. Traditionally, a single forecast was made of the "most probable" level of these future conditions and then used in the test and evaluation of alternative transportation system plans. This single future approach worked well in periods of relative stability, when historic trends in the factors underlying and influencing changes in population, economic activity, and motor fuel cost could reasonably be expected to extend over a 20- to 25-year plan design period. During periods of major change in social and economic conditions, however, and particularly during times when such external factors as the cost and availability of motor fuel may be subject to rapid change, the assumption that historic trends will continue becomes uncertain, and a different procedure becomes necessary for long-range transportation system planning.

Accordingly, in an attempt to deal with the present uncertainties concerning such matters as the future size and distribution of the resident population of the Region, the health of the regional economy, and the cost and availability of motor fuel, the Commission used an "alternative futures" approach to the design, test, and evaluation of alternative primary transit system plans. Under this approach, a number of alternative futures were developed. These futures were intended to define a reasonable range of possible future conditions which may be expected to occur within the Region over the plan design period, and which may be expected to influence the need for, and use of, primary transit facilities. The use of this alternative futures approach enabled the performance of alternative primary transit system plans to be tested and evaluated under a wide range of future conditions. Subsequently, a primary transit system plan that could be expected to perform well under greatly varying future conditions was identified and recommended for implementation.

The formulation of the alternative futures under which the Milwaukee area primary transit system plans were to be tested was accomplished in three steps: 1) the identification and consideration of key factors operating largely external to the Region but influencing future regional public transit needs—as, for example, the cost and availability of energy, economic conditions, and population lifestyles; 2) the development of alternative future regional population and employment levels attendant to these key external factors; and 3) the preparation of centralized and decentralized regional land use plans for each set of alternative population and employment levels. Four alternative futures were developed, ranging from most optimistic to most pessimistic regarding potential transit use. The following summarizes the salient conclusions reached in applying this alternative futures approach to the Milwaukee area primary transit study. Table 43 in Chapter V of this report compares the differences between the key external factors and the attendant regional change under two regional growth-related scenarios, as well as the differences between patterns of land use development under each of the four alternative futures.

- Energy cost and availability, population lifestyles, and economic conditions were identified as being the three factors most critical to the future use of transit facilities in the Region, but as operating largely external to the Region—i.e., factors over which local public officials have little or no control. The future cost and availability of energy may be expected to influence the future cost and convenience of operating an automobile, which in turn may be expected to affect transit need and use. Real—as opposed to inflationary—increases in petroleum prices may be expected to continue in the foreseeable future. However, whether such increases will be rapid and will occur in conjunction with supply disruptions—such as occurred in 1973—or will be moderate and will occur without disruption is not clear. Greater efficiency in energy use and increased conservation of energy appear likely. With respect to the automobile, continued dependence on petroleum-based fuel may be expected, although greater efficiency is probable. The future cost of motor fuel was postulated to range from \$1.50 to \$2.30 per gallon by the year 2000, as measured in constant 1979 dollars. Automobile fuel efficiency was postulated to range from 27.5 to 32.0 miles per gallon, expressed as a vehicle fleet average.

- Population lifestyles were identified as a key external factor because shifts in lifestyles affect land use and travel patterns, which in turn affect future transit needs. Recent changes in population lifestyles have resulted in a substantial shift away from the once traditional family-oriented lifestyle to a more individualistic lifestyle. This has resulted in lower fertility rates, higher female labor force participation rates, and a reduction in average household size. It is not clear at this time whether this recent shift represents only a postponement of family formation by those in or approaching traditional family formation ages or a permanent shift in lifestyle. Accordingly, it was postulated that the trend toward an individualistic lifestyle could continue, or that lifestyles could again become more family-oriented.

- The future level of economic activity in the Region will also greatly influence transit needs in the Milwaukee area. Economic conditions are an important determinant of the future size of the resident population, of per household and per capita incomes, and of the amount of travel for both work and other purposes. The major factor determining the health of the regional economy was concluded to be the extent to which the Region can remain competitive with other regions of the nation in preserving and expanding its economic base. It was concluded that economic conditions over the next two decades could be expected to range from a condition of virtually no growth in economic activity to a condition under which historic high rates of growth would again occur.

- Using the extremes of these ranges in the external factors affecting development in the Region, two scenarios of future development were postulated to provide opposite extreme, yet reasonable and consistent, futures with regard to transit need and use in the Region. A "moderate growth" scenario was postulated to represent a future set of conditions that would result in the highest probable levels of future transit need and use. This scenario assumes a rapid increase in energy costs with some disruption in supply and an attendant substantial increase in the cost of automobile travel; a stabilization of lifestyles accompanied by a relatively small increase in the female labor force participation rate, a return to replacement-level fertility rates, and a stabilization of household size; and a revitalized economic base leading to increasing employment levels, and an attendant cessation of the net population out-migration experienced in the Region over the more recent past. A "stable or declining" growth scenario was postulated to represent a future set of conditions that would result in the lowest probable levels of future transit need and use. This scenario assumes a moderate increase in energy cost, no disruption in supply, and, due to increasing efficiency in motor fuel use, a slight decrease in the real cost of automobile travel; a continuation of the trend toward individualistic population lifestyles accompanied by a significant increase in the female labor force participation rate, a continuation of below-replacement-level fertility rates, and a decline in household size; and a declining regional economic base leading to stable employment levels and continued substantial population out-migration.

- Under the moderate growth scenario, employment in the Region was postulated to increase by 141,300 jobs—from 874,700 jobs in 1980 to 1,016,000 jobs in the year 2000, a 16 percent increase over the 20-year period. Manufacturing employment was postulated to increase by 57,800 jobs, or 22 percent; service employment by 51,800 jobs, or 15 percent; and all other employment by 31,700 jobs, or 12 percent over the 1980 levels. The population of the Region was postulated to increase by 454,400 people—from 1,764,900 persons in 1980 to 2,219,300 persons in the year 2000, a 26 percent increase. The average household size was postulated to range from 2.9 to 3.1 persons in the year 2000, as compared with 2.8 in 1980, with the number of households in the Region expected to range from 681,000 to 739,000, as compared with 628,000 in 1980. Modest increases in household income were assumed, ranging from a real—as opposed to an inflationary—gain of 1.1 to 1.4 percent per year.

- Under the stable or declining growth scenario, employment in the Region was assumed to increase only slightly from the 1980 level of 874,700 jobs to a year 2000 level of 887,000 jobs—an increase of 12,300 jobs, or 1.4 percent. Manufacturing employment was postulated to increase by 3,800 jobs, or 1 percent; service employment by 6,100 jobs, or 2 percent; and other employment by 2,400 jobs, or 1 percent over the 1980 levels. The regional population was postulated to decline by about 4 percent—from 1,764,900 persons in 1980 to 1,688,400 persons in the year 2000. The average household size was postulated to range from 2.2 to 2.5 persons in the year 2000, as compared with 2.8 persons in 1980, with the number of households expected to range from 674,000 to 751,000, as compared with 628,000 in 1980. Changes in household income were assumed to range from no real increase to just over a 0.3 percent annual rate of increase.

- Two land use plans were then prepared for each of the two growth scenarios: one representing a centralized land use pattern and the other a decentralized land use pattern. These two land use plans were developed to encompass the reasonable range of future land use patterns that could be expected to occur within the Region and influence transit needs under each alternative growth scenario. The centralized land use plan for the moderate growth scenario represents the most optimistic of the four futures for transit use, while the decentralized land use plan for the stable or declining growth scenario represents the most pessimistic future for transit use. These two "extreme" alternative futures are shown on Map 15 on page 144 in Chapter V of this report and Map 18 on page 152 in Chapter V.

SUMMARY OF INVENTORY FINDINGS AND CONCLUSIONS

The major findings and conclusions of the inventories and analyses undertaken as part of the Milwaukee area primary transit study may be summarized as follows:

- The major factors affecting the need for transit services are the size and distribution of population; land use, particularly the density and attendant centralization or decentralization; the level and distribution of economic activity, particularly as measured by jobs; personal income; lifestyles, particularly as reflected in household sizes and labor force participation rates; automobile availability; trip generation; and motor fuel cost and availability. Presently, many uncertainties exist with respect to the future condition of these factors in the Region. After 120 years of continuous, rapid population growth, there was virtually no such growth in the Region from 1970 to 1980. The resident population of the Region now stands at about 1.76 million persons, and a virtual balance exists between natural increase and net migration. The regional population has continued to decentralize, with Milwaukee County losing about 8 percent of its residents from 1970 to 1980. This decentralization of population has been accompanied by the rapid conversion of land to urban uses in the outlying counties. Although the population remained stable, the number of jobs within the Region increased from 741,600 in 1970 to 874,700 in 1980, an 18 percent increase. The character of the regional economy has been changing, with manufacturing jobs decreasing in relative importance from about 34 percent of all jobs in 1970, to about 30 percent of all jobs in 1980. Although per capita income in the Region has continued to increase, the rate of increase has been declining.

  These changes in population and economic activity have been accompanied by important changes in lifestyles, including a dramatic reduction in the average household size from 3.20 persons per household in 1970 to 2.75 in 1980, and a marked increase in the labor force participation rate—particularly for females—from 59 percent in 1970 to 69 percent in 1980. The number of automobiles available to the residents of the Region, as well as the amount of tripmaking by such residents, has continued to increase despite population stabilization. Automobile availability within the Region increased from 634,100 in 1970 to 842,500 in 1980, a 33 percent increase. Tripmaking increased from 3.6 million person trips per average weekday in 1963 to 4.5 million person trips per day in 1972, a 25 percent increase. The infusion of public funds into transit systems beginning in the early 1970's has resulted in a reversal of the theretofore long-term decline in transit use, with the number of transit trips per average weekday increasing from a low of 161,000 in 1975 to 213,000 in 1980. The extent to which federal, state, and local funds will continue to be made available for transit purposes is, however, uncertain. The cost of motor fuel has increased from $0.67 per gallon in 1970 to $1.02 per gallon in 1980, expressed in constant 1979 dollars—a 52 percent increase. The overall efficiency of the motor vehicle fleet, however, has increased from about 13 miles per gallon to about 17 miles per gallon over this same period. Thus, fuel costs attendant to automobile operation have increased by only 20 percent—from about 5c per mile to about 6c per mile.

- In order to cope with the many uncertainties that exist in the Region with respect to the factors that affect the need for, and use of, public transit systems, an "alternative futures" approach was applied to the design, test, and evaluation of alternative primary transit plans. Under this approach, it is recognized that certain of the key factors which affect transit use are external to the Region; that is, they are factors over which local officials have little or no control. These key external factors were identified as energy cost and availability, economic conditions, and population lifestyles. Alternative regional population and employment levels attendant to these key external factors were then developed. Finally, centralized and decentralized regional land use plans were prepared for each set of alternative population and employment levels. The extremes of the ranges in the external factors identified as affecting regional development were used to establish two scenarios that provide opposite extreme, yet reasonable and consistent, futures with regard to transit need and use.

A "moderate growth" scenario was postulated to represent a set of conditions that would result in the highest probable levels of future transit need and use. Under this scenario, the year 2000 regional population was assumed to approximate 2.22 million persons—an increase of about 460,000 persons, or about 25 percent, over 20 years—with an employment level of about 1.02 million—an increase of about 145,000 jobs, or 17 percent. Motor fuel costs were assumed to rise from $1.02 per gallon in 1980 to $2.30 per gallon in the year 2000, expressed in constant 1979 dollars, and the efficiency of the motor vehicle fleet was assumed to rise from an average of about 17 miles per gallon (mpg) in 1980 to 27.5 mpg in 2000. Interruptions in motor fuel supply were assumed. The average household size was assumed to stabilize at about 3.0 persons per household, with a return to a more traditional, family-oriented lifestyle.

A "stable or declining growth" scenario was postulated to represent a set of conditions that would result in the lowest probable levels of future transit need and use. Under this scenario, the year 2000 regional population was assumed to approximate 1.69 million persons, a decrease of about 90,000 persons, or about 5 percent, with regional employment increasing only slightly to a level of about 887,000 jobs. Motor fuel was assumed to cost about $1.50 per gallon, and the efficiency of the motor vehicle fleet was assumed to rise to an average of about 32.0 mpg. Average household size was assumed to continue to decline to about 2.4 persons per household.

Centralized and decentralized land use plans were prepared for each of two growth scenarios, thus resulting in four alternative futures to be used as a basis for testing and evaluating alternative primary transit system plans.

- Nearly all of the former electric interurban railway rights-of-way in the Milwaukee area were found to have at least some segments with good potential for new primary transit facility development, although the grades of these rights-of-way are only partially intact and nearly all bridges at former grade separations have been removed. However, whether such rights-of-way would be useful in the development of a new Milwaukee area primary transit system will depend upon the location of the demand for primary transit service. Because they have been established primarily by easements, the electric power transmission line rights-of-way were found to have little potential for new primary transit facility development.

- Many segments of the active railway lines in the Milwaukee area were found to have good potential for the location of at-grade primary transit guideways. Of the abandoned railway rights-of-way, however, only one—the former Chicago & North Western Railway Company main line extending north from downtown Milwaukee—was found to have good potential for new primary transit facility development.

- Six railway lines in the Region were found to have good potential for use in the provision of commuter rail service. These six routes radiate from downtown Milwaukee to Port Washington, to Saukville, to West Bend, to Oconomowoc, to Racine and Kenosha, and to Waukesha. The cost of necessary track rehabilitation on these lines was found to range from a low of about $118,000 per mile, or a total of about $3.8 million for the route to Oconomowoc, to a high of about $484,000 per mile, or a total of about $13.4 million for the route to Saukville. Track rehabilitation costs for the entire six-route system would total approximately $35.7 million.

- The Milwaukee area freeway system was found to have significant potential for providing primary transit service, but only of the modified type involving the operation of motor buses in mixed traffic. Such operation could, however, be significantly enhanced through the institution of an areawide freeway operational control system with attendant ramp meters and preferential access lanes for buses. Based upon the inventory findings, the reservation of existing freeway lanes for the exclusive use of buses in either the normal flow or contraflow direction was eliminated from further consideration, both because of the physical problems presented by the design of the Milwaukee area freeway system for the development of such exclusive bus lanes—particularly the problems presented by the left-hand ramps of the system—and because of the traffic congestion which would be caused by removing an existing lane from use by normal traffic. The inventories further indicated that the medians, outside shoulders, and nonroadway portions of the Milwaukee area freeway system cannot be readily used for the construction of either single or dual busways or railways because of the limited horizontal clearance available along significant portions of the freeway rights-of-way and because of the need to separate any busway or railway from the freeway ramps which would frequently cross potential busways or railway alignments. Corridors that have been cleared for future freeway construction, including the Stadium Freeway-South, the Park Freeway-East, and the Park Freeway-West, were found to have significant potential for accommodating primary transit fixed guideways for either busway or railway purposes.

- Five primary transit modes were found to be feasible for use in the preparation of alternative primary transit systems for the greater Milwaukee area: motor buses on freeways, buses on busways, light rail transit, heavy rail rapid transit, and commuter rail. The electric trolley bus was considered to constitute a special variation of the motor bus mode to be considered further only if the final plan proposes the operation of buses over busways on reserved lanes. The more exotic or futuristic transit technologies were ruled out from further consideration as not being practically available for the provision of transit service in the Milwaukee area within the next two decades. Such technologies, including personal rapid transit (PRT), group rapid transit (GRT), dual mode transit, monorail transit, duorail transit, and moving way transit systems, either are inappropriate for line-haul metropolitan rapid transit service; still require extensive research, experimentation, test, and demonstration; or offer no advantages over the proven transit technologies.

The demographic, economic, land use, natural resource base, public utility, travel habit and pattern, and transportation facility capacity and use information pertinent to primary transit system planning collated from the Regional Planning Commission's planning data bank, together with the important new information provided by the inventories conducted of the potential of abandoned electric interurban and other railway rights-of-way, operating railway rights-of-way, electric power transmission line rights-of-way, and freeway rights-of-way to accommodate primary transit facility development, and of the state-of-the-art of primary transit technology, provides a sound basis for primary transit system planning in the Milwaukee area. Particularly important are the detailed inventories of the ability of the existing freeway system to provide modified primary transit service through the operation of motor buses in mixed traffic, and to accommodate reserved lanes in both the normal and contraflow directions for the exclusive operation of motor buses; and the detailed inventories of the potential of the operating railway lines in the Region to provide commuter rail service.

Equally important, however, to sound, long-range, primary transit system planning is the application of the alternative futures approach. In the face of the uncertainties which exist concerning the future development of the Region, this approach permits the identification of those primary transit facilities and modes that may be expected to perform well under a wide range of future development conditions. Thus, a "robust" system of primary transit facilities can be identified and recommended for implementation with confidence that the facilities comprising the system will constitute needed and useful capital investments under nearly all probable future development conditions within the Region.

ALTERNATIVE PLAN PREPARATION, TEST, AND EVALUATION

Introduction

The design, test, and evaluation of alternative transit system plans, and the selection of a recommended plan on the basis of such design, test, and evaluation, are perhaps the most critical steps in the alternatives analysis. It is in these steps that the degree to which agreed-upon transit system development objectives can be met by alternative transit system plans is determined and comparatively evaluated, and the recommendations for adoption and implementation of the plan which best meets the objectives are prepared.

Base Primary Transit System Plan

Any long-range transportation systems planning effort requires that a base plan be defined against which all alternative plans can be compared and evaluated, and incremental costs and benefits determined. Frequently, in transportation systems planning, such a base plan is called a "do nothing" or a "no build" plan—that is, a plan which requires little or no capital investment in new or improved facilities and services. In the case of the Milwaukee area primary transit system study, the Advisory Committee determined that the base plan should consist of the short-range transit system improvement plan adopted by the Milwaukee County Board of Supervisors on September 10, 1980. This plan is graphically summarized on Map 24 on page 166 in Chapter VI of this report.

The primary transit component of the base plan consists of the Freeway Flyer service presently being provided by Milwaukee and Waukesha Counties in the Milwaukee urbanized area. At the time the base plan was prepared—June 1980—Freeway Flyer service was being provided over 12 bus routes connecting 14 outlying park-ride lots with either the Milwaukee central business district or the University of Wisconsin-Milwaukee campus. Under the base plan, Freeway Flyer service would be provided over 16 routes, of which four would be new routes from downtown Milwaukee to four new park-ride lots—at the intersections of W. Appleton Avenue and W. Silver Spring Drive, N. 107th Street and W. Good Hope Road, IH 94 and W. Ryan Road, and S. Lake Drive and E. Lunham Avenue. Also under the base plan, express bus service would be provided over seven routes during peak travel periods, of which three routes—Fond du Lac Avenue, Forest Home Avenue, and Wisconsin Avenue/UWM—would be new. Finally, under the base plan local transit service within Milwaukee County would be improved through the addition of two new local routes to the 41 existing routes, the extension of 15 existing local routes, the partial rerouting of a number of existing routes to improve connectivity and directness, and the reduction of service headways during off-peak periods on about one-third of the existing routes.

The base system plan was tested through the application of the Commission's travel simulation models for all four alternative futures identified in the study—moderate growth scenario-centralized land use plan alternative, moderate growth scenario-decentralized land use plan alternative, stable or declining growth scenario-centralized land use plan alternative, and stable or declining growth scenario-decentralized land use plan alternative. The results of this quantitative test are summarized in Table 80. Under the base plan, transit ridership could be expected to range on an average annual basis from a high of about 71 million passengers under the moderate growth scenario-centralized land use plan alternative future, to a low of about 54 million passengers under the stable or declining growth scenario-decentralized land use plan alternative future. The proportion of the operating and maintenance costs met by farebox revenue on an average annual basis over the 21-year design period 1980 through 2000 under the base plan could be expected to range from a high of 56 percent to a low of 52 percent under these two futures, respectively, with an average annual capital cost requirement ranging from $7.1 million to $5.1 million, and an average annual operating deficit ranging from $20.5 million to $17.9 million, respectively.

It should be noted that the base transit system plan assumed for purposes of analysis in this study was prepared prior to recent action by Waukesha County to initiate additional Freeway Flyer bus service to the Milwaukee central business district. At the present time, Waukesha County is providing experimental Freeway Flyer service from the Menomonee Falls, Brookfield, Oconomowoc, and Mukwonago areas of Waukesha County to downtown Milwaukee. To the extent that Waukesha County determines to continue such service in future years, it would, of course, constitute a supplement to the base system plan. However, none of the quantitative analyses conducted with respect to that base plan reflect such service.

Maximum Extent System Plan Determination

The first step in the process of preparing alternative primary transit system plans for the greater Milwaukee area involved the determination of the maximum extent of potential networks of services and facilities to be considered for each of the selected transit technologies—bus on freeway, bus on busway, light rail transit, heavy rail rapid transit, and commuter rail—and for each alternative future. Two criteria were used in defining the maximum extent of these primary transit networks: travel demand and availability of rights-of-way for primary transit facilities. Only those corridors characterized by heavy travel demand and having an available right-of-way for a facility, and which would entail relatively low development costs and a minimum of disruption of existing urban development, were included in the maximum networks.

Travel demand was considered an important criterion in the design of the maximum extent primary transit networks because only in corridors of heavy travel demand can the transit ridership level be expected to be high enough to justify the costs of primary transit system construction and operation. Such corridors must have a large total travel market to draw upon, and are usually characterized by traffic and parking congestion sufficiently severe to make travel on high-speed primary transit systems particularly attractive. Furthermore, only in heavily traveled corridors can a greater reliance on transit travel be expected to have important positive impacts on highway congestion, motor fuel consumption, and air pollution. Corridors of major travel demand in the Milwaukee area were identified through an analysis of the location of existing and proposed major land use activity centers—such as major retail and service centers, major industrial centers, major medical centers, and university campuses—which serve as major trip generators; of existing and probable future travel desire lines; of the travel and traffic volumes which may be expected to occur in the absence of primary transit system improvements; and of ridership levels on existing transit routes.

Based upon an analysis of these factors under each of the four alternative futures, seven corridors of major travel demand common to all four futures were identified: 1) a northeast corridor, a radial corridor extending from the Milwaukee central business district (CBD) into the Villages of Shorewood and Whitefish Bay; 2) a north corridor, a radial corridor extending from the Milwaukee CBD into the City of Glendale; 3) a northwest corridor, a radial corridor extending from the Milwaukee CBD into the Village of Menomonee Falls; 4) a west corridor, a radial corridor extending from the Milwaukee CBD into the City of West Allis; 5) a southeast corridor, a radial corridor extending from the Milwaukee CBD into the Cities of St. Francis and Cudahy; 6) a north-south crosstown corridor located west of the Milwaukee CBD and extending from the north side of the City of Milwaukee into the City of Greenfield; and 7) an east-west crosstown corridor located north of the Milwaukee CBD and extending from the Village of Shorewood to the City of Wauwatosa.

The availability of potentially suitable rights-of-way for primary transit facilities and services was considered an important criterion in the design of the maximum extent primary transit networks because the availability of such rights-of-way can substantially decrease the capital costs entailed in facility construction. Accordingly, all of the potentially available rights-of-way for the location of bus-on-busway, light rail transit, and heavy rail rapid transit fixed guideways, as well as the freeways available for bus-on-freeway service and the railways available for commuter rail service, were analyzed in terms of the potential for such guideway development. These include all active and abandoned railway and former electric interurban railway rights-of-way, freeways, and cleared freeway corridors that were determined to have good or fair potential for primary transit fixed guideway development. In addition, those surface arterial streets and highways which were determined to have good potential for the operation of a busway or light rail transit facility providing a somewhat lower level of service than true primary transit but a somewhat higher level than ordinary express bus service over surface streets were identified. Such alignments are generally limited to potential transit malls, particularly in the Milwaukee CBD, and to arterial streets with divided pavements and wide medians. These alignments, together with the existing and planned freeway system and the existing railway system, thus provided a pool of potential rights-of-way to be considered in the design of the maximum extent primary transit networks for each transit technology under each alternative future.

Given the location of the seven defined corridors of major travel demand and of the potential rights-of-way, maximum extent networks were defined for the bus-on-freeway technology, the commuter rail technology, and the fixed guideway technologies, the latter including light rail transit, heavy rail rapid transit, and bus-on-busway transit. These maximum extent networks were found to be common to all four alternative futures, and were defined to include all reasonable possibilities for each primary transit technology.

The maximum extent network in the Milwaukee area for the bus-on-freeway technology is shown on Map 20 on page 162 in Chapter VI of this report. This network provides for the operation of bus-on-freeway primary transit lines over 152 miles of existing and 12 miles of planned freeways in the Region, as well as over 82 miles of extensions of the freeway lines over surface arterial streets. The provision of primary transit service over this network was assumed to include a fully operationally controlled freeway system. Such an operationally controlled system is already partially in place and working in the Milwaukee area, with 20 ramp meters at freeway entrance ramps and four ramps for preferential access of buses to the freeway system already in place. The operational control system would require the installation of additional freeway ramp meters and the interconnection and

Table 80

SELECTED CHARACTERISTICS OF THE EXISTING 1980 MILWAUKEE AREA TRANSIT SYSTEM, THE BASE PRIMARY TRANSIT SYSTEM PLAN, AND THE FINAL RECOMMENDED PRIMARY TRANSIT SYSTEM PLAN

Characteristic	Existing Transit System (1980)[a]	Base Primary Transit System Plan		Lower Tier of the Final Recommended Primary Transit System Plan	
		Optimistic Scenario— Moderate Growth Centralized Land Use Plan[b]	Pessimistic Scenario— Stable or Declining Growth Decentralized Land Use Plan[b]	Optimistic Scenario— Moderate Growth Centralized Land Use Plan[b]	Pessimistic Scenario— Stable or Declining Growth Decentralized Land Use Plan[b]
Transit System Service Characteristics					
Daily Vehicle Miles					
Rapid Transit Element	4,700	8,900	6,620	43,150	14,810
Total Transit System	72,900	94,800	59,300	130,580	65,910
Vehicle Requirements (including spare vehicles)					
Rapid Transit Element	68 buses	86 buses	60 buses	242 buses 27 LRV's	129 buses 16 LRV's
Total Transit System	640 buses	991 buses	579 buses	1,008 buses 27 LRV's	612 buses 16 LRV's
Rapid Transit Headways (minutes)				Bus on Freeway / Light Rail Transit	Bus on Freeway / Light Rail Transit
Peak Periods	4-46	5-30	10-30	5-30 / 4-6	12-30 / 7-10
Off-Peak Periods[c]	55-64	15	30	20-60 / 12-20	45-60 / 30
Average Transit Vehicle Speed (miles per hour)					
Rapid Transit Element	20	19	24	28	27
Total Transit System	12	14	15	18	17
Accessibility					
Population Served Within a One-Half-Mile Walking Distance of Rapid Transit Service	--[d]	257,100	181,500	392,200	260,100
Population Served Within a Three-Mile Driving Distance of Rapid Transit Service	--[d]	1,012,400	698,800	1,300,000	930,600
Employment Served Within a One-Half-Mile Walking Distance of Rapid Transit Service	--[d]	237,000	194,600	309,300	260,200
Transit System Utilization					
Average Annual Ridership (millions)	58.0	70.7	53.7	74.8	54.1
Average Weekday Ridership					
Total Transit Trips	199,700	326,800	169,400	371,700	176,300
Rapid Transit Element	8,200	15,000	9,500	95,200	35,200
Percent of Transit Trips Using Rapid Transit	4	4	6	26	20
Percent of Total Person Trips Made on Transit	6	7	5	8	5
Number of Average Weekday Transit Trips to the Milwaukee Central Business District	32,900	81,700	42,350	86,100	52,600
Transit System Cost (millions)					
Total Design Period Capital Investment	$160.2	$233.3	$161.6	$462.5	$368.9
Total Design Period Capital Cost[e]	108.2	149.1	107.1	302.5	220.9
Average Annual Total Cost (capital and operating and maintenance cost)	50.9	53.7	42.4	69.9	49.9
Average Annual Farebox Revenue	21.9	26.1	19.4	31.5	20.2
Average Annual Net Public Cost	29.0	27.6	23.0	38.4	29.7
Average Annual Capital Cost	5.1	7.1	5.1	14.4	10.5
Average Annual Operating and Maintenance Deficit	23.9	20.5	17.9	24.0	19.2

Table 80 (continued)

Characteristic	Existing Transit System (1980)[a]	Base Primary Transit System Plan: Optimistic Scenario—Moderate Growth Centralized Land Use Plan[b]	Base Primary Transit System Plan: Pessimistic Scenario—Stable or Declining Growth Decentralized Land Use Plan[b]	Lower Tier of the Final Recommended Primary Transit System Plan: Optimistic Scenario—Moderate Growth Centralized Land Use Plan[b]	Lower Tier of the Final Recommended Primary Transit System Plan: Pessimistic Scenario—Stable or Declining Growth Decentralized Land Use Plan[b]
Transit System Propulsion Energy Use					
Total Transportation System Propulsion Energy Use (millions of gallons)	484.1	415.2	343.9	406.0	338.4
Transit Propulsion Energy Use in the Design Year (millions of gallons of diesel fuel)	5.2	10.4	5.5	10.8	5.6
Automobile Propulsion Energy Use (millions of gallons of gasoline)	478.9	404.8	338.4	395.2	332.8
Transit Dependence on Petroleum-Based Fuel	All trips dependent	All trips dependent	All trips dependent	8 percent of transit trips not dependent	8 percent of transit trips not dependent
Transit System Performance					
Cost-Effectiveness					
Average Annual Net Public Cost per Passenger	$0.50	$0.39	$0.43	$0.51	$0.54
Average Annual Net Public Cost per Passenger Mile	$0.14	$0.10	$0.11	$0.10	$0.12
Percent of Average Annual Operating and Maintenance Cost Met by Farebox Revenue	48	56	52	61	52
Energy Efficiency					
Average Annual Transit Passenger Miles per Gallon of Diesel Fuel Used for Vehicle Propulsion	40.7	41.7	38.9	48.1	39.4
Environmental Impacts					
Community Disruption					
Homes, Businesses, or Industries Taken	None	None	None	None	None
Land Required (acres)	None	12	10	123	62
Air Pollutant Emissions—Total Transportation System (Highway and Transit) in Design Year (tons per year)					
Carbon Monoxide	421,010	171,190	165,760	167,300	163,100
Hydrocarbons	42,890	17,360	16,700	16,900	16,400
Nitrogen Oxides	50,930	30,690	30,070	30,000	29,200
Sulfur Oxides	1,980	2,510	2,420	2,600	2,400
Particulates	3,530	4,090	3,960	4,000	3,900

[a]*Data presented in this column represent existing 1980 conditions with two exceptions. These exceptions relate to cost data pertaining to the existing system. One exception relates to the cost data described as "design period" data. These data represent the total costs or investment which would be necessary simply to continue operation of the existing transit system over the 21-year design period from 1980 to 2000. Such costs consist primarily of the cost of the replacement of buses as such buses reach the end of their useful lives over the 21-year period. The other exception relates to the cost data described as "average annual" costs. These costs represent the expected average cost over the 21-year design period necessary to simply continue operation of the existing transit system.*

[b]*Data presented in this column represent design year 2000 forecast data with two exceptions. One exception relates to the data described as "average annual" data. These data represent the expected average cost per year over the 21-year design period from 1980 to 2000. The other exception relates to the data described as "design period" data. These data represent the expected total over the 21-year design period from 1980 to 2000.*

[c]*Primary transit service provided in the off-peak travel periods under the existing 1980 transit system and base system plan is limited to a single route operating over the North-South Freeway (IH 43) during the midday travel periods only.*

[d]*Data for the existing Milwaukee County Transit System will only be available upon analysis of 1980 census data.*

[e]*Capital investment is defined as the total outlay of funds for guideway, station, and support facility construction and vehicle acquisition necessary to implement a plan or continue the existing transit system over the plan design period, and indicates total capital resources required for implementation. Capital cost is defined as the capital investment less the value of the remaining life of facilities and vehicles beyond the plan design period, and indicates the true capital expenditures required for plan implementation or existing system continuation over the design period. A 21-year plan design period has been used in this study, extending from 1980 through 2000.*

Source: SEWRPC.

centralized operational control of such meters, as recommended in the adopted regional transportation system plan. The system of ramp meters already in place has proven to be capable of increasing operating speeds and improving traffic flow on the most congested segments of the Milwaukee area freeway system.

The maximum network defined for commuter rail primary transit service includes the six railway lines radiating from the Milwaukee CBD to the communities of Port Washington, Saukville, West Bend, Oconomowoc, Waukesha, and Racine and Kenosha, as shown on Map 23 on page 165 in Chapter VI of this report. Of all the active railway lines in the Region, these six were determined to be amenable to commuter train operation, having good to excellent potential for such operation based on consideration of the costs of necessary track rehabilitation, grade-crossing protection, and storage and servicing facility requirements. The lines are properly located to connect the Milwaukee CBD to other major trip generators, including concentrations of residential development. Of the seven previously identified corridors of major travel demand, however, only two would be directly served by the potential commuter rail routes: the west and southeast corridors radiating from the Milwaukee CBD. The other five corridors do not contain potential commuter rail routes.

The maximum network of fixed guideway primary transit facilities for the bus-on-busway, light rail transit, and heavy rail rapid transit modes was defined to include alignments in each of seven corridors of major travel demand plus six extensions of those corridors, as shown on Map 19 on page 160 in Chapter VI. The six extensions were included in the maximum extent network because of the availability of at least one existing right-of-way that could be developed at a minimum of cost and because the areas serviced by the corridor extensions were shown to have fairly substantial travel demand.

Each of these maximum extent fixed guideway corridors was then refined in order to select preferred alignments within such corridors for the busway, light rail transit, and heavy rail rapid transit modes. Such alignments were developed to minimize capital costs and community disruption while maximizing potential operating speeds and accessibility. To the extent practicable, the alternative alignments were located along available rights-of-way. The alignments were selected to be as direct as possible in order to provide competitive travel times, to maximize potential use by residents and workers in the Milwaukee area, and to serve existing and proposed major land use activity centers and concentrations of residential development. Capital cost estimates for the construction of each alternative mode on the alignment selected were based on the extent of the alignment to be at-grade, elevated, depressed, or in a subway. Such costs, together with estimated travel times, estimated community disruption, and the number of residents and jobs served, were important considerations in the selection of a preferred alignment within each corridor for each of the three fixed guideway transit technologies.

Following the selection of preferred alignments within each travel corridor for the three fixed guideway transit technologies, it was necessary to synthesize maximum extent busway, light rail transit, and heavy rail rapid transit system plans. To the extent practicable, each of the preferred alignments for each of these three fixed guideway transit modes in each of the seven corridors was retained in the maximum extent system plan for that mode. Other considerations had to be taken into account in the plan synthesis process, however, in order to minimize the cost and disruption attendant to interconnecting the recommended alignments, as well as to minimize any duplication of alignments and to ensure that the alignments served as many major land use activity centers as practicable while providing an overall high level of accessibility to areas of residential concentration. The results of this plan synthesis process for the fixed guideway modes are shown on Map 21 on page 163 in Chapter VI for the busway and light rail transit modes, and on Map 22 on page 164 in Chapter VI for the heavy rail rapid transit mode. The maximum extent busway and light rail transit plans are identical in configuration. The major differences between the maximum extent heavy rail system plan and the maximum extent busway and light rail transit system plans are that the latter include a spur to the University of Wisconsin-Milwaukee campus area, as well as a spur to the Milwaukee County Institutions grounds, and the former includes a fixed guideway along the right-of-way cleared for the Park Freeway-West. The maximum extent system plans for the three fixed guideway transit technologies, together with the maximum extent system plans for the bus-on-freeway and commuter rail technologies, were then tested and evaluated through the application of the Commission travel simulation models.

Evaluation of Maximum Extent System Plans

Analyses of the results of the simulation modeling of the maximum extent system plans for each of the primary transit technologies under each alternative future resulted in decisions by the Advisory Committee relating to further, more detailed consideration of certain technologies, as well as to revisions in the plans in order to better meet the objectives and standards relating to cost-effectiveness. Such plan revisions were based upon route-by-route analyses to determine and eliminate from further consideration inefficient routes or route segments. A particularly important measure of cost-effectiveness used in these analyses was the proportion of operating and maintenance costs that could be expected to be recovered from farebox revenues. The following discussion briefly describes the results of the test and evaluation of the maximum extent system plans for all of the transit technologies under the alternative future considered to be the most optimistic for transit use—the moderate growth scenario-centralized land use plan—and the alternative future considered to be the most pessimistic for transit use—the stable or declining growth scenario-decentralized land use plan. Selected characteristics of this evaluation are summarized in Table 44 of Chapter VI of this report.

Maximum Extent Bus-on-Freeway System Plan: Test and evaluation of the maximum extent bus-on-freeway system plan under all alternative futures indicated that the plan would have significantly higher capital costs and greater operating deficits, both in total and on a per-passenger basis, than the base plan described earlier. In addition, farebox revenues would recover a smaller portion of operating costs under the maximum extent plan than under the base plan. Accordingly, the maximum extent plan was truncated by eliminating, combining, and/or shortening certain routes, the objective being to ensure that the resulting bus-on-freeway system plan would produce farebox revenues of more than 50 percent of the operating and maintenance costs, and favorable total costs per passenger as compared with the base plan. Certain routes at the periphery of the urbanized area were identified as being appropriate for possible further consideration in any final plan as "specialized" routes, providing only limited peak-period service. A different set of service cutbacks was proposed under each of the four alternative futures. The results of this analysis for the four alternative futures are shown on Map 25 on page 173 in Chapter VI of this report.

Maximum Extent Commuter Rail System Plan: Test and evaluation of the maximum extent commuter rail system plan under all alternative futures indicated that this plan would also have significantly higher capital costs and operating deficits than the base plan. The analyses indicated that the commuter rail portion of the total transit system would recover only about 40 percent of operating and maintenance costs under the most optimistic future for transit use, and about 19 percent of such costs under the most pessimistic future. Accordingly, the results of the analyses were reviewed on a route-by-route basis to determine to what extent the maximum plan should be truncated under each of the alternative futures, the conclusions of which are shown on Map 36 on page 192 in Chapter VI of this report.

This analysis indicated that, even under the most optimistic future for transit use, three routes should be considered under a final plan only as "specialized" routes providing limited peak-period service: Milwaukee to Port Washington, Milwaukee to West Bend, and Milwaukee to Waukesha. These three routes had particularly high capital cost requirements for track rehabilitation and had higher-than-average operating costs per passenger mile. The Milwaukee-to-Saukville route was determined to perform well as far north as Grafton. Beyond that point, however, the additional ridership generated did not appear to justify the increase in costs. The Milwaukee-to-Oconomowoc and Milwaukee-to-Racine/Kenosha commuter routes were found to perform best and, together with the truncated Milwaukee-to-Grafton route, were retained for further analysis.

Under the most pessimistic future for transit use, all six commuter rail routes in the maximum extent plan were found to perform poorly, with the proportion of operating and maintenance costs met by farebox revenue ranging from a low of 6 percent on the Milwaukee-to-Port Washington route to a high of 37 percent on the Milwaukee-to-Racine/Kenosha route. Accordingly, it was determined that no further consideration should be given to a commuter rail plan under the stable or declining growth scenario-decentralized land use plan alternative future; rather, the strongest routes—those to Racine/Kenosha, Grafton, Oconomowoc, and Waukesha—should be retained for further consideration under any final plan as "specialized" routes providing limited peak-period service.

Under the two intermediate futures—the moderate growth scenario-decentralized land use plan and the stable or declining growth scenario-centralized land use plan—only the Milwaukee-to-Racine/Kenosha commuter rail route performed well enough to warrant its retention for further analysis. The routes to Grafton, Oconomowoc, and Waukesha would be retained for possible further consideration under both of these futures and to Port Washington only under the moderate growth scenario-decentralized land use plan alternative future and only in terms of special, limited peak-period service.

Commuter rail as an alternative primary transit mode, then, was shown to be viable as a true primary transit system only under the most optimistic of futures considered under this study, and therefore was to be carried forward for further analysis only under the moderate growth scenario-centralized land use plan alternative future. While the route between Milwaukee and Racine/Kenosha was found to be viable under the two intermediate futures, no commuter rail route was found to be viable under the most pessimistic future. Hence, under the stable or declining growth scenario-decentralized land use plan alternative future, commuter rail was eliminated from further consideration, and under the two intermediate futures, only the Milwaukee/Kenosha route was to be further evaluated, with such evaluation to be undertaken on a corridor basis rather than a system basis. Under each of the futures, certain additional individual routes were retained for possible future consideration in a final plan, but limited to "specialized" peak-period service, as shown on Map 36 on page 192 in Chapter VI.

Maximum Extent Busway and Light Rail Transit System Plans: The maximum extent busway and light rail transit system plans as defined above were identical in terms of network extent. For analytical purposes, these networks were segmented in order to determine which portions of the total networks should be retained for further analysis and which segments should be rejected from further consideration under the study. By thus reducing both capital and operating and maintenance costs, the cost-effectiveness of each of these two systems under all four alternative futures could be improved.

Under the most optimistic future for transit, this analysis resulted in identical truncated busway and light rail transit system plans, as shown on Map 30 on page 180 in Chapter VI of this report. The busway and light rail transit route segments deleted consisted of route extensions to Cedarburg, Menomonee Falls, Waukesha, and Oak Creek and those portions of a loop route serving the western Wauwatosa and Milwaukee east side areas. In addition, two routes extending south from Milwaukee into the south shore suburbs were combined into a single route. The resulting truncated busway and light rail transit system plans shown on Map 30 in Chapter VI were assumed to be operated as three major routes: a route extending from the Mayfair Mall Shopping Center in Wauwatosa to downtown Milwaukee; a route extending from South Milwaukee through the Milwaukee central business district and thence northwesterly to a terminus near Timmerman Field; and a crosstown route extending from the Northridge Shopping Center to the Southridge Shopping Center.

The truncated busway and light rail transit system plans identified under all of the three remaining alternative futures were also identical, as shown on Map 31 on page 181 in Chapter VI. The only difference between the truncated light rail transit and busway system plans shown on Map 30 and the system plans shown on Map 31 is the elimination under the two intermediate and the most pessimistic futures for transit of a route extension from Cudahy to South Milwaukee. Thus, in all other respects, the truncated system plans are identical for both the busway and light rail transit modes across all four futures.

Maximum Extent Heavy Rail Rapid Transit System Plan: The maximum extent heavy rail system plan identified on Map 22 on page 164 in Chapter VI of this report was similarly analyzed in terms of cost-effectiveness, with the analysis beginning with the most optimistic future for transit. This analysis indicated that operating a maximum extent heavy rail primary transit system at headways comparable to those provided under the maximum extent busway or light rail transit system plans would result in substantial unused capacity on the heavy rail rapid transit facilities in all corridors. Consequently, less than 34 percent of the total heavy rail rapid transit element operating costs could be expected to be recovered from farebox revenues, and for no routes would farebox revenues cover even 50 percent of the operating costs. The analysis further indicated that there was no need in any corridor during any time period for a train longer than the minimum of two vehicles. Consequently, the inherent efficiencies of the passenger-carrying capacity of a heavy rail system—the ability to use one operator for trains of up to 10 vehicles in length—could not be exploited in the Milwaukee area.

Importantly, a heavy rail rapid transit alternative would require a far greater capital investment for fixed guideway and station development than either the busway or light rail transit alternatives, while providing no advantage in ridership or in annual operating costs. Since all guideways for heavy rail rapid transit must be completely grade-separated, thus requiring the use of expensive subway or elevated structures in densely developed areas, the capital costs over the plan design period and in the plan design year, in terms of both the absolute total and the total per passenger, would be twice the comparable costs of a light rail transit system. The cost of constructing a necessary subway section in downtown Milwaukee beneath W. Wisconsin Avenue between N. 11th Street and the lakefront was estimated at $115 million alone, or about $80 million per mile. Because of these very high capital costs, and because of the inability to utilize the potential capacity of a heavy rail rapid transit system under even the most optimistic future for transit use in the Milwaukee area, the Advisory Committee determined that heavy rail rapid transit should be eliminated from further consideration as a possible alternative mode for providing primary transit service in the Milwaukee area. This finding reconfirmed the findings of a 1966 study by the Regional Planning Commission (see SEWRPC Planning Report No. 7, Land Use-Transportation Study, Volume Three, Recommended Regional Land Use and Transportation Plans: 1990, pages 35 through 43) and a study by Barton-Aschman Associates, Inc., under contract to Milwaukee County in 1971 (see Milwaukee Area Transit Plan, page 19). Consequently, no further work was done toward advancing a final truncated heavy rail rapid transit system plan for the Milwaukee area under any of the alternative futures.

Evaluation of Truncated and Composite System Plans Under Each Alternative Future

The next step in the design, test, and evaluation of alternative primary transit system plans was the test and evaluation of the truncated system plans for each alternative primary transit mode that survived the initial screening—bus on freeway, bus on busway, light rail transit, and commuter rail—under each alternative future. Based on this test and evaluation, a "best" composite plan for the provision of primary transit service in the Milwaukee area for each future was identified. In order to complete this analysis, the truncated maximum extent system plans were further refined so that the geographic extent of primary transit service provided under each alternative was comparable. This refinement involved adding selected bus-on-freeway routes from the truncated bus-on-freeway plan to the truncated busway, light rail transit, and commuter rail plans in travel corridors where those particular modes did not provide service but where the bus-on-freeway plan did provide service. Without such refinements, a fair, comparative evaluation of such plans could not be made.

Moderate Growth Centralized Land Use Plan Alternative Future: The four composite system plans under the moderate growth centralized land use plan alternative future—the most optimistic future for transit use—are shown on Map 26 on page 174 in Chapter VI for bus on freeway, Map 32 on page 183 for busway and light rail transit, and Map 37 on page 193 for commuter rail. The four composite system plans were comparatively evaluated on the basis of the degree to which each plan could be expected to meet the adopted primary transit system development objectives formulated under the study. The results of this extensive comparative evaluation are set forth in SEWRPC Technical Report No. 26, Milwaukee Area Alternative Primary Transit System Plan Preparation, Test, and Evaluation. Data on the performance of each alternative plan with respect to the key standards that support the primary transit system development objectives are presented in Table 45 of Chapter VI.

Generally, all four alternative primary transit system plans could be expected to work well in the plan design year, providing a reasonably similar level of primary transit service. The four plans were found to be quite similar in terms of total ridership, required annual public subsidy of operating and maintenance costs, operating and maintenance cost-effectiveness, and overall level of service. Each system plan could be expected to result in about the same level of total transit ridership in the Milwaukee area, specifically ranging between 366,000 and 379,000 trips on an average weekday in the plan design year. The anticipated average annual operating and maintenance cost deficit is also similar, ranging from $25.2 million to $27.0 million. Also, the proportion of operating and maintenance costs to be recovered from farebox revenues does not differ greatly, ranging from 53 percent to 55 percent on an average annual basis. Finally, each plan is expected to result in about the same average overall speed of travel for transit vehicles on the total transit system, between 16 and 18 mph.

The comparative analyses indicated that substantially more transit trips may be expected to be made on the primary transit element of the busway and light rail transit plans—135,000 and 145,000 weekday trips, respectively, compared with 75,000 trips under the bus-on-freeway plan and 46,000 trips under the commuter rail plan. The additional trips could be expected to be made on transit under the latter two plans as well, but on the local and express elements of those plans at a somewhat lower level of service.

Significant differences were found in the capital investment and capital costs attendant to each of the four plans. Capital investment is defined as the total outlay of funds for guideway, station, and support facility construction and vehicle acquisition necessary to implement the plan, while capital cost is defined as the capital investment less the value of the remaining life of facilities and vehicles beyond the plan design period. Under this future, the bus-on-freeway plan required the least capital investment—$343 million, with the commuter rail plan requiring only slightly more—$375 million. Because of new fixed guideway construction requirements, the busway and light rail transit plans would require substantially more capital investment—$627 million and $834 million, respectively. Because of the relatively long life of primary transit guideways and rail vehicles, the differences in capital cost between the four plans were considerably less than the differences in capital investment. The commuter rail plan was found to have the lowest capital cost—$215 million, followed by the bus-on-freeway plan—$223 million. The busway and light rail transit plans would have capital costs of $347 million and $436 million, respectively. These differences in capital costs between the plans may be expected to dominate the small differences found in the annual operating and maintenance cost subsidies required.

The bus-on-freeway plan was found to have the lowest average annual net public cost of $36.9 million, or $0.49 per passenger. The commuter rail plan was found to have an average annual net public cost of $37.2 million, or $0.70 per passenger; the busway plan $42.0 million, or $0.56 per passenger; and the light rail transit plan $46.0 million, or $0.62 per passenger.

After considering the array of data pertaining to costs, cost-effectiveness, transit utilization, and transit system accessibility, as well as other data pertaining to the standards that support the primary transit system development objectives, the Advisory Committee gave careful consideration to certain intangible matters that in particular would appear to support development of an admittedly higher cost light rail transit plan in the Milwaukee area. These intangible benefits are described below:

- Environmental Advantages: Within specific corridors, light rail transit would have some air pollution and noise advantages, although from a total areawide systems basis, air pollutant emissions and noise generation would not differ significantly between any of the plans considered. Along the selected routes, light rail vehicles would emit no air pollutants, while a diesel motor bus would emit air pollutants locally. In addition, a diesel motor bus may be expected to generate about 20 percent more noise than a light rail vehicle. The noise and air pollution benefits of light rail transit could be expected to be greatest in the Milwaukee central business district, where transit traffic volumes would be significant.

- Land Use Development and Redevelopment Advantages: All transit alternatives involving a fixed guideway have a potential to attract and thereby more effectively guide and shape land use development and redevelopment because they represent a perceived public commitment to high-quality transit service and an increase in accessibility. Light rail transit is considered by many to have a greater potential effect on land development than the bus-on-freeway, bus-on-busway, and commuter rail alternatives because it represents the greatest perceived public commitment to a high level of transit service in a specific location. There are, however, other factors which affect, perhaps more importantly, land development and redevelopment, and which could, therefore, offset the land development potential of light rail transit. These factors include economic forces at work throughout the metropolitan area, which affect the demand for land use development and redevelopment; the attractiveness of sites surrounding light rail transit stations in terms of ease of access, utility and other urban services, zoning, physical factors, and social characteristics; a public land use policy which encourages development and redevelopment on transit lines through coordinated tax policies, infrastructure supply, and appropriate land use controls, as well as local neighborhood and community acceptance and approval; and the presence of land near stations which is available or which can be readily assembled for development and redevelopment.

- Energy Advantages: While the analyses indicated that light rail transit may be expected to effect little savings in petroleum use over the other alternative plans because automobile energy use significantly dominates transit energy use, the use of electricity to provide light rail transit may be regarded as a significant advantage in the event of a serious petroleum shortage. The expansion of light rail transit service during an emergency situation may be difficult, however, particularly in terms of the availability of vehicles for additional service.

- Travel Safety Advantages: A light rail transit system may be expected to be safer than a bus-on-freeway system because of the extensive use of dedicated street right-of-way and the use of signals at crossings which provide preferential treatment for light rail vehicles. In addition, the more massive structure of a light rail vehicle offers more protection to passengers than a motor bus.

- Reliability of Operation Advantages: Both light rail transit and bus-on-busway transit service may be considered to be more reliable than transit service provided over public roadways shared with other traffic. Traffic congestion, traffic accidents, and street and utility repairs, which are common on public arterial street rights-of-way, would be nonexistent or much less common on exclusive rights-of-way. In addition, operational problems which are caused by inclement weather may be expected to be less severe for transit service operated on exclusive guideways than for service provided on public streets. However, light rail transit has the potential to suffer a total loss of service because of breakdowns or an accident involving a single vehicle or train, since light rail vehicles cannot be steered around obstructions. Service disruptions on light rail systems can also occur from power outages, or from a breakdown in the overhead power distribution system.

The Advisory Committee also directed that corridor analyses be conducted to compare bus-on-freeway service with busway, light rail transit, and commuter rail services in order to determine if there were any corridors in which the bus-on-freeway would be more costly and less cost-effective than any of the rail or fixed guideway plans. These corridor analyses indicated that, in every case, the bus-on-freeway plan may be expected to attract more transit ridership and entail no greater capital costs and no greater public operating and maintenance cost subsidy than the commuter rail plan. Similarly, these analyses indicated that the busway and light rail transit plans, while having substantially higher total public costs because of the capital investment required, would not in any corridor attract significant additional transit ridership over the bus-on-freeway plan.

After considering all of the data presented, both at a systems level and at a corridor level, the Advisory Committee concluded that the bus-on-freeway plan would be the best plan under the moderate growth centralized land use plan alternative future. The Committee noted that the bus-on-freeway plan would attract the highest transit ridership of the four plans considered, and would have the lowest total public cost over the plan design period.

Moderate Growth Decentralized Land Use Plan Alternative Future: Three composite system plans were prepared for the moderate growth decentralized land use plan alternative future. These are shown on Map 27 on page 175 in Chapter VI of this report for bus-on-freeway transit and on Map 33 on page 186 in Chapter VI for busway and light rail transit. In addition, a corridor analysis was conducted in order to compare the bus-on-freeway and commuter rail modes in the corridor extending from the Milwaukee central business district to the Cities of Racine and Kenosha.

The corridor analysis comparing the bus-on-freeway and commuter rail alternatives was undertaken only in the Milwaukee to Racine and Kenosha corridor because all of the other commuter rail routes were found to be not viable under previous analyses.

The analysis indicated that the bus-on-freeway service in this corridor may be expected to carry about 42 percent more passengers in the design year than the commuter rail service—13,900 passengers on an average weekday in the design year compared with 9,800 passengers. Under either alternative, most of these trips would originate or terminate in the Milwaukee central business district. Under the commuter rail alternative, an additional 2,300 trips could be expected to be made on the local and express portion of the transit system, thus resulting in a total ridership under the commuter rail alternative of about 12,100 passengers per average weekday in the design year, still somewhat less than the ridership under the bus-on-freeway alternative.

The corridor analysis further indicated that, given the anticipated total operating and maintenance costs, the bus-on-freeway service would require an average subsidy in the design year of $0.46 per passenger, compared with $1.37 per passenger for the commuter rail service. The bus-on-freeway service could be expected to recover about 22 percent more of its design year operating and maintenance costs from farebox revenues than the commuter rail service, 69 percent compared with 47 percent. The capital investment required to provide rapid transit service in this corridor would approximate $30.1 million under the bus-on-freeway plan and $37.1 million under the commuter rail plan, while the capital cost would approximate $17.2 million under the bus-on-freeway plan and $15.3 million under the commuter rail plan. Based upon these findings, the Advisory Committee concluded that bus-on-freeway service would be superior to commuter rail service within this corridor as it would attract substantially greater ridership and be more cost-effective. Accordingly, no further consideration was given to commuter rail service under this alternative future.

Summary data on the performance of the three remaining modal plans under this alternative future—bus on freeway, busway, and light rail transit—are provided in Table 46 of Chapter VI of this report. As with the previous alternative future, all three primary transit system plans could be expected to work well in the plan design year, providing a reasonably similar level of primary transit service. The three systems were found to be quite similar with respect to total transit ridership, ranging between 238,000 and 242,000 trips per average weekday in the plan design year. The anticipated average annual operating and maintenance cost deficit was also similar, ranging from $24.0 million to $24.7 million. Each of the alternatives would be expected to recover a similar proportion of their operating and maintenance costs from farebox revenues, ranging from 49 percent to 50 percent on an average annual basis. Substantially more trips may be expected to be made on the primary transit element of the busway and light rail transit plans—75,500 and 83,200 trips per average weekday, respectively, compared with 37,300 trips under the bus-on-freeway plan.

As shown in Table 46, the capital investments and capital costs attendant to implementation of the busway and light rail transit plans are significantly greater than the capital investment and capital cost attendant to implementation of the bus-on-freeway plan. This is to be expected, because the busway and light rail transit plans would both require fixed guideway construction, whereas the bus-on-freeway alternative relies on the existing freeway system, for which the costs of maintenance and rehabilitation are assumed to be incurred in any event and, accordingly, are not charged to transit in this analysis. The differences in capital costs dominate the relatively small differences found in the three alternatives in annual operating and maintenance cost subsidy requirements.

The bus-on-freeway plan was found to have the lowest average annual net public cost of $32.9 million, or $0.54 per passenger. The busway plan would require $38.1 million, or $0.63 per passenger; and the light rail transit plan $41.1 million, or $0.68 per passenger.

After considering all of the data presented, the Advisory Committee concluded that the bus-on-freeway plan would be the best plan under the moderate growth decentralized land use plan alternative future. The bus-on-freeway plan was noted as attracting the highest transit ridership of the final plans considered at the lowest total public cost over the plan design period.

Stable or Declining Growth Centralized Land Use Plan Alternative Future: Three composite system plans were prepared for the stable or declining growth centralized land use plan alternative future. These are shown on Map 28 on page 176 in Chapter VI of this report for bus-on-freeway transit and on Map 34 on page 188 in Chapter VI for busway and light rail transit. In addition, as in the previously discussed alternative future, a corridor analysis was conducted in order to compare the bus-on-freeway and commuter rail modes in the corridor extending from the Milwaukee central business district to the Cities of Racine and Kenosha. The same conclusion was reached under the corridor analysis for the stable or declining growth centralized land use plan alternative future as under that for the previous future—that is, that bus-on-freeway service would be superior to commuter rail service because it would attract substantially greater ridership and be more cost-effective. Accordingly, no further consideration was given to commuter rail service under this alternative future.

Summary data on the performance of the three remaining modal plans under this alternative future—bus on freeway, busway, and light rail transit—are provided in Table 47 in Chapter VI of this report. Again, all three primary transit system plans could be expected to work well in the plan design year, providing a reasonably similar level of rapid transit service. The three systems were found to be quite similar with respect to total transit ridership, ranging between 223,700 and 228,500 trips per average weekday in the plan design year. The anticipated average annual operating and maintenance cost deficit was also similar, ranging from $20.2 million to $21.2 million. Each of the alternatives could be expected to recover a similar proportion of their operating and maintenance costs from farebox revenues, ranging from 52 percent to 53 percent on an average annual basis. Substantially more trips may be expected to be made on the primary transit element of the busway and light rail transit plans—50,300 and 57,300 trips per average weekday, respectively, compared with 22,500 trips under the bus-on-freeway plan.

As under the other alternative futures considered, the capital investments and capital costs attendant to implementation of the busway and light rail transit plans were found to be significantly greater than the capital investment and capital cost attendant to implementation of the bus-on-freeway plan. These differences in capital costs dominate the relatively small differences found among the three alternatives in annual operating and maintenance cost subsidy requirements. The bus-on-freeway plan was found to have the lowest average annual net public cost of $28.7 million, or $0.48 per passenger. The busway plan would require $34.6 million, or $0.59 per passenger; and the light rail transit plan $36.9 million, or $0.62 per passenger.

Given these cost considerations, the Advisory Committee concluded that the bus-on-freeway plan would be the best plan under the stable or declining growth centralized land use plan alternative future. The bus-on-freeway plan would attract the highest transit ridership of the three final plans considered at the lowest total public cost over the plan design period.

Stable or Declining Growth Decentralized Land Use Plan Alternative Future: Three composite system plans were also prepared for the stable or declining growth decentralized land use plan alternative future. These are shown on Map 29 on page 177 in Chapter VI of this report for bus-on-freeway transit and on Map 35 on page 190 in Chapter VI for busway and light rail transit. Commuter rail as a primary transit mode was screened out as a viable alternative under this particular future.

Summary data on the performance of the three modal plans under this alternative future are provided in Table 48 in Chapter VI. As in the previous futures, all three primary transit system plans could be expected to work well in the plan design year, providing a reasonably similar level of primary transit service. Total transit ridership could be expected to range between 177,200 and 180,200 trips per average weekday in the plan design year, with the anticipated average annual and operating and maintenance cost deficit ranging from $20.7 million to $21.4 million. Each of the alternatives could be expected to recover a similar proportion of their operating and maintenance costs from farebox revenues, ranging from 49 percent to 50 percent on an average annual basis. As under the previous futures, substantially more trips may be expected to be made on the primary transit element of the busway and light rail transit plans—37,600 and 43,500 trips per average weekday, respectively, compared with 15,300 trips under the bus-on-freeway plan.

Again, the capital investments and capital costs attendant to implementation of the busway and light rail transit plans were found to be significantly greater than those attendant to implementation of the bus-on-freeway plan, and such capital costs differences dominate the relatively small differences found among the three alternatives in annual operating and maintenance cost subsidy requirements. The bus-on-freeway plan was found to have the lowest average annual net public cost of $28.2 million, or $0.51 per passenger. The busway plan would require $33.8 million, or $0.62 per passenger; and the light rail transit plan $36.7 million, or $0.68 per passenger.

Once again, the Advisory Committee concluded that, given the cost considerations, the bus-on-freeway plan would be the best plan under the stable or declining growth decentralized land use plan alternative future. The bus-on-freeway plan would attract the highest transit ridership of the three final plans considered at the lowest total public cost over the plan design period.

Conclusions Drawn from the Process of Test and Evaluation of Alternative Plans

The following conclusions were drawn by the Advisory Committee in reflecting upon the extensive data generated in the evaluation of the alternative primary transit system plans for each mode designed for each alternative future.

- Heavy rail rapid transit should be eliminated from further consideration in the Milwaukee area since it was found to be not viable under even the most optimistic future for transit need and use considered. This determination was based upon the inability of this technology to utilize its inherent efficiencies for transporting very large numbers of passengers at high speeds in the Milwaukee area without substantial unused capacity in all corridors. In addition, because heavy rail requires a fully grade-separated, exclusive right-of-way, the capital costs for such an alternative would be very high, ranging from two-and-one-half times those of a comparable light rail transit plan, to about three-and-one-half times those of a comparable busway plan.

- As an areawide primary transit system, commuter rail could be expected to be viable under only the most optimistic of the alternative futures for transit need and use—the moderate growth centralized land use plan future. Under that future, three commuter rail routes radiating from the Milwaukee central business district—north to Grafton, west to Oconomowoc, and south to Racine and Kenosha—would have the potential to meet at least one-half of their annual operating and maintenance costs from farebox revenues. The route to Racine and Kenosha could also be expected to perform well under the two intermediate futures for transit need and use. Under the least optimistic future for transit use, however, not even the Racine/Kenosha route was found to be viable. These commuter rail conclusions relate only to the provision of a system of true primary transit service—that is, service throughout the entire weekday period, as well as some service on weekends. They would not rule out the possible introduction of specialized peak-period, weekday-only service along one or more of the routes considered and the inclusion of such service in any final plan that may be selected.

- The bus-on-freeway, busway, and light rail transit modal alternatives—the latter two modified as necessary to include supplemental bus-on-freeway service to make the plans comparable to the bus-on-freeway plan—may be expected to perform well in the Milwaukee area under a wide range of future conditions. These three alternatives were determined to have the potential to provide essentially identical levels of service, to attract very similar levels of transit ridership, to result in similar annual operating and maintenance cost subsidy requirements, and to have similar systemwide energy consumption and environmental impacts. The light rail transit plan would require the least amount of petroleum-based motor fuel, ranging from 5 percent to 8 percent less than the busway plan and 8 percent to 11 percent less than the bus-on-freeway plan, depending upon the alternative future considered. From 21 percent to 27 percent of all transit trips could be expected to be made on electrically propelled vehicles under the light rail transit plan. Any savings in the consumption of petroleum-based motor fuel attendant to implementation of a light rail transit plan would, however, represent less than a 1 percent savings in petroleum-based motor fuel used on the total transportation system in the Milwaukee area.

- The only significant measurable difference between the bus-on-freeway, busway, and light rail transit alternative plans lies in the capital costs attendant to plan implementation. The bus-on-freeway plan would entail substantially less capital costs over the 21-year plan design period than either the busway or light rail transit plans. Capital costs attendant to the bus-on-freeway plan could be expected to range from $7 million to $11 million annually, depending upon the alternative future. The busway and light rail transit plans would entail between 50 percent and 150 percent more capital costs because they require extensive new fixed guideway facility construction. The busway plan would require capital costs ranging from $13 million to $17 million per year, with the light rail transit plan requiring capital costs ranging from $16 million to $21 million per year. Consequently, while the light rail transit and busway plans would have greater potential annual net operating and maintenance cost savings, such savings would be offset by the capital cost requirements. Considering tangible costs alone, then, the bus-on-freeway plan would be the best plan for the Milwaukee area under a wide range of future conditions.

- The light rail transit plan, however, would appear to be preferable to the bus-on-freeway and bus-on-busway plans if consideration is given to some of the intangible implications of primary transit system performance. Light rail transit would probably have a greater, although uncertain and unmeasurable, potential to influence land development and redevelopment, would probably provide a more reliable and safer public transit system, and would be less subject to the adverse effects of highway system deterioration from deferred maintenance. Light rail transit has an inherent operational advantage of a potentially higher passenger-carrying capability per operator because of its ability to couple more than one vehicle into a train. Because of its electrical propulsion, light rail transit would also have an operational advantage in the severe winter climate of the Milwaukee area, would have the best potential to continue and expand operations during a petroleum-based fuel shortage, and perhaps would have an advantage in long-term usefulness given the prospects for reduced domestic and foreign petroleum production in the 21st century. These and other intangible benefits attendant to fixed guideway technology are set forth in Table 63 in Chapter VI, along with the Advisory Committee's conclusions regarding their importance.

DESCRIPTION OF RECOMMENDED PRIMARY TRANSIT SYSTEM PLAN OPTIONS

Given these conclusions, the Advisory Committee determined that two recommended plan options should be prepared and presented along with the base system plan at a series of public informational meetings and at a public hearing. One of the two plan options would be the bus-on-freeway plan, and would represent a continued public commitment to the provision of primary transit service in the Milwaukee area exclusively through the bus-on-freeway mode. The other plan option, however, would recognize the importance of the intangible advantages inherent in light rail transit technology, and would recommend implementation of that technology in the Milwaukee area in at least one important travel corridor. This would be done by dividing the second plan option into lower and upper tiers. The lower tier would seek to implement a basic bus-on-freeway system plan, together with a light rail transit facility in the northwest travel corridor of the Milwaukee area—one of the corridors not served by existing or proposed freeway facilities. Under the upper tier of the two-tier system plan option, certain of the bus-on-freeway routes would eventually be converted to light rail transit or commuter rail operation, as may be appropriate, depending upon future conditions.

Bus-on-Freeway System Plan: Recommended Plan Option 1

One of the two recommended plan options directed by the Advisory Committee to be the subject of public review and comment is a bus-on-freeway system plan. Should this or a similar plan ultimately be selected for adoption, it would mean that, after public review, the Advisory Committee concluded that the intangible benefits attendant to development of a light rail transit or commuter rail system in the Milwaukee area do not outweigh the large capital cost differences between those fixed guideway plans and the bus-on-freeway plan. The bus-on-freeway system plan is graphically summarized on Map 38 on page 214 in Chapter VI of this report. The plan proposes a system of 24 bus-on-freeway routes totaling 955 route miles in length and having a total of 53 stations, 48 of which would have attendant park-ride lots. Selected data pertaining to the design and performance of this plan option under the two extreme futures for transit need and use in the Milwaukee area are set forth in Table 56 in Chapter VI of this report.

This proposed bus-on-freeway plan is identical in network extent to the truncated bus-on-freeway plan that was tested and evaluated under the most optimistic future for transit need and use, with some adjustment in the supporting express and local transit services. The extent of facilities and services identified in this plan can be confidently recommended because, even under the most pessimistic future for transit need and use in the Milwaukee area, operation of all of the bus-on-freeway services included in the plan would be viable during at least the peak travel periods. The provision of expanded operations to provide all-day weekday service at maximum headways of 30 minutes in peak travel periods and 60 minutes in off-peak travel periods is recommended only on a staged basis, the staging also being identified on Map 38 in Chapter VI. Those routes and stations identified in the first stage would be provided with all-day service during the early years of the plan design period, since these routes could be expected to work well under even the most pessimistic future conditions for public transit envisioned under this study. The routes identified for all-day service under the second stage of the plan are those which could be expected to work well under the intermediate future conditions considered for the Milwaukee area, but not under the most pessimistic set of future conditions. Finally, the routes identified for all-day service under the third stage would be those that could be expected to work well only if future conditions approach those considered to be the most optimistic for transit need and use in the Milwaukee area.

The bus-on-freeway plan option also includes a recommendation to complete the design, construction, and implementation of a freeway operational control system in the Milwaukee area. This will require the expansion of the present limited freeway traffic management system serving central Milwaukee County to an areawide system. Under this proposal, all freeway on-ramps in the Milwaukee urbanized area would need to be ramp-metered to restrain automobile and truck access to the freeways during peak travel periods. The ramp meters would be operated through a central control system which would continuously measure traffic volumes on those portions of the freeway system needed for transit service through an interconnected series of traffic-sensing devices. As freeway traffic volumes approached the levels beyond which freeway operating speeds may be expected to deteriorate, fewer automobiles and trucks would be permitted to enter the freeway system. Buses, however, would have free access to the system through preferential ramps. Sufficient constraint would be exercised in the operation of the system to ensure uninterrupted traffic flow and operating speeds of at least 40 mph on all freeway segments, including otherwise congested segments. Consequently, average bus speeds on these primary transit routes, including all stops, would range between 19 and 35 mph, a very high average speed for a primary transit system of any kind.

The bus-on-freeway plan option would also include complementary expansion and improvement of the express and local elements of the Milwaukee transit system. Five express routes would be provided in addition to the seven routes included in the previously described base plan. These 12 express routes would operate in a coordinated manner with the bus-on-freeway primary transit system. The supporting local transit system would be extended where cost-effective into contiguous areas of urban development. Finally, in order to accommodate a heavy volume of buses, Wisconsin Avenue in downtown Milwaukee would be converted to a mall for the exclusive use of public transit vehicles between N. 10th Street and N. Prospect Avenue, a distance of about 1.3 miles.

Analyses of the performance of this plan indicate that total transit ridership in the Milwaukee area could be expected to range from 371,300 trips on an average weekday in the plan design year under the most optimistic future for transit need and use, to 176,000 trips on an average weekday under the most pessimistic future for transit need and use. The anticipated average annual operating and maintenance cost deficit could be expected to approximate $24.2 million under the most optimistic future, and $19.4 million under the most pessimistic future; while the proportion of operating and maintenance costs to be recovered from farebox revenues could be expected to range from 57 percent to 51 percent on an average annual basis. The capital investment required to implement the plan is estimated at $329.7 million and $229.9 million, respectively, for the two futures, with the corresponding capital costs estimated at $214.3 million and $160.9 million. The average annual net public cost would be expected to range from $34.4 million, or $0.46 per passenger, under the most optimistic future, to $27.1 million, or $0.50 per passenger, under the most pessimistic future.

A benefit-cost analysis was conducted in order to evaluate the economic viability of the transit system proposals set forth in this plan. In preparing this analysis, the benefits and costs were calculated as accruing over a period of time extending from 1980 through the year 2000, with an allowance for the salvage value of the transit facilities at that time. The analysis was conducted by determining the direct benefits to be derived from the proposed bus-on-freeway system and dividing those benefits by the costs involved in developing, operating, and maintaining the system. Transit user benefits were defined as savings in transit user costs, including savings attendant to reductions in travel time, out-of-pocket costs, and accident costs, in comparison to the base—or "do nothing"—plan. Total system cost was defined as the sum of the construction and operating and maintenance costs of the entire transit system—including the supporting express and local transit facilities—minus revenue received from the users through farebox collections. Present worth values were calculated using alternative rates of return on capital investment of 6 percent and 10 percent.

The results of the benefit-cost analysis indicate that the bus-on-freeway plan option under the moderate growth centralized land use plan alternative future will have a benefit-cost ratio of 1.7. Under the stable or declining growth decentralized land use plan alternative future, the bus-on-freeway plan option would have a benefit-cost ratio of 1.0. Both of these ratios were calculated assuming a 6 percent rate of return. Assuming a 10 percent rate of return, the benefit-cost ratios would be 0.8 and 0.7, respectively. It should be noted that these ratios apply to the aggregations of transit services proposed within each plan, and do not imply that individual projects within the aggregation will necessarily have similar benefit-cost ratios.

Two-Tier System Plan:
Recommended Plan Option 2

The second recommended plan option directed by the Advisory Committee to be submitted to public review and comment is a two-tier plan. The lower tier of the plan option would include implementation of all the bus-on-freeway facilities and services of the previously described option except those for the northwest corridor of the Milwaukee area, where a light rail transit facility would be implemented. In addition, the bus-on-freeway facilities recommended under the lower tier of the plan would be modified as necessary to permit the eventual conversion to light rail transit operation in four other Milwaukee area corridors and to commuter rail operation in the corridor between Milwaukee and Racine and Kenosha. The upper tier would thus consist of light rail transit facilities in these four additional Milwaukee area corridors, together with commuter rail facilities in the Milwaukee to Racine and Kenosha corridor.

The lower tier of the two-tier plan option is graphically summarized on Map 42 on page 224 in Chapter VI of this report. Map 43 on page 226 in Chapter VI identifies the general alignments of the four additional light rail facilities and the single commuter rail facility that would be included in the upper tier of the plan. Selected data pertaining to the design and performance of the lower tier of this plan option under the two extreme futures for transit need and use in the Milwaukee area are set forth in Table 56 in Chapter VI of this report.

With respect to bus-on-freeway service, the lower tier of the plan option would consist of 22 bus-on-freeway routes totaling 900 route miles in length and having a total of 47 stations, 43 of which would have attendant park-ride lots. The initial light rail transit facility would lie entirely within the City and County of Milwaukee and would extend from the Milwaukee central business district westerly along W. Wisconsin Avenue to N. 44th Street and then in a northerly direction along the right-of-way of the Milwaukee Road's Fifth Subdivision and the eastern boundary of Washington Park to N. Sherman Boulevard. The facility would then extend along N. Sherman Boulevard to W. Silver Spring Drive, and thence northwesterly along the right-of-way of the Wisconsin & Southern Railroad Company and N. 76th Street to a terminus at the Northridge Shopping Center. The facility would have a length of about 14.3 miles, of which 11.8 miles would be located on the surface and 2.5 miles would be located on elevated structure. At-grade intersections would be provided at most public street crossings, but the light rail vehicles would receive preferential treatment at intersections through traffic signalization. A total of 27 stations would be provided along this light rail transit facility, 3 of which would have park-ride lots. Average speeds on the light rail transit route would approximate 20 mph, with headways during the peak periods ranging from 4 to 10 minutes and during the off-peak periods from 12 to 30 minutes.

The lower tier of the two-tier plan option includes a recommendation for the implementation of a freeway traffic management system in the Milwaukee area to ensure uninterrupted freeway traffic flow and operating speeds of at least 40 mph on all freeway segments. In addition, the two-tier plan option envisions complementary expansion and improvement of the express and local elements of the Milwaukee transit system. Three additional express routes would be provided beyond the seven routes included in the base plan. These 10 express routes would operate in a coordinated manner with both the bus-on-freeway service and the light rail transit service in the lower tier of the two-tier plan option. As in Recommended Plan Option 1, Wisconsin Avenue in downtown Milwaukee would be converted to a mall for the exclusive use of motor buses and light rail vehicles.

Under the upper tier of the plan option, four additional light rail transit facilities are proposed, along with one commuter rail facility. The light rail facilities and services would be located on four routes in four corridors extending outward from the Milwaukee central business district. One route would extend from the intersection of N. 6th Street and W. Wisconsin Avenue north along N. 6th Street and the one-way pair of N. 7th and N. 8th Streets through the near north side of the City of Milwaukee. The route would then proceed in a northwesterly direction along W. Atkinson Avenue, W. Capitol Drive, and W. Appleton Avenue, terminating at Timmerman Field. A second route would extend from the intersection of N. 6th Street and W. Wisconsin Avenue south across the 6th Street viaduct, along the one-way pair of S. 4th and S. 5th Streets. The route would then continue along S. Chase and S. Howell Avenues, turning east to follow the former electric interurban railway Lakeside Belt Line right-of-way to S. Kinnickinnic Avenue. At S. Kinnickinnic Avenue, the route would proceed along the Chicago & North Western Railway right-of-way through the City of Cudahy, terminating at S. Whitnall Avenue. The third route would, as in the northwest corridor, extend from downtown Milwaukee along W. Wisconsin Avenue to N. 44th Street, where it would turn in a southerly direction passing Milwaukee County Stadium. The route would proceed along the cleared right-of-way of the Stadium Freeway-South extension through the Village of West Milwaukee, continuing south along S. 43rd Street before proceeding southwesterly along the former electric interurban railway Lakeside Belt Line right-of-way, W. Forest Home Avenue, and S. 76th Street. The route would terminate at the Southridge Shopping Center in the Village of Greendale. The fourth route would extend from downtown Milwaukee along W. Wisconsin Avenue to S. 44th Street, as in the route to the Southridge Shopping Center, would pass Milwaukee County Stadium, and would then continue in a westerly direction along the former electric interurban railway Local Rapid Transit Line right-of-way as far west as N. Glenview Avenue. The route would then proceed in a northwesterly direction through the Milwaukee County Institutions grounds, terminating at the Mayfair Mall Shopping Center in the City of Wauwatosa.

Commuter rail service, extending to the south from the Milwaukee central business district to Kenosha, would be provided under the upper tier of the plan option over trackage owned and operated by the Chicago & North Western Transportation Company. Commuter rail service would be provided to the communities of St. Francis, Cudahy, South Milwaukee, Oak Creek, Racine, and Kenosha. A total of nine stations would be located along this 33-mile route.

Under the lower tier of the plan option, the recommended light rail transit facility in the northwest corridor is proposed to be developed in three stages: preliminary engineering, final design, and construction. The preliminary engineering stage is particularly important because it must consist of an in-depth study, including an environmental impact analysis, of variations in such characteristics of the recommended facility as horizontal and vertical alignment, the location and sizing of stations and attendant park-ride lots, vehicle type, vehicle storage and maintenance needs, and fixed guideway construction staging. In addition, the preliminary engineering study should include an in-depth analysis of the potential for this particular light rail transit facility to induce sound land development and redevelopment in the corridor served by the facility. Only if it is concluded from the preliminary engineering study that light rail transit will indeed have a high probability of inducing sound land development and redevelopment in the corridor would final design and construction of the facility proceed.

Those light rail transit and commuter rail facilities included in the upper tier of the plan option would not be recommended for implementation at this time. Implementation of these facilities would be considered only following the implementation of the lower tier of the plan option and following an assessment of the intangible benefits attained by the single light rail transit facility proposed to be constructed in the lower tier of the plan option.

Analyses of the performance of this plan indicate that total transit ridership in the Milwaukee area, given full implementation of the lower tier, could be expected to range from 372,900 trips on an average weekday in the plan design year under the most optimistic future for transit need and use to 176,300 trips on an average weekday under the most pessimistic future for transit need and use. The anticipated average annual operating and maintenance cost deficit could be expected to approximate $24.1 million under the most optimistic future and $19.1 million under the most pessimistic future; and the proportion of operating and maintenance costs to be recovered from farebox revenues would be expected to range from 57 percent to 51 percent on an average annual basis. The capital investment required to implement the plan is estimated at $470.7 million and $364.5 million, respectively, for the two futures, with the corresponding capital costs estimated at $306.3 million and $217.9 million. The average annual net public cost would be expected to range from $38.7 million, or 0.52 per passenger, under the most optimistic future, to $29.5 million, or $0.54 per passenger, under the most pessimistic future.

A benefit-cost analysis was also conducted of the lower tier of the two-tier plan option. The results of this analysis indicate that the two-tier plan option could be expected to have a benefit-cost ratio of 1.3 under conditions attendant to the moderate growth centralized land use plan alternative future, and a benefit-cost ratio of 0.6 under conditions attendant to the stable or declining growth decentralized land use plan alternative future, assuming a 6 percent rate of return. Assuming a 10 percent rate of return, the benefit-cost ratios would be 0.7 and 0.4, respectively.

THE RECOMMENDED PRIMARY TRANSIT SYSTEM PLAN

The task of selecting a recommended primary transit system plan from among the many alternatives available was, in fact, the central purpose of the Milwaukee area primary transit system alternatives analysis. The methodology utilized in that analysis provides for the identification and evaluation of all transportation technologies practicable for the provision of primary transit service in the greater Milwaukee area, and of the potential viability of primary transit service in the major travel corridors of the greater Milwaukee area under a wide range of future conditions. Through the extensive inventories and analyses—including simulation model studies—undertaken, it was possible to identify from among the broad range of technology-based and corridor-based alternatives considered two viable primary transit system plans for the greater Milwaukee area for public review, prior to the selection of a final recommended plan.

The extensive inventories undertaken as a part of the alternatives analysis resulted in a number of important findings and conclusions which served to define the extent and limits of the alternative system plans that warranted full consideration under the analysis. The inventory phase of the alternatives analysis indicated that five public transit modes were potentially applicable to the provision of primary transit service in the Milwaukee area and warranted consideration in the systems analyses. These modes included motor bus on metered freeway, bus on busway, light rail transit, heavy rail rapid transit, and commuter rail. The inventories also indicated that there are numerous rights-of-way in the Milwaukee area which have potential for use as the location of primary transit facilities and services, thus offering the possibility of some reduction in implementation costs. Because of the great uncertainties that exist in the Region regarding the primary factors which affect the demand for primary transit service, an "alternative futures" approach was considered to be especially appropriate for this study. Under this approach, alternative primary transit systems are tested and evaluated under a range of future conditions in order to identify systems which may be expected to perform well under a wide range of future conditions in the Milwaukee area.

A number of important conclusions pertaining to the applicability of the various transit technologies in the Milwaukee area were drawn from the design, test, and evaluation phase of the alternatives analysis. Reconfirming the findings of earlier planning efforts in the Region, this phase of the study indicated that heavy rail rapid transit would be inapplicable to the greater Milwaukee area, the travel demand in the most heavily traveled corridors under even the most optimistic future for transit use being insufficient to permit utilization of the high capacities and efficiencies of this mode. As an areawide primary system, commuter rail may be expected to be viable only under the most optimistic future conditions for public transit need and use. This mode may, however, have applicability in special, limited service within certain corridors under the other futures considered.

Three primary transit modes, including bus on metered freeway, bus on busway, and light rail transit, could be expected to perform well under a wide range of future conditions, with the only significant difference among these modes being the capital cost requirements. Finally, if consideration is given to the intangible benefits of primary transit system performance, the potential advantages of certain fixed guideway modes could outweigh any capital cost disadvantage.

Based on these findings and conclusions, the Advisory Committee determined that two preliminary recommended primary transit system plan options should be prepared and presented, together with a base—or status quo—plan, at a series of public informational meetings and at a public hearing. The first recommended plan option was a bus-on-freeway plan. The adoption of this plan would represent a continued public commitment to the provision of primary transit service in the Milwaukee area through the bus-on-freeway mode. The second recommended plan option would call for the immediate implementation of a single light rail transit facility in the northwest corridor of the Milwaukee area, as well as the possible future implementation of additional light rail transit and commuter rail facilities and services in other travel corridors of the greater Milwaukee area.

A series of public informational meetings and a public hearing were held on the findings and preliminary recommendations of the alternatives analysis. The record of these meetings and hearing indicated strong support for implementation of the two-tier system plan option, and, conversely, little support for either the base plan or the bus-on-metered freeway system plan options. With respect to the two-tier plan option, strong support was expressed for the proposed light rail transit facility in the northwest corridor, although it was suggested that consideration should be given to other alignments in addition to the preferred alignment included in the plan. It was also indicated that consideration should be given to extending the light rail transit mode through the lower east side of Milwaukee to the University of Wisconsin-Milwaukee campus. Support was also expressed for the proposed commuter rail service between Milwaukee, Racine, and Kenosha, as well as for commuter rail services in other corridors, including the corridor between the Milwaukee central business district and the City of Oconomowoc. It was also suggested at the public meetings that General Mitchell Field be directly served by primary transit service.

The Advisory Committee met on April 23, 1982, to deliberate on the public reaction to the primary transit system plan options and the base system plan. After considerable discussion and debate, the Committee concluded that the two-tier system plan option should be recommended for adoption as the primary transit system plan for the greater Milwaukee area. Five reasons were cited in support of this determination: 1) the potential intangible benefits attendant to the development of rail transit technology which requires the use of a fixed guideway and permits the use of electrical propulsion over the long-term future; 2) the flexibility inherent in the two-tier plan option with respect to the evolutionary development of primary transit technology in the Milwaukee area, such flexibility being particularly desirable in view of the great uncertainties which exist concerning future conditions affecting transportation system need and use in the greater Milwaukee area; 3) the complexity and importance of the issue of the best means of providing a high level of transportation service in the greater Milwaukee area, and the need to provide ample time and adequate opportunity to fully and properly consider this issue within the area; 4) the need to provide a high level of transportation service in the northwest corridor of Milwaukee County in light of the removal of certain freeway segments from the long-range transportation system plan for the area; and 5) the public support for the two-tier plan option as evident from the testimony provided at the public informational meetings and public hearing.

The Advisory Committee therefore recommended a final primary transit system plan for the greater Milwaukee area which consists essentially of the two-tier plan option as originally presented for public review, but with three modifications. These modifications are: 1) the inclusion of direct bus-on-freeway primary transit service to General Mitchell Field; 2) the inclusion of an option to operate specialized commuter rail service on an experimental, demonstration basis under the lower tier of the plan, should there exist substantial public interest and demand for such demonstration service; and 3) the inclusion of light rail transit service in the northeast corridor of the Milwaukee area under the upper tier of the plan.

The final recommended primary transit system plan consists of a lower tier and an upper tier. Under the lower tier of the recommended plan, a light rail transit facility would be constructed in the Milwaukee northwest corridor; the existing system of bus-on-freeway routes would be expanded into all other major travel corridors of the Milwaukee area; most primary transit service would be expanded from weekday peak-period service to all-day service at maximum headways of 30 minutes during peak travel periods and 60 minutes during off-peak travel periods; and preferential treatment would be provided for buses operating in primary transit service over a metered freeway system. The lower tier of the recommended plan is shown on Map 52 on page 274 in Chapter VII of this report.

Several steps would need to be taken prior to the actual construction and operation of light rail transit service in the northwest corridor. Included in these steps is a detailed corridor analysis, including preliminary engineering and an assessment of the environmental and land use development impacts, of the several alternative alignments. While the initial phase of the alternatives analysis—the findings and recommendations of which are reported within this planning report—is not intended to result in the final recommendation of a specific alignment, it was necessary to select a preliminary alignment for purposes of testing and evaluation of the primary transit system plan. This preliminary light rail transit line would have a length of about 14.3 miles, and would include a total of 27 stations, 3 of which would have park-ride lots. Headways would range from 4 to 12 minutes during the weekday peak periods and from 12 to 30 minutes during midday and evening travel periods, with service being provided by trains of one or two articulated light rail vehicles.

The bus-on-freeway facility services under the lower tier of the plan would consist of 24 bus-on-freeway routes totaling 1,057 route miles in length, and having a total of 55 stations, 50 of which would have park-ride lots. Bus-on-freeway primary transit service would be expanded from operation only during the weekday peak travel periods to all-day weekday service at maximum headways of 30 minutes during the peak travel periods and 60 minutes in off-peak travel periods, using articulated, high-capacity motor buses. The Milwaukee area freeways over which motor buses in primary transit service would operate would be operationally controlled during peak travel periods, requiring the expansion of the present limited freeway traffic management system serving central Milwaukee County to an areawide system. This system would restrain automobile and motor truck access to the freeways during peak travel periods at the freeway on-ramps to ensure uninterrupted freeway traffic flow and operating speeds of at least 40 mph on all freeway segments, including otherwise congested segments. Motor buses would be able to bypass vehicle queues at the on-ramps to immediately take advantage of the high-speed freeway operation.

The recommended plan also envisions complementary expansion and improvement of the express and local elements of the Milwaukee area transit system. In order to accommodate the increased volume of transit vehicles anticipated, it is further proposed that Wisconsin Avenue in downtown Milwaukee be converted to a mall for the exclusive use of motor buses and light rail vehicles between N. 10th Street and N. Prospect Avenue, a distance of 1.3 miles. Finally, the lower tier of the recommended plan includes the option of operating up to three commuter rail routes on a temporary, demonstration basis. Such demonstration service could be considered for the routes between Milwaukee and Grafton, Milwaukee and Oconomowoc, and Milwaukee, Racine, and Kenosha.

The recommended plan provides substantial improvements and increases in transit service over the base system plan in terms of routes, coverage of the Milwaukee area, and overall system speeds. Under the recommended plan, there would be about 1,060 route miles under the full range of future conditions for transit need and use, and route miles of express and local service operated would increase to between 1,300 and 1,500 miles under the recommended plan.

The primary transit element of the two-tier recommended plan under the moderate growth scenario-centralized land use plan alternative future would serve about 1.3 million residents within a three-mile driving distance of primary transit service, along with 392,000 residents and 309,000 jobs within walking distance of primary transit stations and stops. Under the stable or declining growth scenario-decentralized land use plan alternative future, the recommended plan would serve about 931,000 residents within a three-mile driving distance of primary transit service, along with 260,000 residents and 260,000 jobs within walking distance of primary transit stations and stops.

Average vehicle speeds could be expected to range between 27 and 29 mph, and average speeds of passenger travel on primary transit vehicles, between 30 and 34 mph. The average speeds on all elements of the recommended plan could be expected to range from 17 to 18 mph with respect to vehicles, and from 19 to 21 mph with respect to passenger travel.

The level of transit ridership under the recommended plan could be expected to range between 176,300 and 371,700 trips and between 0.9 and 2.5 million passenger miles per average weekday, depending upon future conditions. The Milwaukee central business district could be expected to remain the most important trip generator in the Milwaukee area, accounting for over 6 percent of the approximately 4.4 million trips expected to be made within the Milwaukee area on an average weekday under the most optimistic future conditions. Downtown Milwaukee could also be expected to remain the singularly most important transit trip generator, accounting for about 25 percent of the average weekday transit trips made under the recommended plan.

The capital cost of the recommended plan would range from about \$221 million, or about \$11 million annually, to about \$302 million, or about \$14 million annually, depending upon the alternative future considered. The public subsidy required for operation and maintenance may be expected to total between \$504 million, or about \$24 million annually, and \$403 million, or \$19 million annually, depending upon the alternative future considered. The total public cost of the recommended plan, including all capital and net operating and maintenance costs, would therefore range from \$624 million, or about \$30 million annually, to about \$807 million, or about \$38 million annually. Higher total public costs would be incurred under the moderate growth scenario-centralized land use plan alternative future because of the need for more transit vehicles and transit vehicle miles of service to meet the higher transit demand under that future. In terms of cost-effectiveness, the average total public cost per passenger trip over the 21-year plan design period for the recommended plan would range between \$0.51 and \$0.54.

Under the recommended plan, total energy consumption would range from about 16,577 billion British Thermal Units (BTU's) to about 23,212 billion BTU's. Furthermore, under the alternative future most conducive to transit use the recommended plan would require about 2,830 BTU's per passenger mile, and under the future least conducive to transit use, would require about 2,540 BTU's per passenger mile. The recommended two-tier plan would require up to 7 percent less petroleum-based motor fuel than the base plan, since under the two-tier recommended plan about 8 percent of the transit trips would be made on electrically propelled vehicles. However, this savings of motor fuel would represent less than a tenth of 1 percent savings in petroleum-based motor fuel used on the total transportation system in the Milwaukee area.

The recommended plan would not require the taking of any homes, businesses, or industries. The plan would, however, require the acquisition of some right-of-way for the construction of fixed guideway stations, park-ride lots, and maintenance and storage facilities.

The total levels of highway and transit air pollutant emissions would be about 2 percent less under the recommended plan as compared with the base plan, principally because of the decline in automobile travel anticipated under the recommended plan.

The upper tier of the recommended primary transit system plan is shown on Map 54 on page 295 in Chapter VII of this report. No actions would be proposed to implement the upper tier of recommendations other than those required to ensure that the concerned facilities could be developed at some time in the future with a minimum of disruption and at minimal cost, and that any bus-on-freeway facilities and services implemented under the lower tier of the plan are adaptable to the possible eventual conversion to rail transit operation. Implementation of the upper-tier light rail transit and commuter rail recommendations would occur only following the implementation of light rail transit in the northwest corridor, and following a determination, based on that implementation, of the extent to which the intangible benefits of rail transit, particularly with respect to land development and redevelopment, were being achieved.

Under the upper tier of the plan, up to five additional light rail transit routes, or corridors, are planned, along with one commuter rail line. The light rail facilities and services could be located on the routes in five corridors extending from the Milwaukee central business district and could entail up to an additional 45.8 miles of fixed guideway. The proposed commuter rail primary transit service would extend from the Milwaukee central business district to the Cities of Racine and Kenosha, a distance of 33.1 miles.

PLAN IMPLEMENTATION

The recommended primary transit system plan for the greater Milwaukee area cannot be considered complete until the steps required to implement the plan—that is, to convert the plan into action plans and policies—have been specified. The legal and governmental framework of the Southeastern Wisconsin Region is such that the existing county and local units and agencies of government, and certain private concerns, can implement all of the major recommendations contained in the primary transit system plan. In Chapter VIII of this report, a comprehensive, cooperative, intergovernmental plan implementation program is set forth indicating the specific actions which will be required by each level, agency, and unit of government if the recommended primary transit system plan is to be fully implemented.

The plan implementation recommendations detailed in Chapter VIII will not be repeated here. It is, however, important to recognize that major responsibilities for plan implementation will rest with the City of Milwaukee, Milwaukee County, and the State of Wisconsin. The close coordination and cooperation among these units of government, as well as by other units of government affected by this plan, cannot be overemphasized. The adoption or endorsement of the recommended plan by the affected local units of government and by various state and federal agencies is highly desirable and, in some cases, essential in order to secure a common understanding of the primary transit system development objectives and to permit the necessary plan implementation work to be cooperatively programmed and jointly executed. Finally, it must be understood that the recommended primary transit system plan, as presented in this report, is intended to constitute a flexible guide to the development of primary transit facilities and services in southeastern Wisconsin, and should therefore not be considered as an inflexible mold to which all public transit improvements in the Region should conform.

CONCLUSION

The recommended two-tier primary transit system plan for the greater Milwaukee area as presented in this summary planning report amends one of the most important elements of the comprehensive plan for the physical development of the seven-county Southeastern Wisconsin Region. It provides a sound basis for the development of primary or "rapid" transit services and facilities within the Region. This plan, together with the arterial street and transportation systems management, elderly and handicapped transportation, local transit development, and airport elements of the adopted transportation plan, provides the Region and its public officials and citizens with a sound, coordinated guide to transportation facility and service development.

The recommended primary transit system plan is based upon extensive inventories and analyses of socioeconomic, land use, and transportation conditions and trends in the Region as these conditions relate to the need for and use of mass transit; of the state-of-the-art of primary transit technology; and of anticipated change in the Region, as well as of anticipated change in factors external to the Region which affect the need for and use of mass transit under a wide range of alternative futures. The plan has been carefully selected from among many alternatives which together provide consideration of the full range of proven primary transit technologies which may be expected to be available for use within the Region in the next two decades, and of all possible corridors of high travel demand in the Region. A technical advisory committee comprised of elected and appointed public officials and other representatives of local, county, state, and federal levels of government, and knowledgeable and concerned citizen members, has endorsed the plan after appropriate consideration of the public reaction to the alternatives considered as presented at a series of five public informational meetings and at a public hearing. The results of this public review are documented in published minutes of the meetings and hearing, as well as summarized in Chapter VII of this report.

In conclusion, it may be useful to reflect upon the overall significance of the findings and recommendations of the primary transit system alternatives analysis for the greater Milwaukee area. The currently adopted regional transportation system plan calls for the provision of primary transit service solely by the operation of motor buses over operationally controlled freeways. The new primary transit system plan, while continuing to place heavy reliance on the provision of primary transit service by motor buses operating over metered freeways, also envisions the construction of an initial light rail transit line in the northwest corridor of Milwaukee County. Subsequent consideration would be given to implementing light rail transit in up to five other Milwaukee area corridors, as well as to the institution of commuter rail service between Milwaukee, Racine, and Kenosha, and, on a demonstration basis, between Milwaukee and Grafton and Milwaukee and Oconomowoc. This plan therefore provides the greater Milwaukee area with a broader and a more flexible range of transit technologies with which to meet future public transit needs in the area.

The change in emphasis envisioned in the new primary transit system plan has resulted from, and is consistent with, the Regional Planning Commission's long-standing conception of planning as a cyclical process. Indeed, the recommended two-tier plan is a third-generation primary transit plan which has evolved from the original regional transportation plan adopted in 1966 and the reevaluated transportation plan adopted in 1978. Such periodic reexamination and reconsideration has been especially crucial in view of changing public attitudes resulting from the steadily increasing cost of operating private automobiles, the uncertainty regarding future petroleum-based motor fuel supplies, and an increased desire for a higher-quality man-made and natural environment. These concerns, in fact, strongly suggest a commitment to recentralization of land use development in the Milwaukee area and of the public facilities and services—including mass transit facilities and services—required for such recentralization. This points to a regional development pattern consistent with that recommended by the Regional Planning Commission during the past two decades, a pattern which can provide more efficient and effective progression of public facilities and services of all kinds, reduce energy consumption, preserve and protect the natural resource base, and provide a higher quality of life and an overall framework for the sound social and economic development of the area.

Major changes in the structure of a large and complex urbanized area cannot be brought about overnight, and are difficult to perceive in the face of great uncertainty regarding future conditions. The recommended two-tier plan addresses both of these considerations in that the plan is designed to be implemented in a series of steps or stages which are contingent upon the presence of the appropriate conditions and factors which affect the demand and need for primary transit facilities and services—both internal and external to the Region. Furthermore, the new recommended plan is comprised of elements which may be expected to perform well under a wide range of future conditions in the Milwaukee area, thus, creating a "robust" plan. More importantly, the recommended two-tier primary transit system plan, with this inherent flexibility, will contribute toward enhancing the overall quality of the Region, and thereby contribute toward making greater Milwaukee and the Southeastern Wisconsin Region more attractive areas in which to live and work.

APPENDICES

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Appendix A

MEMBERSHIP OF THE STEERING AND ADVISORY COMMITTEES FOR THE MILWAUKEE AREA PRIMARY TRANSIT SYSTEM ALTERNATIVES ANALYSIS

Appendix A-1

LIGHT RAIL TRANSIT STUDY PROSPECTUS STEERING COMMITTEE

Frank P. Zeidler, Chairman	Citizen Member, Milwaukee County
Kurt W. Bauer, Secretary	Executive Director, Southeastern Wisconsin Regional Planning Commission
Robert W. Brannan	Deputy Director, Department of Public Works, Milwaukee County
Douglas F. Haist	Deputy Administrator, Division of Planning, Wisconsin Department of Transportation
Edwin J. Laszewski, Jr.	City Engineer, City of Milwaukee
Henry M. Mayer	Managing Director, Milwaukee County Transit System
Theodore G. Weigle, Jr.	Regional Director, Urban Mass Transportation Administration, Region V, U. S. Department of Transportation

Appendix A-2

MILWAUKEE AREA PRIMARY TRANSIT SYSTEM ALTERNATIVES ANALYSIS CITIZENS INTERGOVERNMENTAL AND TECHNICAL COORDINATING AND ADVISORY COMMITTEE[1]

Frank P. Zeidler, Chairman	Citizen Member, Milwaukee County
Kurt W. Bauer, Secretary	Executive Director, Southeastern Wisconsin Regional Planning Commission
F. Thomas Ament	County Board Chairman, Milwaukee County
Michael J. Brady	Chief Field Representative for Congressman Henry S. Reuss
Robert W. Brannan	Deputy Director, Department of Public Works, Milwaukee County
David Carley	Citizen Member, City of Milwaukee
Michael Corriveau	Executive Assistant, Office of the Milwaukee County Executive
Arne L. Gausmann	Director, Bureau of Systems Planning, Wisconsin Department of Transportation
P. Douglas Gerleman	Director, Planning Division, Urban Mass Transportation Administration, Region V, U. S. Department of Transportation
John M. Hartz	Director, Bureau of Transit, Wisconsin Department of Transportation
Edwin J. Laszewski, Jr.	City Engineer, City of Milwaukee
J. William Little	Administrator, City of Wauwatosa
Frank M. Mayer	Division Administrator, Federal Highway Administration, U. S. Department of Transportation
Henry F. Mixter	President, Village of Whitefish Bay
John O. Norquist	Wisconsin State Representative
Brian F. O'Connell	Planner, Department of City Development, City of Milwaukee
Harout O. Sanasarian	Supervisor, Milwaukee County Board; Chairman, Milwaukee County Transit Committee; Commissioner, Southeastern Wisconsin Regional Planning Commission
Harvey Shebesta	District Director, District 2, Wisconsin Department of Transportation

The following individuals also participated in the work of the Citizens Intergovernmental and Technical Coordinating and Advisory Committee as alternate members or as interested parties present at Committee meetings: William Barwis, Bureau of Railroads and Harbors, Wisconsin Department of Transportation; James A. Beckwith, Bureau of Transit, Wisconsin Department of Transportation; James E. Carley, Partner, Carley Capital Group; Terrence Cooley, Research Analyst, Milwaukee County Board; Harold L. Crane, Community Planner, Urban Mass Transportation Administration, Region V, U. S. Department of Transportation; Thurman Dansby, Legislative Research Analyst, Milwaukee County Board; Carol T. Everett, Administrative Aide to Wisconsin State Representative Kevin Soucie; Thomas L. Frank, Planning and Research Engineer, Federal Highway Administration, U. S. Department of Transportation; Richard M. Haase, Parking and Transit Advisory Committee, University of Wisconsin-Milwaukee; John D. Hendrickson, Director, Transportation Division, Department of Public Works; Milwaukee County; Fred F. Klotz, Engineer in Charge, Public Ways Division, City of Milwaukee Bureau of Engineers; Terry Kocourek, Research Analyst, Milwaukee County Board; Donald Koser, Transit Planner, Milwaukee County Transit System; Robert Lazear, Administrative Aide, Wisconsin State Assembly; Mordecai Lee, Wisconsin State Representative; Paul F. Mathews, Supervisor, 5th District, Milwaukee County; Robert B. Monnat, Carley Capital Group; James P. Moody, Wisconsin State Senator; Lois C. Plous, Wisconsin State Representative; Donald V. Revello, Chief of Transportation Forecasts and Analysis, Wisconsin Department of Transportation; Robert P. Schmitt, Office of Statewide Transportation Programs, University of Wisconsin-Milwaukee; Gerald Schwerm, Director of Transportation, Milwaukee County; Oran Severson, Chief Special Projects Engineer, Bureau of Engineers, City of Milwaukee; Dennis C. Vierra, Planning Representative, Urban Mass Transportation Administration, Region V, U. S. Department of Transportation; Kenneth J. Warren, Executive Assistant, Milwaukee County Transit System; Gary Weiher, Transportation Planner, Department of Public Works, Milwaukee County; David M. Weis, Assistant Manager, Village of Whitefish Bay; Julie Weitman, Administrative Intern, Milwaukee County; and Thomas A. Winkel, Chief Planning Engineer, District 2, Wisconsin Department of Transportation.

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[1] *The following individuals were members of the Committee during a part of its life: George C. Berteau, Chairman, Southeastern Wisconsin Regional Planning Commission; William Ryan Drew, Commissioner, Department of City Development, City of Milwaukee; Thomas P. Kujawa, Supervisor, 24th District, Milwaukee County; and Herbert R. Teets, Division Administrator, Federal Highway Administration, U. S. Department of Transportation.*

Appendix B

federal register

WEDNESDAY, SEPTEMBER 22, 1976

PART II:

DEPARTMENT OF TRANSPORTATION

Urban Mass Transportation Administration

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MAJOR URBAN MASS TRANSPORTATION INVESTMENTS

MAJOR URBAN MASS TRANSPORTATION INVESTMENTS: STATEMENT OF POLICY

Federal Register, Volume 41, No. 185, September 22, 1976, pp. 41511-41514.

The purpose of this notice is to issue a Statement of Federal Policy with respect to decisions on major urban mass transportation investments assisted under the Urban Mass Transportation Act of 1964, as amended. The need for such a Statement has resulted from the growing complexity of the UMTA capital program and the increasing demands placed upon the available funds.

At the outset of the urban mass transportation assistance program in 1964, the $75 million annual budget was directed toward the preservation of urban transit service in selected cities through the conversion of failing private transit companies to public ownership. A decade later UMTA's annual capital assistance budget exceeds $1 billion, and is primarily devoted to modernizing existing transit properties and constructing new transit facilities. Not only has the magnitude and duration of Federal transit investments increased and changed significantly but the number of potential recipients has grown. The pressure of these competing demands requires the Department of Transportation to ensure that the available Federal resources are utilized in the most prudent and effective manner.

In the interest of making all urban areas aware of the procedures which are followed and the issues considered in Federal decisions to participate in the financing of locally initiated major mass transportation investments, the Department of Transportation is promulgating this Statement of Federal Policy. The policy represents a process-oriented approach designed to allow each urban area to take into account its unique characteristics in the planning, design and implementation of transportation improvements. As a condition of eligibility for Federal assistance, the policy requires that alternative investment strategies be considered in order to determine which investment best serves the locality's transportation needs, promotes its social, economic, environmental and urban developments goals, and supports national aims and objectives. The policy stresses the need to consider combinations of transit modes and technologies appropriate to the service requirements of specific corridors, and requires major fixed guideway systems to be implemented incrementally, with priority given to the most immediate needs of the locality.

This Statement of Policy has been developed in concert with Federal, State and local transportation and planning officials, transit operators, public interest groups and other parties potentially affected by the Policy. Comments and opinions from these diverse groups have been sought by UMTA through individual solicitations, through interest groups such as the American Public Transit Association (APTA), and through two major UMTA-sponsored consultative conferences (Airlie House Conference and Hunt Valley Conference).

The Policy Statement was first issued for public comment on August 1, 1975 (FR, Vol. 40, No. 149). Sixty-eight responses were received from local, State and transit agencies, metropolitan planning organizations and other interested parties. These comments led to a revision of the Statement and the addition of a description of UMTA procedures. By spelling out clearly the process by which it makes major capital grant decisions, UMTA hoped to increase its own accountability and add a measure of predictability to the discretionary grant award process.

The revised Statement of Policy was discussed at a working conference held under the auspices of the Transportation Research Board at Hunt Valley, Maryland on March 29 through April 1. In arriving at this final Statement of Policy, UMTA has taken careful account of the views and comments expressed at that conference and throughout the 20-month consultative process.

The following significant changes have been made from the initially proposed text of the Statement as issued in the Federal Register on August 1, 1975.

The section entitled "Extent of Federal Commitment" which appeared in the earlier version of the Policy Statement has been deleted. The proposition that the Federal Government might provide funding for alternatives which the local analysis had determined as not cost-effective is deemed to be inconsistent with the Federal obligation to ensure prudent and effective use of the taxpayers' money. The Department's policy of confining Federal financial support to cost-effective alternatives remains unchanged.

Review of the comments received indicated also the desirability of removing certain ambiguities and making certain clarifications in the Policy Statement. These changes are discussed below.

1. A number of respondents felt that no single overall measure of transportation cost-effectiveness could fully reflect all of the significant issues which must be considered in reaching responsible decisions. A single measure was not the intent of the policy. The statement now makes it clear that multiple measures of cost and of levels of effectiveness should be considered, and that effectiveness is measured by the degree to which the proposed investment meets the locality's transportation needs, promotes its social, economic, environmental and urban development goals, and supports national objectives.
2. Some comments interpreted the emphasis on a short planning horizon as a rejection of the concept of comprehensive metropolitan planning. The policy does not challenge the concept of long range planning, and UMTA recognizes the need for such planning as a means of giving an overall direction to metropolitan development. However, UMTA believes that it is not prudent for either a locality or the Federal Government to make a massive commitment to a fixed course of action for mass transportation based solely on the necessarily speculative projections that must characterize plans which target 30 or 25 years in the future. Changing social priorities, demographic shifts, environmental concerns, accelerated inflation and other unanticipated developments can drastically alter even the most carefully conceived long range plans. It is desirable therefore to base immediate investment decisions on a shorter planning horizon. The sections on "Long Range Plan" and "Incremental Development" now bring out more clearly these considerations.
3. A number of respondents felt that a 10-year horizon for the short term analysis was too close in the future to permit investments, such as advanced acquisition of rights-of-way, that pay off only in the long run. These comments are well taken. Considering the long lead times that are required for most fixed guideway projects, a somewhat longer planning horizon is justified. The policy has now adopted a horizon of up to 15 years, counting from the time the analysis was carried out. Since major fixed guideway projects taken up to 5-8 years to complete, this is tantamount to a 7-10 year horizon from the date of initial start-up operation.
4. Several comments expressed doubt about the feasibility of the incremental approach to transit system implementation because of the need to offer benefits more or less simultaneously to the entire region. UMTA agrees that there must be some geographic equity in transit development. But the incremental approach is not inconsistent with an equitable distribution of transit benefits. An "increment" of the plan may contain a package of projects designed to benefit an entire metropolitan area. For example, the initial "increment" of the plan may include express bus service in exclusive lanes, new fringe parking facilities, improved feeder services in suburban communities, as well as the first localized segment of a fixed guideway system.
5. The original conception of requiring Transportation System Management improvements in the operation of the existing transportation system as an alternative to the construction of new facilities was felt by many observers to be too confining. The policy now distinguishes between two concepts: the need to assess the potential of low-cost alternatives (e.g., express bus service in reserved lanes) as a discrete option to more capital intensive alternatives; and the need to employ various types of Transportation System Management actions to support and complement (but not substitute for) the proposed fixed guideway investment.
6. A more precise definition of a "major urban mass transportation investment" was urged by several respondents. This point has been clarified by bringing under the coverage of the policy all projects involving new construction or extension of existing fixed guideway systems, except projects identified by UMTA as part of a demonstration program (such as the proposed "Downtown People Mover" demonstrations). Projects involving rehabilitation or modernization of existing facilities are not within the scope of the alternatives analysis requirement. Fixed facilities by nature of their permanence and irreversibility have potentially the greatest impact upon the urban area in terms of land use, fi-

nancial burden, and urban growth. Decisions concerning construction of new fixed facilities, therefore, deserve particular care, regardless of their financial scope.

7. Questions were raised concerning the relationship of the Environmental Impact Assessment to the analysis of alternatives. The Policy now explicitly integrates the two processes and calls for the circulation of a final Environmental Impact Statement prior to a decision on the award of the preliminary engineering grant.

Issued in Washington, D.C. on September 9, 1976.

William T. Coleman, Jr.
Secretary

FEDERAL POLICY ON ASSISTANCE FOR MAJOR URBAN MASS TRANSPORTATION INVESTMENTS

Since the beginning of this decade, the Federal Government has provided an increasing share of the Nation's capital investment in urban mass transportation. In the years ahead, as more and more communities seek Federal financial aid to improve and expand their mass transportation systems, it is more essential than ever that Federal funds be effectively and efficiently utilized.

Since each metropolitan area has differing characteristics, Federal mass transportation assistance cannot be based on standardized prescriptions. Rather, Federal support should be flexible, relying heavily on local ability to assess present and anticipated transportation needs, identify and evaluate alternative opportunities for improvement, and initiate needed actions.

The Federal Government does, however, have a strong interest in ensuring that Federal funds available for mass transportation investments be used prudently and with maximum effectiveness. While there are no simple or standard procedures that will guarantee this outcome, a careful and systematic evaluation of the implications of alternative courses of action in advance of a Federal commitment should improve the quality of decision. To this end an analysis of transportation alternatives and the filing of a final Environmental Impact Statement will be required as a condition of eligibility for Federal assistance for a major mass transportation investment. Federal support will be available only for those alternatives which the analysis has demonstrated to be cost-effective, where effectiveness is measured by the degree to which an alternative meets the locality's transportation needs, promotes its social, economic, environmental and urban development goals, and supports national aims and objectives.

A major mass transportation investment for purposes of this Statement is any project which involves new construction or extension of a fixed guideway system (rapid rail, light rail, commuter rail, automated guideway transit) or a busway, except where such project is determined by the Administrator to be of importance as a demonstration of advanced technology. Rehabilitation and modernization projects are not included in the scope of this definition.

The analysis of alternatives shall be carried out as part of a comprehensive transportation planning process in accordance with the following principles:

A. LONG RANGE PLAN

Proposals for major mass transportation investments shall be consistent with an urban area's comprehensive long range plan which articulates the overall direction for metropolitan development and identifies major transportation corridors.

The long range plan should reflect an awareness that different levels and types of transportation service may be needed in different portions of the metropolitan area. Each major corridor should be considered individually to determine the level and type of service that will best meet its projected requirements.

The long range plan should further recognize the need for local community-level transit service as well as for express line-haul connections that foster region-wide accessibility.

As an example, a comprehensive transportation plan may call for the construction of a rail rapid transit line in a corridor of heavy demand, a "people mover" to facilitate local circulation in the central business district, a light rail network or busways to serve intermediate capacity corridors in the lower density portions of the metropolitan area, and fleets of fixed route buses and flexibly routed paratransit vehicles acting as feeders and distributors to the higher capacity line-haul systems and providing neighborhood circulation service in the local communities within the metropolitan region.

The long range plan should be reassessed and revised periodically as part of a continuing transportation planning process to reflect changes in local goals, priorities and long range forecasts; to respond to new land development and travel patterns; to adapt to new technologies as they are developed; and to adjust to the impact of previously implemented actions.

B. INCREMENTAL DEVELOPMENT

Where an area's comprehensive long range transportation plan calls for the creation of a fixed guideway system, the system should be proposed for implementation incrementally. Initial segments of the system should be proposed in corridors which can justify the need for fixed guideway service within 15 years of the date of the analysis. Each segment should be capable of justification on its own merits.

Corridors which cannot justify fixed guideway transit service within 15 years of the date of the analysis should be provided with levels and types of service appropriate to their needs, with the level of service being progressively upgraded as demand develops. Incremental developmental aims to ensure that high priority corridors receive initial attention; that appropriate balance is maintained between the transportation requirements of the entire region and those of local communities within the region, and between long range and short range needs for transportation improvements; that flexibility is preserved to respond to changing technology, land use patterns and growth objectives; and that the fiscal burden is spread over a long period of time.

C. EVALUATION OF ALTERNATIVES

In the interest of improving the quality of the local planning and investment decisions, any metropolitan area which intends to apply for Federal assistance for a major mass transportation investment must undertake an analysis of transportation alternatives with regard to any corridors in which fixed guideway facilities have been proposed for implementation. The analysis should consider a range of alternatives, including improvements involving better management and operation of the existing street and highway network, e.g., through provision of reserved lanes for buses and other high occupancy vehicles.

This analysis should assess each alternative's capital and operating costs; ridership attraction; capital and operating efficiency and productivity; effects on modal choice, level of automobile use, environmental impacts and energy consumption; impact on land use and development patterns; extent of neighborhood disruption and displacement; job creation impact; and such other factors as are considered important by the local community.

The analysis should also compare the relative costs and effectiveness of each alternative, where effectiveness is measured by the degree to which the alternative meets the locality's transportation needs, promotes its social, economic, environmental and urban development goals, and supports national aims and objectives.

As part of the analysis of alternatives, a draft Environmental Impact Statement shall be prepared jointly by UMTA and the applicant in accordance with published guidelines.

D. TRANSPORTATION SYSTEM MANAGEMENT

Plans for a fixed guideway project should include transportation system management (TSM) actions to enhance the project's accessibility and convenience and to improve the quality of transportation service in other parts of the metropolitan area which will not be served by the fixed guideway project. Supportive TSM actions shall include the provision of adequate bus and paratransit feeder services and parking facilities at transit stations, and may include other measures aimed at increasing transit ridership and reducing unnecessary use of private automobiles within the transit corridor.

E. PUBLIC INVOLVEMENT

There should be full opportunity for the timely involvement of the public, local elected officials, and all levels of government in the alternatives analysis process. This involvement should be initiated early, so that all affected groups have an opportunity to influence the process in a timely and constructive fashion, particularly as to the alternatives to be considered, measures of effectiveness to be used, actions to be taken to minimize or avoid adverse effects and priority actions for implementation.

After completion of the draft Environmental Impact Statement a formal public hearing shall be held as required by the Urban Mass Transportation Act of 1964, covering both the analysis of alternatives and the draft Environmental Impact Statement.

PROCEDURES

This section states the procedures which UMTA will normally follow in reviewing the alternatives analysis, in implementing the Environmental Impact Statement requirement of the National Environmental Policy Act of 1969, and in making funding commitments to support major mass transportation investments.

1. The initial phase of the alternatives analysis process shall involve a preliminary analysis leading to the development of a citizen involvement mechanism, the choice of appropriate demand forecasting techniques and cost-effectiveness analysis methodology, the designation of a priority corridor(s), and the selection of a small set of promising transportation alternatives for analysis. UMTA must concur in these elements of analysis before the applicant may proceed with a detailed evaluation of the alternatives.

2. After obtaining UMTA's concurrence, the applicant shall proceed with the alternatives analysis and the preparation of a proposed draft Environmental Impact Statement (EIS). The proposed draft EIS shall be combined in a single document with the results of the alternatives analysis and shall be prepared jointly by UMTA and the applicant in accordance with published UMTA guidelines. Each alternative selected for study shall be presented at the same level of detail.

The applicant shall designate, in a separate document to be submitted simultaneously, the preferred cost-effective alternative which he recommends for implementation, and state a rationale for his choice. The recommended alternative shall be described in terms of its corridor location, length of initial segment(s), technology, horizontal and vertical alignment, grade separation, station location and other relevant factors. This document shall clearly state that any recommendation is solely that of the applicant and that UMTA's judgment is reserved until the environmental process is complete.

3. Upon receipt of the combined alternatives analysis and proposed draft Environmental Impact Statement, UMTA will undertake a review of the document to ensure that the analysis has been carried out in conformance with UMTA policy and UMTA guidelines. This review will normally be completed within 90 days of the receipt of the draft alternatives analysis and proposed draft EIS.

4. After the consolidated alternatives analysis and proposed draft Environmental Impact Statement has been found in conformance with UMTA guidelines, UMTA will circulate it for comment. During the circulation period the applicant will hold a public hearing on the document and may, at applicant's option, include in such hearing consideration of any application for a grant for preliminary engineering on the applicant's preferred alternative.

5. At the end of the circulation period UMTA and the applicant will address the questions and comments received, correct any deficiencies in the analysis, and begin preparation of a final Environmental Impact Statement on a recommended alternative. The final EIS shall be prepared at the same level of detail as the draft EIS.

The final Environmental Impact Statement may also incorporate UMTA's decision with respect to a preliminary engineering grant, subject to the condition of satisfactory completion of the 30-day circulation period required for the final Environmental Impact Statement. This decision will be based upon a comparison of projects emerging from the alternatives analysis process.

UMTA may admit projects into preliminary engineering whose combined cost exceeds available Federal contract authority. This will be done in anticipation of any of several possibilities: the withdrawal of projects as a result of changing local priorities; a local decision to use non-Federal resources to finance more than 20 percent of total cost; or changing conditions such as the availability of detailed cost estimates which might lead to a later decision that a particular project cannot be Federally financed.

6. During the execution of preliminary engineering, the applicant will be expected to complete all the steps which must precede a full Federal commitment of capital grant funds to the project. These steps include providing evidence of firm commitment of the non-Federal capital share, providing evidence of State and/or local consensus regarding the financing of operating deficits, and planning for and gaining financial commitment to necessary supportive actions to promote effective utilization of the proposed fixed guideway system.

7. Upon completion of the preliminary engineering phase, the applicant may prepare a capital grant application for the construction (including final engineering and right of way acquisition) of the proposed project, and shall hold a public hearing thereon.

8. A definite funding commitment by UMTA for construction in a specific dollar amount will be made upon review of the capital grant application, the transcript of the public hearing and the detailed cost estimates emerging from preliminary engineering. The decision will be based upon a comparison of projects then pending.

Appendix C

GLOSSARY OF TECHNICAL TERMS

The following list provides definitions of certain technical terms used throughout this planning report, as well as throughout the four supporting technical reports documenting the findings and recommendations of the Milwaukee area primary transit system alternatives analysis.[1] It should be recognized that while many of these terms may have different meanings when used in a nontransportation-related context, or even slightly different meanings when used in the context of other transportation studies, the definitions set forth herein are those which relate directly to primary transit planning in southeastern Wisconsin as conducted under the Milwaukee area primary transit system alternatives analysis.

ACCESSIBILITY: A measure of the ease of travel between various geographic subareas.

ACCESS TIME: The time elapsed on a trip from the moment of leaving the point of origin to the moment of boarding a transit vehicle.

ALTERNATIVES ANALYSIS: A long-range planning process whereby a range of urban transportation alternatives is designed, tested, and evaluated with respect to possible implementation in specific corridors of major travel demand.

AMORTIZATION PERIOD: The useful life measured in years of a facility or piece of equipment.

ARTERIAL EXPRESS OPERATION: The operation of rubber-tired transit buses over arterial streets in a secondary level of service with some form of preferential treatment over other motor vehicle traffic.

ARTICULATED BUS: A high-capacity bus—typically 55 to 60 feet in length—that bends in the middle in order to better negotiate curves.

AT-GRADE: A public transit facility which is located essentially on the prevailing surface of the terrain.

AT-GRADE CROSSING: See "Grade Crossing."

[1] *See SEWRPC Technical Report No. 23, Transit-Related Socioeconomic, Land Use, and Transportation Conditions and Trends in the Milwaukee Area; SEWRPC Technical Report No. 24, State-of-the-Art of Primary Transit System Technology; SEWRPC Technical Report No. 25, Alternative Futures for Southeastern Wisconsin; and SEWRPC Technical Report No. 26, Milwaukee Area Alternative Primary Transit System Plan Preparation, Test, and Evaluation.*

AUTOMATED GUIDEWAY TRANSIT: A passenger transportation technology which utilizes vehicles that proceed from origin to destination without a driver.

AUTOMATIC BLOCK SIGNALS: A signal system which automatically maintains a safe distance between trains.

AVERAGE SPEED: The overall speed which a vehicle achieves between stations, including acceleration and deceleration.

BASE PLAN: A plan which represents the existing system and which is used to evaluate the incremental costs and benefits derived from alternative improvement plans.

BI-DIRECTIONAL: Rail transit vehicles or trains which are capable of reversing direction at the end of a trip or route without the need to physically turn the vehicles around.

BLOCK: With respect to railway traffic control, a length of track over which the movement of trains is governed by a signal.

BTU: British Thermal Unit; the quantity of heat required to raise the temperature of one pound of water one degree fahrenheit.

BUS BAY: See "Turnout Bay."

BUS LANE: See "Reserved Lanes."

BUSWAY: A special-purpose paved roadway designed for the exclusive or predominant use of motor buses and possibly high-occupancy vehicles and emergency vehicles.

BYPASS LANE: A specially designated lane on metered freeway entrance ramps for the exclusive use of transit vehicles and possibly high-occupancy vehicles to bypass waiting queues of automobiles and trucks.

CAPACITY: The number of passengers that can be transported over a given section of transit line during a given time period under prevailing traffic conditions.

CAPITAL COST: The capital expenditure required for the implementation of a particular plan or project, calculated by subtracting the value of the remaining life of facilities and vehicles beyond the plan design period from the capital investment required.

CAPITAL INVESTMENT: The total outlay of funds for guideways, stations, and support facility construction and vehicle acquisition necessary to implement a particular plan or project.

CATENARY: A type of power distribution system which consists of an overhead contact wire attached to hangers suspended from a messenger wire.

CENTRAL BUSINESS DISTRICT: The downtown area of a city which is characterized by very high land valuation, high levels of traffic flow, and concentrations of retail business offices, theaters, hotels, and services.

CENTRALIZED TRAFFIC CONTROL: A traffic control system for railway operations in which the signals and turnouts for a designated section of track are controlled from a distant location.

COMMUTER: A person who travels regularly between home and a fixed work or school location.

COMMUTER RAIL: A rail transit mode that utilizes diesel-electric or electric locomotives pulling or pushing railway passenger cars and operating over right-of-way and trackage generally shared with railway freight trains and possibly intercity passenger trains.

COMPOSITE SYSTEM: An alternative primary transit system plan consisting of both fixed guideway routes and bus-on-freeway routes which together produce a system similar in geographic extent to a pure bus-on-freeway alternative system.

CONTRAFLOW LANE: A lane of a freeway or expressway pavement reserved for the exclusive use of transit vehicles which operates against the direction of motor vehicle traffic on the other lanes of the pavement.

CONVENTIONAL MOTOR BUS: A nonarticulated bus typically 35 to 40 feet in length.

CORRIDOR OF MAJOR TRAVEL DEMAND: A broad geographical band that follows the general direction of major traffic flows and that may contain a number of streets and highways, and transit route alignments.

CRUSH CAPACITY: The maximum passenger-carrying capacity of a vehicle in which the spacing between passengers is zero and even one more passenger cannot enter without causing serious discomfort to the others.

DEADHEAD: To move a revenue vehicle without passengers on board, such as from a storage area to the beginning of a regular route.

DEPRECIATION: A decrease in value of property through wear, deterioration, or obsolescence.

DEPRESSED IN CUT: A public transit facility which is located below the prevailing surface of the terrain in an excavated cut which has not been covered.

DESIGN YEAR: The final year of a plan design period by which all elements of an alternative plan are assumed to be implemented.

DESIRE LINE: A straight line connecting the origin and destination of a trip.

DOUBLE ARTICULATED: A high-capacity, light rail vehicle which bends on two joints in order to better negotiate sharply curved trackage.

DOUBLE-DECK BUS: A high-capacity bus which includes passenger seating on two levels.

DOUBLE-TRACK LINE: A railway line that has two tracks which permits trains to move in opposite directions at the same time without interruption.

DUAL GUIDEWAY: A fixed guideway which consists of at least two paved roadway lanes or two railway tracks so that opposing streams of traffic can be operated at the same time without interruption.

DUORAIL SYSTEM: See "Rubber-Tired Duorail System."

DWELL TIME: The amount of time a vehicle stands at a station or stop.

ELECTRIC INTERURBAN RAILWAY: An electrically powered railway providing primarily passenger service with equipment similar to but heavier and faster than city streetcars, operating in mixed traffic over streets in cities and over private rights-of-way in rural areas. Light rail transit technology has, in part, evolved from this mode, which is now considered to be obsolete.

ELECTRIC TROLLEY BUS TECHNOLOGY: Public transit facilities, equipment, and vehicles characterized by the operation of rubber-tired vehicles over paved roadways which are propelled by electric power collected from a pair of overhead contact wires.

ELEVATED ON AERIAL STRUCTURE: A public transit facility which is located on a structure that provides overhead clearance for vehicles that operate on the prevailing surface of the terrain.

ELEVATED ON FILL: A public transit facility located above the prevailing surface of the terrain that is supported by an embankment rather than by a structure.

EXCLUSIVE GUIDEWAY: A paved roadway or

railway trackage which is utilized solely by public transit vehicles and which may or may not be grade-separated.

EXCLUSIVE RIGHT-OF-WAY: A right-of-way which is utilized solely by public transit vehicles, is access controlled, and may or may not be grade-separated.

EXISTING RIGHTS-OF-WAY: An existing strip of land which may have potential for the physical location of primary transit facilities.

EXOTIC TECHNOLOGY: Public transit facilities, equipment, and vehicles characterized by modes which are either unproven or still under development and thus considered to be experimental.

EXPRESS SERVICE: See "Secondary Service."

EXPRESSWAY: A divided highway for through motor vehicle traffic that has partial access control and may or may not have grade separations at major intersections.

FAREBOX REVENUES:
See "Operating Revenues."

FAR-SIDE STOP: A transit stop located on the far side of an intersection which requires that the transit vehicle cross the intersection before picking up or discharging passengers.

FEEDER SERVICE: A service that transports passengers to a station or transfer point for connection to primary transit services; considered to be a form of secondary or tertiary service.

FIXED COST: An indirect cost that remains relatively constant, irrespective of the level of operational activity.

FIXED TRACK: Railway track structure consisting of steel rails attached directly to the floor or superstructure of a subway, tunnel, bridge, or trestle.

FREEWAY: A divided highway for through motor vehicle traffic that has full access control and grade separations at all intersections.

FREEWAY FLYER SERVICE: The operation of diesel motor buses in a primary level of transit service over freeways in mixed traffic.

FREEWAY OPERATIONAL CONTROL SYSTEM: A traffic management system whereby automobile and truck access to the freeway is restrained by means of metering the freeway entrance ramps during peak travel periods to increase the operating efficiency of otherwise congested freeway segments. Motor buses and high-occupancy vehicles are frequently given preferential access to operationally controlled freeways through the use of bypass lanes at entrance ramps.

FREEWAY TRAFFIC MANAGEMENT SYSTEM: See "Freeway Operational Control System."

GRADE CROSSING: A crossing of highways, railroad tracks, other fixed guideways, or pedestrian walks or of combinations of any of these at the same level.

GRADE SEPARATION: A separation of intersecting streams of traffic by the provision of overpasses or underpasses.

GROUP RAPID TRANSIT: See "Light Guideway Transit."

HEADWAY: The time interval between vehicles moving along the same lane or track in the same direction.

HEAVY RAIL RAPID TRANSIT: A rail transit mode which utilizes electrically propelled vehicles, usually coupled into trains, operating on a predominantly exclusive and fully grade-separated right-of-way serving corridors of extremely high travel demand. Power supply is from a third rail, and passenger access to vehicle is from high-level platforms. Fare collection is usually off-train.

HIGH-OCCUPANCY VEHICLE: A passenger vehicle that carries two or more passengers such as a bus or a carpool or vanpool vehicle.

HONOR SYSTEM: See "Self-Service Ticketing."

INCREMENTAL COST: The net change in dollar costs that is directly attributable to a given decision or proposal as compared with some other alternative.

INTANGIBLE BENEFITS: Benefits that are clearly real and identifiable but are either difficult or impossible to quantify.

INTERMEDIATE-CAPACITY TRANSIT SYSTEM: A public transit mode not unlike light rail transit with vehicles that have steerable axle trucks and are propelled by linear induction motors, therefore requiring a fully grade-separated fixed guideway.

KEY EXTERNAL FACTORS: The most important conditions which affect the need for transit services but over which local officials have little or no control, including energy cost and availability, population lifestyles, and economic conditions.

KISS-AND-RIDE: An access mode to a public transit station in which the passenger is dropped off by an automobile which does not park at the station.

LEVEL OF SERVICE: A set of characteristics that indicate the quality and quantity of public transportation services being provided, including characteristics that are quantifiable such as travel time, travel costs, and the number of transfers, and those that are difficult to quantify such as comfort and modal image.

LIGHT GUIDEWAY TRANSIT: An automated guideway transit mode which utilizes vehicles operated singly or in small trains over an exclusive guideway, generally under automatic control.

LIGHT RAIL RAPID TRANSIT: Light rail transit systems which make particularly extensive use of exclusive, fully grade-separated rights-of-way.

LIGHT RAIL TRANSIT: A rail transit mode which utilizes predominantly reserved but not necessarily grade-separated rights-of-way with the operation of electrically propelled vehicles either singly or in trains. Power supply is from an overhead wire, and passenger access to vehicles may be from either ground-level or high-level platforms. Fare collection is self-service or on board the vehicles.

LINE HAUL: The high-speed, limited-stop portion of a trip provided by public transit services, generally along a single corridor.

LOAD FACTOR: The ratio of the total number of passengers carried on a transit vehicle to the capacity of the vehicle.

LOCAL SERVICE: See "Tertiary Service."

LOWER TIER: That part of a plan which recommends immediate implementation of certain facilities and services.

MAIN LINE: The principal part of a roadway, railway, or other transportation facility over which all or most of the traffic moves; it excludes branches, spurs, side roads, sidings, ramps, and yards.

MAJOR TRAFFIC GENERATOR: A distinct geographical area characterized by a high concentration of trip origins and destinations and heavy traffic volumes and densities.

MARGINAL COST: See "Incremental Cost."

MARRIED PAIR: Two heavy rail rapid transit vehicles that are semi-permanently coupled together.

MAXIMUM CAPACITY: The maximum number of passengers that a vehicle is designed to accommodate comfortably, including seated and standing passengers.

MAXIMUM SPEED: The highest speed that a vehicle or train is capable of attaining.

MEDIAN: That portion of a divided highway or freeway which separates the opposing flows of motor vehicle traffic.

METERED FREEWAY: A freeway to which access is restrained by entrance ramp signals that use fixed-time signal settings or are regulated by a computerized surveillance system to prevent freeway congestion.

MIXED TRAFFIC OPERATION: The operation of public transit vehicles in lanes which are open to all other types of motor vehicle traffic.

MONORAIL: Passenger transportation technology which utilizes a single rail for vehicle support as well as lateral guidance.

MOTOR BUS TECHNOLOGY: Public transit facilities, equipment, and vehicles characterized by the operation of diesel engine-powered, rubber-tired vehicles over paved roadways.

MOVING WAY TRANSIT SYSTEM: A passenger transportation technology designed for short-distance shuttle service and over which vehicles or passengers are propelled passively by a moving belt, cable, or other mechanical means.

MULTIPLE-UNIT OPERATION: The operation of two or more railway vehicles which are coupled together and equipped so that all cars in the train may be operated from the operator's station in the leading car.

NEAR-SIDE STOP: A stop located on the near side of an intersection at which the transit vehicle picks up or discharges passengers before crossing the intersection.

NORMAL FLOW LANE: A lane reserved for the exclusive use of transit vehicles which operates in the same direction as other traffic.

OPEN TRACK: Railway track structure consisting of steel rails attached to cross ties anchored to the roadbed by crushed rock ballast.

OPERATING COST: The sum of all costs that can be associated with the operation and maintenance of a transit system during the period under consideration.

OPERATING REVENUES: Revenues earned by carrying passengers along regularly scheduled routes and which include the base fare, zone premiums, and express service premiums, and reflect any applicable quantity discounts.

OPERATING SPEED: The maximum speed at which a vehicle can be safely operated under prevailing environmental conditions.

PARK-RIDE LOT: A parking lot located at a public transit station specifically constructed for the use of passengers who access the transit system by private automobile.

PAVED TRACK: Railway track structure consisting of steel rails attached to cross ties or held by tie bars, with the area between and on the sides of the rails being paved to allow rubber-tired vehicles to share the same right-of-way.

PAY-AS-YOU-ENTER: Fare collection procedure typical of North American operations whereby passengers deposit coins, tickets, or tokens into the farebox upon entering the transit vehicle.

PEAK PERIOD: The hours, usually during the weekday morning or afternoon, when the demand for transportation services is the heaviest.

PEOPLE MOVER SYSTEMS: See "Light Guideway Transit."

PERSONAL RAPID TRANSIT: An automated guideway transit mode in which small vehicles, each with a capacity of two to six passengers, operate under automatic control over an exclusive, fully grade-separated fixed guideway.

PLAN DESIGN PERIOD: A specified length of time, measured in consecutive years, for which alternative plans are tested and evaluated. Under the Milwaukee area primary transit system alternatives analysis, this period was determined to be 21 years in length, beginning in 1980 and ending in 2000.

POWER TURNOUT: A turnout which is remotely controlled from a distant location.

PREEMPTION: See "Traffic Signal Preemption."

PRELIMINARY ENGINEERING: That phase of project planning which describes a recommended facility in terms of its corridor location, length of initial segment, specific technology, horizontal and vertical alignment, grade separation, and station location.

PRIMARY TRANSIT SERVICE: That component of the total urban public transportation system which provides the highest operating speeds and serves the longest trips along the most heavily traveled corridors.

PUSH-PULL TRAIN: A conventional locomotive and set of commuter rail coaches which can be controlled either from the locomotive or from a cab in the rear coach.

RAIL TRANSIT TECHNOLOGY: Public transit facilities, equipment, and vehicles characterized by the operation of flanged steel-wheeled vehicles over railway trackage.

RAPID TRANSIT SERVICE: See "Primary Transit Service."

RESERVED LANES: Existing lanes typically located on freeways or arterial streets which are dedicated for the exclusive use of transit vehicles during part or all of the day.

REVERSIBLE LANE: A lane which is reserved for the exclusive use of transit vehicles and possibly other high-occupancy vehicles and that can be operated in either direction, depending upon the direction of predominant traffic flow.

RIDE QUALITY: A measure of the comfort level experienced by a passenger in a moving vehicle, taking into account vibration frequency, acceleration, decleration, jerk, pitch, yaw, and roll.

RUBBER-TIRED DUORAIL SYSTEM: A variation of the modern heavy rail rapid transit mode which utilizes pneumatic rubber tires instead of steel wheels for vehicle support and traction.

SEATED CAPACITY: The number of passenger seats in a vehicle.

SECONDARY SERVICE: That component of the urban public transportation system which serves moderate-length trips, generally over arterial streets and highways, with stops located at intersecting transit routes and major traffic generators.

SELF-PROPELLED VEHICLE: A railway car used in commuter rail service, propelled by a diesel engine which is carried on the vehicle itself.

SELF-SERVICE TICKETING: Fare collection procedure whereby passengers purchase tickets from vending machines, validate them at time of use, and are subject to random checking once on board the vehicle.

SHARED GUIDEWAY: A paved roadway or railway trackage which is utilized not only by public transit vehicles but also by nontransit traffic.

SHARED RIGHT-OF-WAY: Right-of-way which is utilized not only by primary transit vehicles but also by other transit and nontransit traffic.

SIDING: A track auxiliary to the main track for passing or meeting trains, or a track for industrial purposes.

SINGLE ARTICULATED: A high-capacity light rail vehicle which bends on a single joint in order to better negotiate sharply curved trackage.

SINGLE GUIDEWAY: A fixed guideway which consists only of a single paved roadway lane or railway track and which can accommodate traffic movement only in a single direction at any one time.

SINGLE-TRACK LINE: A railway line which has one track and for which passing sidings are required for opposing movements.

SPECIALIZED SERVICE: With respect to primary transit operations, limited services which operate only during specific times of the day and which may serve only certain market segments.

SPECIAL WORK: Specialized parts and assemblies required for overhead contact wire systems at junctions and crossings.

SPUR TRACK: A stub track diverging from the main or other track and connected at one end only.

STANDARD MOTOR BUS: See "Conventional Motor Bus."

STATE-OF-THE-ART: The technological level of development at which a transit mode is regarded as being at its most advanced level, yet proven and fully implementable without the need for a lengthy break-in period.

STATION: A facility used primarily for passengers who are boarding, alighting, or transferring between operating revenue transit vehicles. Also, with reference to mainline railway operations, a specific location designated in the operating timetable by name which does not necessarily denote the existence of depot buildings or other passenger facilities.

STOP: An area usually designated by distinctive signs or by curb or pavement markings at which passengers wait for or alight from public transit vehicles.

STREETCAR: Electrically propelled rail transit vehicle utilized in the operation of street railway systems.

STREET RAILWAY: A rail transit mode which is characterized by electrically propelled vehicles operating singly and predominantly in mixed traffic on public streets. Light rail transit technology is an evolution of this mode, which is now considered to be obsolete.

SUPPORT REQUIREMENTS: Those miscellaneous facilities and services which are not directly involved with transporting passengers but which are required for the operation of the public transit system; for example, facilities for vehicle storage and maintenance and guideway and station maintenance, and such services as traffic control and fare collection.

TERMINAL: The end of a transit route or an elaborate transit station which is designed to handle not only the movement of transit vehicles in the boarding and alighting of passengers, but also the transfer of movements between routes and/or different modes.

TERTIARY SERVICE: That component of the urban public transportation system which provides either a local or a collection-circulation distribution service for trips of short length.

THIRD RAIL: A type of power distribution system which provides for current collection through an energized third rail at track level instead of through an overhead contact wire.

TOTAL COST: The sum of operating and capital costs.

TOTAL PUBLIC COST: The sum of the capital cost and the operating and maintenance deficit for a particular plan or project.

TOTAL TRAVEL TIME: As utilized in travel simulation modeling, the duration of a linked trip from the point of origin to the final destination, including all waiting and walking times at trip ends and transfer points.

TRACKLESS TROLLEY: See "Electric Trolley Bus Technology."

TRAFFIC SIGNAL PREEMPTION: A means of providing public transit vehicles with priority at traffic signals by either extending or advancing the green phase of a traffic signal cycle.

TRANSBUS: Federally mandated diesel motor bus design which was to incorporate features for improved passenger comfort and quality of ride, reduced maintenance costs, and better accessibility for the elderly and handicapped.

TRANSFER TIME: The time required to effect a change of mode or a transfer between routes of the same mode.

TRANSITION LANE: A specially designed lane segment which allows motor buses to cross from a reserved lane on one side of a freeway median to a reserved lane on the other side of the median.

TRANSIT MALL: A public street or other area which has been designated for the exclusive use of transit vehicles and pedestrians, generally along major retail shopping streets and in conjunction with areawide redevelopment efforts. Emergency vehicles are permitted.

TRAVEL DEMAND: The number of trips that would be made by vehicles or passengers along a particular route or corridor under specified conditions.

TRAVEL TIME: See "Total Travel Time."

TRIP PURPOSE: The primary reason for making a trip such as work, shopping, medical appointment, or recreation.

TRIP TIME: See "Total Travel Time."

TROLLEY COACH: See "Electric Trolley Bus Technology."

TRUNCATED SYSTEM: A primary transit system which has had certain segments eliminated from further testing and evaluation because they were found not to be cost-effective.

TURNOUT: The complete mechanical assembly which allows railway vehicles and rolling stock to be diverted from one track to another.

TURNOUT BAY: A specially marked location or a widening of a street or busway which permits motor buses to stop without obstructing other traffic while passengers board or alight.

UNDERGROUND:
See "Heavy Rail Rapid Transit."

UNDERGROUND IN SUBWAY: A public transit facility which is located below the surface in a tunnel and which has been constructed by either the cut-and-cover or deep tunneling method.

UPPER TIER: That part of a plan which identifies certain improvements which could be implemented in the future.

VEHICLE LEVITATION SYSTEM: Propulsion concept whereby the vehicle is raised above the fixed guideway by the use of magnetic levitation to minimize friction.

WAIT TIME: Time spent waiting for a transit vehicle.

YARD: A system of either railway tracks or paved roadways utilized for storing vehicles or making up trains.