**MINUTES OF THE FIFTEENTH MEETING**

**REGIONAL TELECOMMUNICATIONS PLANNING ADVISORY COMMITTEE (Reconstituted)**

DATE: August 29, 2006

TIME: 2:00 P.M.

PLACE: Commissioners' Conference Room
Regional Planning Commission Offices
W239 N1812 Rockwood Drive
Waukesha, Wisconsin

Members Present

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| Kurt W. Bauer<br>Chairman | Executive Director Emeritus, SEWRPC |
| Bob Chernow | Chairman, Regional Telecommunications Commission |
| David L. DeAngelis | Village Manager, Village of Elm Grove |
| Michael Falaschi | President, Wisconsin Internet |
| Barry Gatz | Network Supervisor, CenturyTel |
| Michael E. Klasen | Director, Regulatory Affairs, AT&T |
| J. Michael Long | Attorney-at-Law, Murn and Martin, SC |
| Jeff M. Lowney | Vice President/General Manager, Time Warner Telecom |
| Rob N. Richardson | Director, Racine County Information Systems |
| Steven L. Ritt | Attorney at Law, Michael Best & Friedrich |
| Darryl Winston | Director of Data Services, City of Milwaukee Police Department |
| Gustav W. Wirth, Jr. | SEWRPC Commissioner |

Members Absent

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| William R. Drew<br>Vice Chairman | Vice-Chairman, SEWRPC; Executive Director, Milwaukee County Research Park |
| Roger Caron | President, Racine Area Manufacturers and Commerce |
| Jeff Mantes | Commissioner of Public Works, City of Milwaukee |
| George E. Melcher | Director, Office of Planning and Development, Kenosha County |
| Paul E. Mueller | Administrator, Washington County Planning and Parks Department |
| James W. Romlein | Managing Director, MVLabs, LLC |
| Bennett Schliesman | Director, Kenosha County Emergency Management /Homeland Security |
| Michael Ulicki | Vice President and Chief Technology Officer, Norlight Telecommunications |
| Dale R. Shaver | Director, Waukesha County Department of Parks and Land Use |

Staff

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| Philip C. Evenson | Executive Director, SEWRPC |
| Kenneth J. Schlager, PhD | Chief Telecommunications Engineer, SEWRPC |
| Lynn G. Heis | Staff Secretary, SEWRPC |

## CALL TO ORDER AND ROLL CALL

Chairman Bauer called the meeting to order at 2:00P.M. Roll call was taken by circulating an attendance signature sheet, and a quorum was declared present.

## CONSIDERATION OF THE MINUTES OF THE MEETING OF JULY 10, 2006

Chairman Bauer noted that copies of the minutes of the fourteenth meeting of the Reconstituted Regional Telecommunications Planning Advisory Committee held on July 10, 2006, had been distributed to all members of the Committee for review prior to the meeting. He asked the Committee to consider approval.

Chairman Bauer reminded the Committee that under the Committee established procedure, approval of the minutes would also constitute final approval of Chapter VII, "A Regional Wireless Telecommunications Plan for Southeastern Wisconsin" of SEWRPC Planning Report No. 51, *A Wireless Antenna Siting and Related Infrastructure Plan for Southeastern Wisconsin.* He noted that the chapter incorporated changes, which the Committee at its meeting held on July 10, 2006, had directed to be made based upon the Committee review of preliminary draft of the chapter.

There being no corrections or additions, on a motion by Mr. Wirth, seconded by Mr. Chernow, and carried unanimously, the minutes of the meeting of July 10, 2006, were approved as submitted.

## CONSIDERATION OF DRAFT OF ENVIRONMENTAL IMPACTS ASSESSMENT OF THE REGIONAL BROADBAND WIRELESS SYSTEM PLAN FOR SOUTHEASTERN WISCONSIN.

Chairman Bauer noted that a copy of the preliminary draft of an Environmental Assessment of the Regional Broadband Wireless System Plan as set forth in Chapter VII of SEWRPC Planning Report No. 51, *A Wireless Antenna Siting and Related Infrastructure Plan for Southeastern Wisconsin,* had been provided to all members of the Committee for review prior to the meeting.

Chairman Bauer then asked Dr. Schlager to undertake a page by page review of the preliminary draft with the Committee.

In answer to a question by Mr. Chernow, Dr. Schlager indicated that the Federal Communications Commission (FCC) – Institute of Electrical and Electronic Engineers (IEEE) standards were based upon the level of radiation exposure, expressed in watts per square meter, and upon the frequency range of the transmissions, expressed in megahertz, and not upon distance, even though the radiation exposure will clearly vary with distance from a transmitter. With respect to the proposed Commission wireless telecommunications plan, at a distance of 100 meters, the radiation exposure would be far below the standards. With respect to time of exposure, Dr. Schlager said, the standards are based upon a maximum period of thirty minutes for radiation levels exceeding the standard; it being implicit that continuous exposure would be safe at radiation levels below the standard.

In answer to a further question by Mr. Chernow, Dr. Schlager said that the standards were intended to apply to exposure by the general public; and are set at about 20 percent of the limits for the allowable exposure in controlled environments, defined as environments in which technical personnel are aware of the radiation hazard involved.

Mr. Chernow observed that the Appendix concerned was highly technical, and expressed concern that certain statements made in the Appendix may be used in specific situations by particular interest groups to misrepresent the hazards entailed. He suggested that a simplified summary of the findings should be

included to provide comfort to concerned lay persons. Chairman Bauer observed that the summary section of the Appendix, as set forth on page 12, clearly states in the very first sentence, that the existing and Commission proposed wireless telecommunications systems within the Region are in compliance with the maximum permissible exposure limits promulgated by the Federal Communications Commission. He noted that those limits applied only to thermal effects. Therefore, to be credible, he said, the Appendix had to note that there may be other harmful effects, but that no agreement exists at this time among the scientific communities concerned about such effects. If this made some members of the public uneasy, he said, so be it. Dr. Schlager agreed, noting that the practice in Europe was to utilize more restrictive thermal effect standards, and, in addition, to impose standards for athermal effects as well.

Dr. Schlager indicated that the move in the proposed Commission plan to lower power transmitters was the most prudent approach to the abatement of harmful radiation exposure levels currently available. Dr. Schlager indicated that the use of lower power transmitters would not only have beneficial effect with respect to potential impacts on human health, but would also reduce potential interference between transmitters.

Mr. Chernow called attention to the statement on page three that radio antenna radiation induced heating of the eye could result in cataracts, or even blindness, as being unnecessarily alarming. Dr. Schlager indicated that studies have indeed shown such potential effects. Chairman Bauer indicated that the Commission could not afford to remain silent about this knowledge if it was to maintain its credibility.

In answer to a question by Mr. Evenson, Mr. Chernow indicated that his expressed concerns were not related to any informed consideration of the issues, but to the potential for uninformed, sometimes irrational, statements made and discussions held at public meetings and hearings on proposed telecommunications improvements. He noted that there were examples within the Region in which local communities had unnecessarily rejected permit application for new antenna stations based on health concerns. Mr. DeAngelis agreed that there are often irresponsible statements made at public meetings and hearings about the health effects of microwave transmissions, often using sources of information found on the Internet, with the information being cited out of context, or in some cases, the information being totally incorrect. Mr. Richardson also agreed with Messrs. Chernow and DeAnglis, noting that health effects recited at public meetings and hearings can often be traced to a single study the results of which are not universally accepted within the scientific communities concerned.

Dr. Schlager indicated that the staff had been very careful to compose the environmental assessment presented in the Appendix based only upon the standards adopted by the Federal Communications Commission and the Institute of Electrical and Electronic Engineers.

Mr. Ritt suggested, and it was agreed, that where the results of the radio propagation calculations are set forth on pages five and six, the applicable standards be cited along with the results of the calculations of exposure. Chairman Bauer indicated that staff would attempt to respond to Mr. Ritt's suggestion by either drafting appropriate additions to the text, or by providing a supplementary table. In any case he said, the Committee would see the results, as always, in a revised text attached to the minutes of this meeting.

[Secretary's Note: The following table comparing the results of the radio propagation calculations and the applicable standards was prepared for inclusion on page 11 of the Appendix concerned.

**Table I-1**

**COMPARISON OF RADIATION EXPOSURE LIMITS, COMPUTED VALUES AND MEASURED VALUES: SEPTEMBER 2006**

| Type | Frequency (Megahertz) | Standard | | Computed | | Measured | |
|---|---|---|---|---|---|---|---|
| | | Power Density (watts per meter$^2$) | Field Strength (volts per meter) | Power Density (watts per meter$^2$) | Field Strength (volts per meter) | Power Density (watts per meter$^2$) | Field Strength (volts per meter) |
| Cellular/PCS | 1,932 | 9.5 | 59.8 | 0.00079 | 0.54 | 0.000120 | 0.213 |
| WiFi/WiMAX | 2,400 | 10.0 | 61.4 | 0.00030 | 0.34 | 0.000051 | 0.139 |

Note: Radio propagation computations and field measurements are based on radiation levels 100 meters from the antenna location.

*Source: SEWRPC.]*

In answer to a question by Mr. Chernow, Dr. Schlager indicated that there were indeed numerous wireless telecommunication towers located within residential areas of the Region, often in close proximity of homes. In answer to a question by Mr. Ritt concerning the field strength shown on Maps 1 and 2, Dr. Schlager indicated that the maps were based upon radio propagation modeling, and that the particular antenna concerned would indeed be very similar to an analogue cellular telephone antenna with a tower height of approximately 100 feet. Dr. Schlager indicated that the calculations had been validated by field measurements, albeit a limited number of measurements.

In answer to a question by Mr. Chernow, Dr. Schlager indicated that the calculations, and the maps concerned, were based upon a single antenna mounted on a mast or tower. If multiple antennae were mounted on the mast or tower, he said, the exposure levels would be multiplied by the number of antennae concerned. Chairman Bauer observed that Mr. Chernow had raised a very important point which needed to be described in an addition to the text. He indicated that the staff would draft such an addition which would be subject to Committee review as a part of the consideration of its minutes to this meeting.

[Secretary's Note: The following statement was drafted for insertion on page 10 of the Appendix concerned.

"The field strength plots shown on Maps 1 and 2 are based upon one transceiver-antenna unit mounted on a station structure. For multiple unit installations the radiation output will be a multiple of the transceiver-antenna units. The maximum number of co-located antennas in the Region was five. Even the power radiated by this collection of antennas would still be a very small percentage of the standard for the worst case in the 800 MHz band."]

There being no further questions or comments, on a motion by Mr. Wirth, seconded by Mr. Falaschi, and carried, the preliminary draft of the Environmental Impact Assessment of the proposed Regional Broadband Wireless Plan for Southeastern Wisconsin, an Appendix to SEWRPC Planning Report No. 51, *A Wireless Antenna Siting and Related Infrastructure Plan for Southeastern Wisconsin*, was approved as presented, with Mr. Chernow voting no.

Mr. Chernow explained his vote by indicating that while the Assessment as submitted may be technically sound, the specific wording in places colors the hazards to health that may be involved in an unnecessarily pessimistic manner; and that some of these statements may be used out of context by opponents to proposed telecommunications improvements.

**CONSIDERATION OF PRELIMINARY DRAFT OF CHAPTER IV "INVENTORY FINDINGS - BACKGROUND CONDITIONS" OF SEWRPC PLANNING REPORT NO. 53, *A REGIONAL COMPREHENSIVE BROADBAND TELECOMMUNICATIONS PLAN FOR SOUTHEASTERN WISCONSIN.***

Chairman Bauer noted that a copy of the preliminary draft of Chapter IV "Inventory Findings - Background Conditions" of SEWRPC Planning Report No. 53, *A Regional Comprehensive Broadband Telecommunications Plan for Southeastern Wisconsin,* had been provided to all members of the Committee for review prior to the meeting.

Chairman Bauer noted that it was identical to Chapter IV "Inventory Findings - Background Conditions" of SEWRPC Planning Report No. 51 *A Wireless Antenna Siting and Related Infrastructure Plan for Southeastern Wisconsin* which report sets forth the recommended wireless telecommunications system plan for the Region. He noted that the Committee had reviewed this chapter as prepared for inclusion in SEWRPC Planning Report No. 51 at its meeting held on April 12, 2005 and had then acted unanimously to approve the chapter for publication. Accordingly, he said, he would suggest that a page by page review of the chapter be dispensed with and asked the Committee's pleasure.

There being no questions or comments, on a motion by Mr. Chernow, seconded by Captain Winston, and carried, the preliminary draft of Chapter IV "Inventory Findings – Background Conditions" of SEWRPC Planning Report No. 53, *A Regional Comprehensive Broadband Telecommunications Plan for Southeastern Wisconsin,* was approved as presented, with Messrs. Klasen and Ritt voting no.

Mr. Klasen explained his vote by indicating that it was the position of AT&T that, while the firm concurred with the Commission efforts to understand the status of the telecommunications industry within the Region, the firm could not support the efforts of the Commission to develop plans affecting a highly competitive private industry, and that it was not in the best interest of the Commission to expend resources for that purpose. Mr. Ritt indicated concurrence in Mr. Klasen's explanation.

Chairman Bauer expressed surprise at Messrs. Klasen's and Ritt's votes, noting that at the Committee meeting held on May 10, 2005, both Messrs. Klasen and Ritt had voted to approve this identical chapter as a part of SEWRPC Planning Report No. 51, the report documenting the Commission proposed wireless plan. Chairman Bauer recalled that at that time, Mr. Klasen had expressed no objection to the Commission's engaging in inventory activities.

**CONSIDERATION OF PRELIMINARY DRAFT OF CHAPTER I "INTRODUCTION" OF SEWRPC PLANNING REPORT NO. 53, *A REGIONAL COMPREHENSIVE BROADBAND TELECOMMUNICATIONS PLAN FOR SOUTHEASTERN WISCONSIN.***

Chairman Bauer noted that a copy of the preliminary draft of Chapter I "Introduction" of SEWRPC Planning Report No. 53, *A Regional Comprehensive Broadband Telecommunications Plan for Southeastern Wisconsin,* had been provided to all members of the Committee for review prior to the meeting.

Chairman Bauer then asked Dr. Schlager to undertake a page by page review of the preliminary draft with the Committee.

There being no questions or comments, on a motion by Mr. Chernow, seconded by Mr. Wirth, and carried, the preliminary draft of Chapter I "Introduction" of SEWRPC Planning Report No. 53, *A Regional Comprehensive Broadband Telecommunications Plan for Southeastern Wisconsin,* dated August 23, 2006, was approved as presented with Messrs. Klasen and Ritt voting no.

Messrs. Klasen and Ritt indicated that the basis for their vote had already been explained with respect to the Committee's action on Chapter IV, taken earlier in the meeting.

[Secretary's Note: By an electronic communication dated August 31, 2006, Mr. Mantes requested that the second sentence of the partial first paragraph under the title "Plan Design Year" be divided into two sentences, revised to read as follows:

"This design year was selected to correspond with the year 2015 stage of a set of new land use and transportation system plans being prepared for the Region. These plans are to have a design year 2035 with appropriate ten year stages.]

**CONSIDERATION OF PRELIMINARY DRAFT OF CHAPTER II "BASIC PRINCIPLES AND CONCEPTS" OF SEWRPC PLANNING REPORT NO. 53, *A REGIONAL COMPREHENSIVE BROADBAND TELECOMMUNICATIONS PLAN FOR SOUTHEASTERN WISCONSIN.***

Chairman Bauer noted that a copy of the preliminary draft of Chapter II "Basic Principles and Concepts" of SEWRPC Planning Report No. 53, *A Regional Comprehensive Broadband Telecommunications Plan for Southeastern Wisconsin,* had been provided to all members of the Committee for review prior to the meeting.

Chairman Bauer then asked Dr. Schlager to undertake a page by page review of the preliminary draft with the Committee.

Mr. Klasen indicated that a statement to the effect that the Commission's plan recommendations would not in any way prohibit private service providers from adopting technologies and plans that may not be consistent with the Commission plans should be included in the text. Chairman Bauer noted that he recalled Mr. Klasen asking for the insertion of such a statement in Chapter VII of SEWRPC Planning Report No. 51 – the chapter which presents the Commission proposed wireless telecommunication plan for Southeastern Wisconsin. In answer to a question by Chairman Bauer, Mr. Klasen indicated that he would be satisfied if such a statement were again included in an appropriate chapter of the SEWRPC Planning Report No. 53.

[Secretary's Note: The statement requested by Mr. Klasen is set forth on page 1 of Chapter VII, "A Regional Wireless Telecommunications Plan for Southeastern Wisconsin" of SEWRPC Planning Report No. 51 *A Wireless Antenna Siting and Related Infrastructure Plan for Southeastern Wisconsin* and reads as follows:

"It is important to understand that the fourth generation (4G) regional broadband wireless plan for Southeastern Wisconsin as set forth in this chapter represents one of a number of possible plans by which the objectives and standards set forth in Chapter III of this report might be achieved. The plan herein set forth is not intended to impede the implementation of alternative plans prepared and put forth by private providers, or by counties or municipalities within the Region, that would move the existing level of service within the Region toward the agreed upon objectives and standards or to achieve those objectives and standards. It is, however, hoped that the

plan herein presented would serve as a point of departure for further telecommunication planning by private providers and public agencies."

A similar paragraph, modified to reflect the comprehensive nature of the plan concerned will be included in Chapter VII of SEWRPC Planning Report No. 53.]

There being no further questions or comments, on a motion by Mr. Chernow, seconded by Mr. Falaschi, and carried, the preliminary draft of Chapter II "Basic Principles and Concepts" of SEWRPC Planning Report No. 53, *A Regional Comprehensive Broadband Telecommunications Plan for Southeastern Wisconsin,* dated August 23, 2006, was approved as presented, with Messrs. Klasen, Gatz and Ritt voting no.

Messrs. Klasen and Ritt indicated that the basis for their vote had already been explained with respect to the Committee's action on Chapter IV, taken earlier in the meeting. Mr. Gatz explained his vote by indicating that the firm he represented, CenturyTel, objected to making public information on the location of its facilities and did so for security reasons.

**CONSIDERATION OF PRELIMINARY DRAFT OF CHAPTER III "OBJECTIVES, PRINCIPLES, AND STANDARDS" OF SEWRPC PLANNING REPORT NO. 53, *A REGIONAL COMPREHENSIVE BROADBAND TELECOMMUNICATIONS PLAN FOR SOUTHEASTERN WISCONSIN.***

Chairman Bauer noted that a copy of the preliminary draft of Chapter III "Objectives, Principles, and Standards" of SEWRPC Planning Report No. 53, *A Regional Comprehensive Broadband Telecommunications Plan for Southeastern Wisconsin,* had been provided to all members of the Committee for review prior to the meeting.

Chairman Bauer then asked Dr. Schlager to undertake a page by page review of the preliminary draft with the Committee.

Mr. Klasen referred to the reference on page 6 to the international standard H.393 and indicated that he was unable to find a copy of this standard. Dr. Schlager indicated that he would provide a full reference to Mr. Klasen by electronic mail.

[Secretary's Note: The reference to standard H393 was a typographical error. The reference should have been to standard H323 – the Internet video and VoIP standard.]

Mr. Ritt indicated that he was still seeking an explanation from the staff as to how it was envisioned that the Commission's public plans would interrelate with plans prepared by the private sector entities concerned. A lengthy discussion ensued.

In that discussion Dr. Schlager described current planning efforts being conducted by the Commission for the creation of broadband wireless plans for the Towns of Addison and Wayne in Washington County, and for the seven "North Shore" suburbs of Milwaukee County. He indicated that it was the Commission staff intent that upon completion of the system plans concerned and attendant field testing, the communities would issue requests for proposals to private service providers for the installation, operation, and maintenance of the planned systems. Accordingly, any of the private service providers operating within the Region could propose to provide the planned facilities and services. Dr. Schlager indicated further that there was absolutely nothing that would prevent the private service providers from planning and implementing their own service improvements in the areas concerned.

Chairman Bauer observed that the plan implementation process proposed by the Commission was set forth in Chapter VIII, "Regional Wireless Network Plan Implementation" of SEWRPC Planning Report No. 51, and clearly envisioned private sector implementation of the Commission recommended plans. It was envisioned, he said, that public sector implementation, he said, would be resorted to only if no private service providers responded to the requests for proposals, and the local municipalities concerned determined to proceed with public implementation of the plans concerned. In any case, he said, Commission plans were entirely advisory to its constituent public bodies and to the private sector.

Mr. Ritt expressed concern that there might be a potential conflict of interest involved in situations where the Commission has prepared a service plan, private sector providers are also preparing enhancements to their networks, and the community, or communities concerned, request the Commission for advice on the proposals being submitted by the private providers. In response, Mr. Wirth observed that the Commission only provides community assistance service when requested to do so, and that he did not see any potential conflict of interest in responding to such requests, but rather a means of reinforcing sound private sector proposals. Chairman Bauer agreed with Mr. Wirth, observing that the Commission had for forty years prepared on request detailed land subdivision layouts for local communities, these layouts usually covering about 160 acres and constituting an urban neighborhood unit. When a private sector developer then proposes a subdivision design covering, a part, or all of the neighborhood unit, the Commission's position, he said, has always been that if the plan submitted by the developer is shown to be an improvement over the Commission prepared plan, then the plan should be changed to accommodate the private sector proposal. Chairman Bauer indicated that the Commission's platting layouts were intended to provide a point of departure for the preparation, and a basis for the comparative evaluation, of the publicly planned layout and private sector alternative layouts. He indicated that he was uncertain as to how far a parallel between the land subdivision design and telecommunications system design situations could be carried, but indicated that it would be reasonable to assume that if a private sector provider proposed a broadband wireless network to serve a local community, or group of communities, that was better than the plan prepared by the Commission, then there should be no reason why system development should not proceed in accordance with the private plan.

Mr. Evenson indicated that he was puzzled by Mr. Ritt's expressed concerns and asked why local communities would come to the Commission for assistance in preparing a local service plan if the private sector had prepared better plans and had informed the communities concerned about those plans. Mr. Ritt responded that he was concerned that the work of the Commission not be misperceived. He indicated that misperceptions about the intent of the Commission to – in effect – enforce its plans would make implementation of the privately prepared plans more difficult, and would be counter-productive to achieving the best possible telecommunication service within the Region. He noted that any unfavorable comments by the Commission based upon the Commission plans, could discourage private investment in the Region. Mr. Evenson indicated that the Commission is interested only in achieving the objectives and supporting performance standards agreed to by this Committee as necessary to make the Region economically competitive with other regions, and that whatever plans – public or private – that can best meet these objectives and standards, should be carried out.

Dr. Schlager indicated that the issue was not whether the Commission's plan should be implemented rather than a private provider's plan, but rather which plan could be expected to perform better. Dr. Schlager indicated further that the Commission's planning efforts were also intended to encourage investment in telecommunication facilities and services in areas of the Region where the private sector providers, for whatever reasons, are not making the investments required to provide the needed level of service. In those instances, the Commission's plans are intended to provide an incentive for private sector response.

In response to Mr. Evenson's earlier question, Mr. Falaschi indicated that the reason why some communities seek Commission assistance in this area, was due, in part, to the attention called by the national news media to efforts by local communities to provide public broadband services. These news reports, he said, contribute to a perception that the proposed public systems are better than what the private sector can provide. In this respect, he indicated that in his opinion, the Commission should be devoting its efforts to planning for the creation of sound police, fire, and emergency medical service communications systems within the Region, and that the potential benefits to the public from such an approach would far exceed the potential benefits from the development of this type of broadband access networks the Commission is now concerning itself with. Mr. Evenson agreed with Mr. Falaschi with respect to the need for planning of the emergency telecommunications response networks, but indicated that the Commission can only respond to requests for assistance. Only one request, he said, for assistance in the planning of public safety networks has been received to date – that from Ozaukee County.

There being no further questions or comments, on a motion by Mr. Chernow, seconded by Captain Winston, and carried, the preliminary draft of Chapter III "Objectives, Principles, and Standards" of SEWRPC Planning Report No. 53, *A Regional Comprehensive Broadband Telecommunications Plan for Southeastern Wisconsin,* dated August 23, 2006 was approved as presented with Messrs. Gatz, Klasen, and Ritt voting no.

Messrs. Gatz, Klasen, and Ritt indicated that their votes had already been explained with respect to the Committee's actions on Chapters II and IV, taken earlier in the meeting.

Mr. Falaschi then distributed a copy of a newsletter issued by an industry organization known as Wireless Internet Service Providers, dated August 2006, which, he said, illustrated the need for the Commission to become involved in the planning of the 4.9 gigahertz public safety networks within the Region (copy attached to the minutes).

**CORRESPONDENCE**

Chairman Bauer reported that there was no correspondence to be brought to the attention of the Committee.

**DATE AND TIME OF NEXT MEETING**

Chairman Bauer then asked the Committee to consider the date and time for the next Committee meeting. After brief discussion, it was agreed that the next meeting of the Committee would be held on Tuesday, November 14, 2006, at the Commission offices beginning at 2:00PM.

**ADJOURNMENT**

There being no further business to come before the Committee, on a motion by Mr. Chernow, seconded by Mr. Wirth, and carried unanimously, the meeting was adjourned at 3:40 PM.

Respectfully Submitted,

Lynn G. Heis
Committee Secretary

KWB/lgh
9/21/06
#120373 V1 - T/C Minutes 15th Meeting

# APPENDIX

## ENVIRONMENTAL IMPACT ASSESSMENT OF THE REGIONAL BROADBAND WIRELESS SYSTEM PLAN FOR SOUTHEASTERN WISCONSIN

### Introduction

It has been the long-standing policy of the Southeastern Wisconsin Regional Planning Commission to perform an environmental assessment of its recommended plans, and to include the findings of such assessments in the planning reports which set forth the Commission recommended plans. Accordingly, this Appendix sets forth the findings of an environmental assessment of the Commission's recommended wireless telecommunications plan for Southeastern Wisconsin.

The environmental assessment focuses on the potential effects on human health of radio frequency transmissions, considering to the extent possible given the current state of the art both the thermal and athermal effect of such transmissions. The assessment does not concern itself with the potential impacts of the location of transmitting and receiving structures on surrounding land uses and on property values. Such impacts are highly site specific and can only be properly considered in the preliminary engineering stage of plan implementation when specific station locations together with their surrounding environments have been identified.

### Background Information

Wireless communications systems are usually based on transfers of radio frequency electromagnetic energy between users with antenna base stations or network access points as intermediaries. Some wireless networks such as amateur radio and citizen band radio also allow for direct communications between users without the need for base station or access point intermediaries. The radio frequency signals used in these wireless networks are typically of low power, with transmitting powers ranging from about 100 milliwatts to as high as 1,000 watts. To put these power levels in perspective, most commercial AM radio broadcasting stations transmit at power levels of 50,000 watts. The Voice of America broadcasts at power levels of 500 kilowatts, with directional power levels as high as 100 megawatts. The typical cellular wireless network base station transmits at about 150 watts, far below the levels of radio and television broadcasting stations, and also far below the levels of shortwave radio broadcasting stations and many amateur radio stations.

Whatever the power level, the function of wireless radiowave communications is to convey information, not to transfer power or energy. Whether the media is voice, data, or video, radio frequency signal performance is based on the transfer rate of information and not the watts of power. To transfer information, however, an adequate level of radio frequency power is required, the power required depending on the frequency of the signal transmitted, the distance, the nature of the propagation path traversed, and the sensitivity of the receiver processing these signals. Although the primary function in telecommunications is information transfer, various levels of radio frequency power may have secondary effects. These secondary effects may affect the health of persons in the path of radio frequency radiation. The purpose of this assessment is to evaluate the potential health effects of radio frequency radiation created by wireless telecommunications networks particularly those existing and proposed networks comprising a part of the broadband wireless telecommunications system plan for Southeastern Wisconsin.

The two types of radio frequency health effects to be examined are thermal effects and athermal effects. The thermal effects of radio frequency energy on the human body are fairly well understood, and maximum permissible exposure limits as a function of frequency are specified by the Federal Communications Commission (FCC). Wireless telecommunications networks are prohibited by law from violating these exposure limits in their network operations. Athermal effects, in contrast, are not well understood, and are currently very controversial with conflicting results from controlled laboratory and epidemiological studies.

The findings of this assessment of potential environmental impacts indicate that the FCC maximum permissible exposure limits for radio frequency thermal exposure are not being violated by cellular/PCS or other wireless systems currently deployed within the Region. The Commission planned broadband WiFi/WiMAX based systems with their very low transmitting power are even farther below these thermal exposure limits, and pose no thermal health hazards for citizens of Southeastern Wisconsin.

Athermal effects present a more ambiguous picture with conflicting results in different controlled studies. A recent major study sponsored by the European Union (EU 2004), which aggregated the results of many RF-EMF (radio frequency electromagnetic fields) studies, did indicate that there were valid concerns about athermal effects on human DNA strands and various body tissues at lower than published FCC thermal effect exposure levels. These studies, all based on *in vitro* laboratory investigations, however, were not directly related to human health effects; and, therefore, were not considered conclusive with respect to use in establishing new maximum permissible exposure (MPE) limits for athermal radio frequency radiation.

Given the uncertainty of radio frequency radiation athermal health effects, prudence would require that a low power telecommunications approach be used in the preparation of Commission broadband wireless communications plans. Radio frequency radiation effects, whether thermal or athermal, are a function of radio frequency power density. Low power telecommunications facilities may be defined as facilities with transmitting powers limited to a maximum power of 5 watts. Use of such relatively low power requires significantly increased receiver sensitivities to compensate for reduced transmitting power. Such enhanced receiver sensitivities, are well within the current state of telecommunications technologies. Use of low power transmitters not only reduces the risks of radio frequency exposure, but also provides an improved radio frequency environment. Radio frequency interference (RFI) has become one of the major obstacles to wireless telecommunications, and universal adaptation of low power standards would do much to alleviate this obstacle. Environmentally, low power transmission also allows for the use of solar panels on access points, taking wireless off the electric power grid for more reliable and environmentally-friendly telecommunications.

**Radio Frequency Radiation**

Radio frequency (RF) radiation, for the purposes of this study is defined as radiation in the spectral range of 50 MHz to 18 GHz. Such a frequency range encompasses all known current commercial and public wireless communications networks. Most existing and planned commercial and public wireless networks are, and may be expected to remain in the 800 MHz to 6 GHz range. The only major exceptions are satellite broadband transmissions which operate in the 12 to 18 GHz band. Some public safety telecommunications networks still operate in the 50 or 150 MHz bands.

Radio frequency radiation is classified as a non-ionizing form of radiation in contrast with x-rays, gamma rays, and even some ultra-violet fields which are designated as ionizing radiation. Ionizing radiators have enough energy to dislodge electrons from their atoms. When this happens, positive and negative ions are formed with well-documented potential damage to human health. At sufficiently high power densities, however, radio frequency radiation can pose health hazards. Experience since the early days of radio has shown that radio frequency energy can cause injury by heating body tissue. Radio frequency burns can be extremely painful, but even lower level tissue heating can be damaging to internal body organs. Radio frequency induced heating of the eye can result in cataracts or even cause blindness. These heat-related hazards of radio frequency radiation are called thermal effects.

Extensive research has also been conducted on changes in physiological function in the presence of radio frequency energy that is too low to cause heating. These athermal effects are more subtle than thermal

heating and involve changes in function at the cellular level that may produce breakages in DNA strands. The conflicting results of laboratory studies relating to this concern make it difficult to establish exposure guidelines. The alternative approach is to adopt a policy requiring low power telecommunications.

**Thermal Effects of Radio Frequency Energy**

Body tissues exposed to very high levels of radio frequency energy may suffer serious heat damage.[1] These effects depend upon the frequency of the energy, and the power density of the radio frequency field striking the body, together with other factors such as the polarization of the radio wave.

Radio frequency energy is absorbed more efficiently at frequencies near the body's natural frequency which is about 35 MHz for a grounded person, and 70 MHz for a person insulated from ground. Various parts of the body have different resonant frequencies such as the adult head of about 400 MHz and the infant head of about 700 MHz. As the frequency moves away from body resonance, less radio frequency heating is experienced. The specific absorption rate, (SAR) defines the rate at which radio frequency energy is absorbed in tissue.

Based on power density levels specified by the IEEE/FCC in the latest releases, there is no evidence to support a conclusion that existing or planned wireless base stations, or access points, exceed the thermal radio frequency exposure limits. On October 3, 2005, the Standards board of the IEEE Standards Association approved a new "Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3kHz to 300 GHz"[2,3] The maximum permissible exposure standard for the frequency range of interest is between 2 watts per square meter and 10 watts per square meter in the band from 400 to 2000 MHz, and 10 watts per square meter for frequencies above 2000 MHz.

Three particular frequencies of interest related to existing cellular/PCS or planned WiFi/WiMAX networks are:

Cellular – 800 to 900 MHz
PCS – 1900 MHz
WiFi/MAX – 2.4 to 5.8 GHz

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[1] Hare E. Radio Frequency Exposure and You, American Radio Relay League, 2003-Chapter 3.
[2] Lin, James, A New Standards for Safety Levels with Respect to Human Exposure to Radio Frequency Radiation IEEE Antennas and Propagation Magazine, 48, 1, February 2006.
[3] IEEE International Committee on Electromagnetic Safety (SCC39), IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz, IEEE Std C95.1™-2005 (Revision of IEEE Std C95.1-1991).

The maximum permissible exposure (MPE) for these three frequency bands are:

800-900 MHz: 4.0 to 4.5 $W/m^2$
1900 MHz: 9.5 $W/m^2$
2.4 to 5.8 GHz: 10.0 $W/m^2$

The above MPEs are all for so-called "uncontrolled environments" in which the people involved are unaware of radio frequency radiation. Such limits generally are about 20 percent of the limits for controlled environments where technical personnel are aware of radio frequency radiation.

The formula for radio frequency power flux density in free space is:

$S = p_t/4\pi r^2$
Where
S – power flux density – watts per square meter
$p_t$ – transmit power – kilowatts
r – distance – kilometers

Using logarithmic ratios and practical units:

$S = -41 + P_t - 20 \log d$
Where
S – power flux density in
dBW – decibels relative to watt per square meter
$P_t$ –power dBKW decibels relative to 1 kilowatt
d – distance – kilometers

The above formula represents radio propagation in free space. In terrestrial application, the presence of natural foliage and structural interferences will attenuate the radio signal below free space levels. Therefore, free space presents a worst case scenario.

Based on the above formula, a typical 100 watt cellular transmitter in the 800 MHz frequency band produces a power density of 0.00079 watts per square meter at 100 meters from the site and 0.079 watts per square meter at 10 meters from the site. The largest regional cellular transmitter radiating at 1,000

watts would result in 0.0079 watts per square meter at 100 meters, and 0.79 watts per square meter at 10 meters from the site. A low power -- 4 watt -- WiFi transmitter creates power densities of only 0.0003 watts per square meter at 100 meters from an access point and 0.003 watts per square meter at 10 meters from the access point.

From the above, it is apparent that none of the three classes of wireless radio frequency radiation violate the latest IEEE/FCC MPE limits. These limits are based upon thermal effects testing involving heating tissue with radiation of two watts per kilogram of body weight. Although none of the above examples violate the latest IEEE/FCC MPE restrictions; the 1,000 watt transmitter at 800 MHz does approach the limit -- 0.79 watts per square meter versus 4.00 watts per square meter -- and the question of cumulative effects arises. The averaging time used to determine the above MPE standards is 30 minutes; the radio frequency temperature effects on human tissue and organs having been studied during 30 minute periods. Varying levels of radio frequency radiation were evaluated, and the level of radio frequency radiation that produced sustained temperature rise in human tissue was established. MPE limits were then set at two percent of these thresholds, providing a safety factor of 50 to one for uncontrolled environments. The MPE for controlled environments was set five times higher at 10 percent of the sustained temperature threshold.

The official IEEE/FCC position on cumulative effects is that such effects do not exist below the MPE limits. Restated, if the radio frequency radiation level is below the MPE limit for the frequency of interest, the exposure time whether continuous or intermittent is irrelevant. The rationale for this stated position is clear. If the radio frequency radiation level does not produce sustained heating of human tissue, then exposure time does not matter.

In summary, investigation of the potential thermal effects of radio frequency radiation on human health from wireless communications systems in Southeastern Wisconsin indicates that all current and planned systems should be operating within the latest IEEE/FCC standards. Since the investigation was based entirely on theoretical radio propagation in free space, it is important to confirm this analysis with propagation modeling and some field measurements.

**Radio Propagation Modeling**

Radio propagation modeling estimates radio frequency radiation levels in a given terrestrial environment. Such radiation levels will be lower in value than those estimated by the free space propagation power

density formulas because of signal attenuation from buildings and terrestrial vegetation. To determine the effects of terrestrial attenuation on radio frequency radiation exposure, a series of radio propagation modeling plots were prepared for both cellular (800-900 MegaHertz) and WiFi/WiMAX (2400 MHz) frequency bands. Because available modeling software produced results only in terms of field strength, it was first necessary to convert the IEEE/FCC standard into field strengths limits. To utilize the standard FCC formula for field strength conversion set forth in FCC DET Bulletin 65, Edition 97-01, it is necessary to convert from watts per square meter to milliwatt per square centimeter.

By dimensional analysis:

10 watts per square meter = one milliwatt per square centimeter

The conversion formula in FCC Bulletin 65 states:

$E^2 = 3770S$

where E = electric field strength in volts per meter

and S = power density of one milliwatt per square centimeter

Solving

E = 61.4 volts per meter

$E = 61.4 \times 10^6$ microvolts per meter

$= 20 \log_{10} 61.4 \times 10^6$

= 155.8 decibels microvolts per meter (dB μV/m)

The lower two watts per square meter standard for the 800 MHz band is[4]

E = 27.4 volts per meter

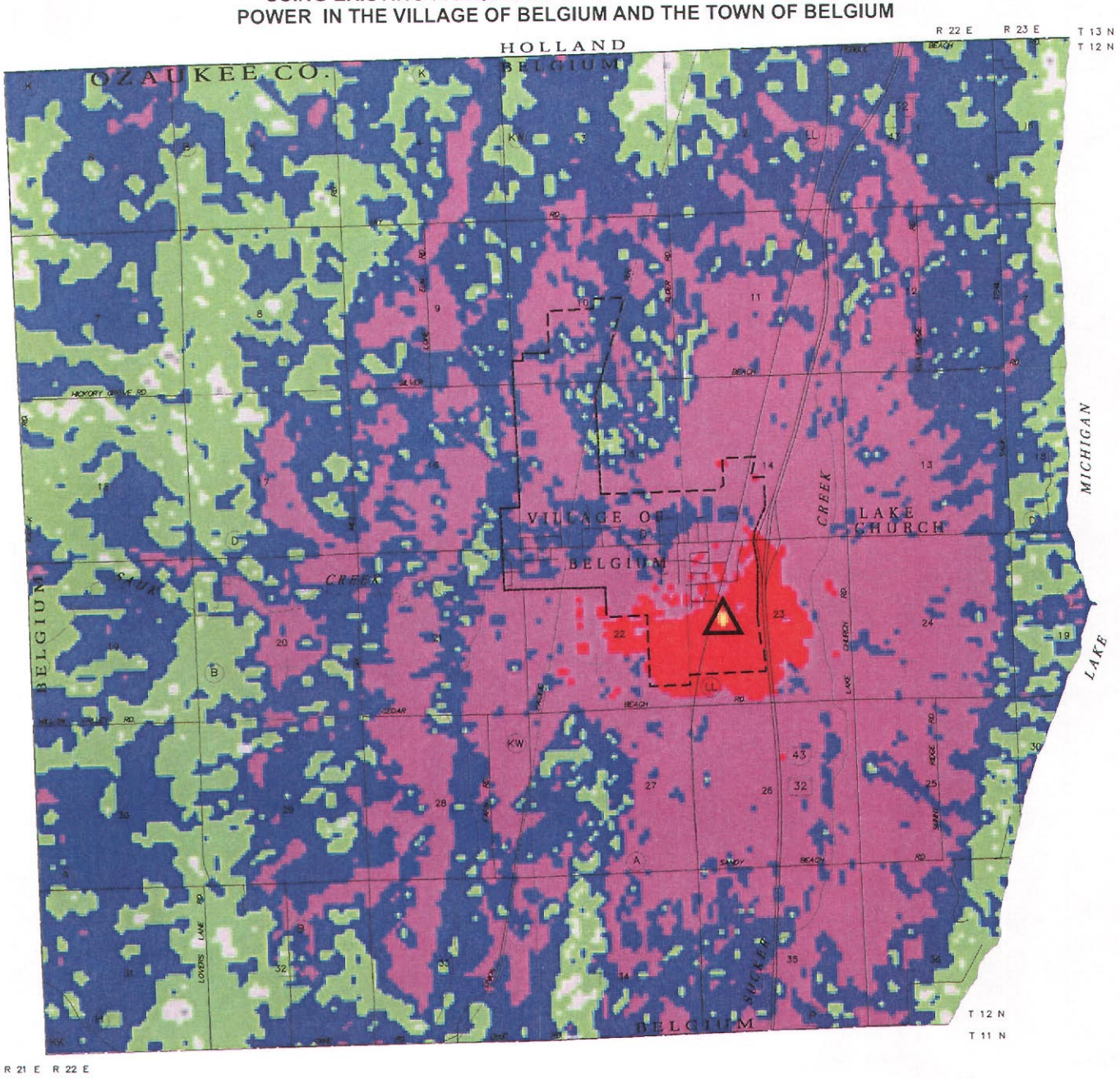
= 148.7 dB μV/m

Observing the two radio propagation plots shown on Maps 1 and 2, the highest field strength category for a 100 watt, 891 MHz site is represented by the yellow colored area, representing a field strength of only one volt per meter, well below the 27.4 volt per meter standard. The highest field strength level predominant near the base station is indicated by the brown colored area which represents about 0.1 volts per meter – again well below the MPE standard.

[4] Barclay, Les, Propagation of Radio Waves, The Institution of Electrical Engineers, United Kingdon, 2003.

## Map 1

### FIELD STRENGTH OF SIGNAL AT REMOTE ANTENNA USING EXISTING FREQUENCY OF 891 Mhz AND 100 WATTS OF POWER IN THE VILLAGE OF BELGIUM AND THE TOWN OF BELGIUM




LEGEND

EXISTING ANTENNA

- GREATER THAN 120 dBuV/m
- 105 dBuV/m TO 120 dBuV/m
- 90 dBuV/m TO 105 dBuV/m
- 75 dBuV/m TO 90 dBuV/m
- 60 dBuV/m TO 75 dBuV/m
- 45 dBuV/m TO 60 dBuV/m
- 30 dBuV/m TO 45 dBuV/m
- 15 dBuV/m TO 30 dBuV/m
- 0 dBuV/m TO 15 dBuV/m
- LESS THAN 0 dBuV/m

GRAPHIC SCALE

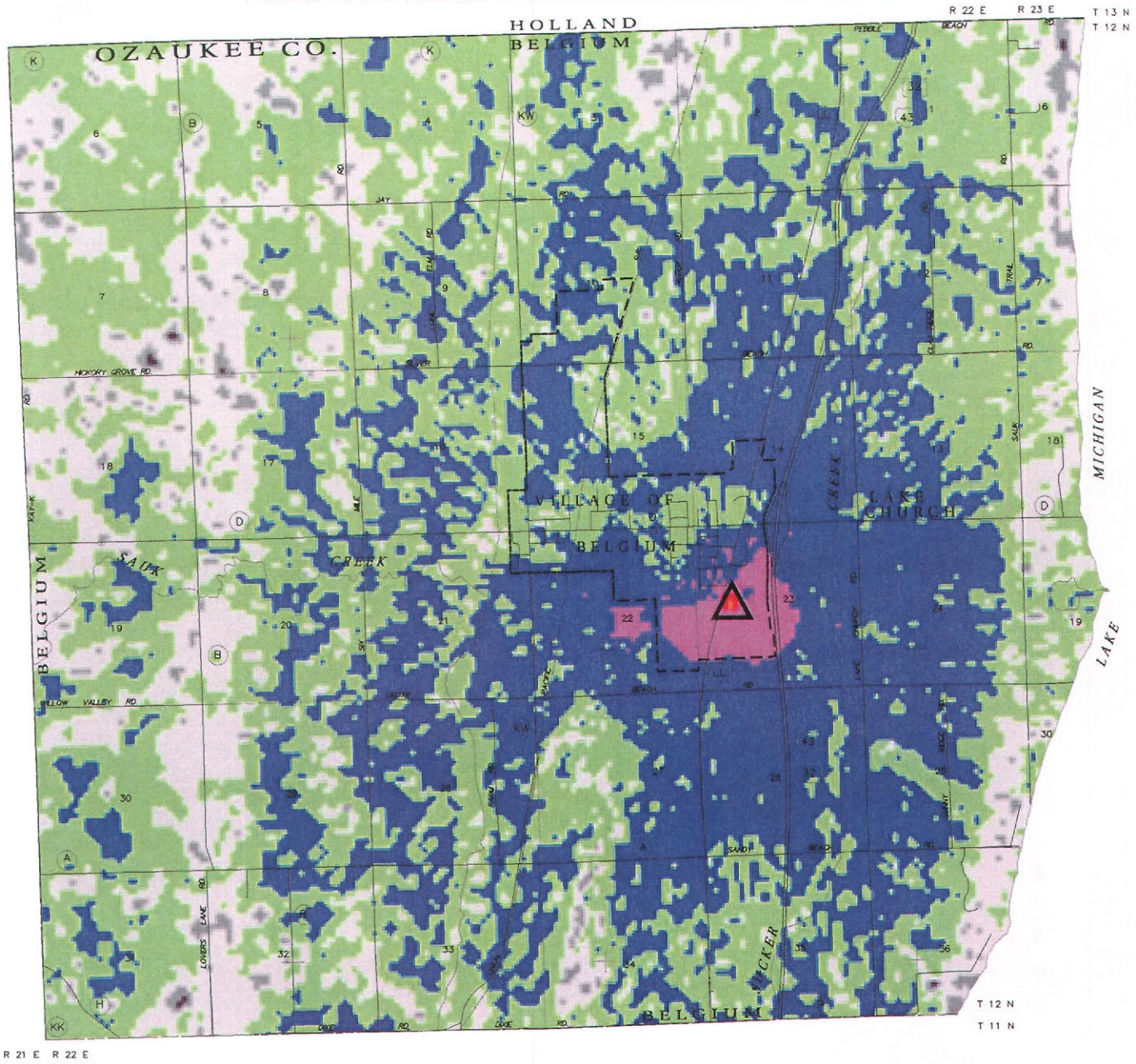
0 1/2 1 MILE

0 2,000 4,000 8,000 FEET

*Source: SEWRPC.*

## Map 2

### FIELD STRENGTH OF SIGNAL AT REMOTE ANTENNA USING PROPOSED FREQUENCY OF 2400 Mhz AND 4 WATTS OF POWER IN THE VILLAGE OF BELGIUM AND THE TOWN OF BELGIUM




LEGEND

EXISTING ANTENNA

GREATER THAN 120 dBuV/m
105 dBuV/m TO 120 dBuV/m
90 dBuV/m TO 105 dBuV/m
75 dBuV/m TO 90 dBuV/m
60 dBuV/m TO 75 dBuV/m
45 dBuV/m TO 60 dBuV/m
30 dBuV/m TO 45 dBuV/m
15 dBuV/m TO 30 dBuV/m
0 dBuV/m TO 15 dBuV/m
LESS THAN 0 dBuV/m

GRAPHIC SCALE
0 1/2 1 MILE
0 2,000 4,000 6,000 FEET

*Source: SEWRPC.*

In Map 2, for a four watt WiFi access point, the highest field strength level is indicated by the purple colored area representing 75 dB μV/m which is three orders of magnitude below a field strength of about 0.001 to 0.002 volts per meter.

From the above field strength plots shown in Maps 1 and 2, it is clear that both the existing cellular/PCS base stations should operate well within the IEEE/FCC MPE standards. Future WiFi/WiMAX networks may be expected to be at least three orders of magnitude below these same standards.

*The field strength plots shown on Maps 1 and 2 are based upon one transceiver-antenna unit mounted on a station structure. For multiple unit installations the radiation output will be a multiple of the transceiver-antenna units. The maximum number of co-located antennas in the Region was five. Even the power radiated by this collection of antennas would still be a very small percentage of the standard for the worst case in the 800 MHz band.*

**Field Testing**

Thermal radiation effects based on free space formulas and radio propagation modeling were supplemented by field measurements taken with a Spectran HF spectrum analyzer instrument manufactured by Aaronica AG of Germany. Measurements were made of both a 100 watt, *1932* ~~878~~ MHz base-station and a 4 watt 2.4 GHz access point. The following power density and field strength levels were recorded.

1. *1932* ~~878~~ MHz base station at a distance of 300 feet from the base of the antenna tower
   S = *120.14* ~~4.38~~ microwatts per square meter
   E = *0.213* ~~0.04~~ volts per meter
2. 2.4 GHz access point at a distance of 300 feet from the base of the utility pole.
   S = *51.4* microwatts per square meter
   E = *0.139* volts per meter

*A comparison of the RF radiation standards compliance for thermal effect is summarized in Table I-1. It is apparent from the table that whether radio propagation formulas or field measurements are applied that both cellular/PCS and WiFi/WiMAX networks are well below FCC/IEEE exposure standards.*

**Table I-1**

**COMPARISON OF RADIATION EXPOSURE LIMITS, COMPUTED VALUES AND MEASURED VALUES: SEPTEMBER 2006**

| Type | Frequency (Megahertz) | Standard | | Computed | | Measured | |
|---|---|---|---|---|---|---|---|
| | | Power Density (watts per meter$^2$) | Field Strength (volts per meter) | Power Density (watts per meter$^2$) | Field Strength (volts per meter) | Power Density (watts per meter$^2$) | Field Strength (volts per meter) |
| Cellular/PCS | 1,932 | 9.5 | 59.8 | 0.00079 | 0.54 | 0.000120 | 0.213 |
| WiFi/WiMAX | 2,400 | 10.0 | 61.4 | 0.00030 | 0.34 | 0.000051 | 0.139 |

Note: Radio propagation computations and field measurements are based on radiation levels 100 meters from the antenna location.

*Source: SEWRPC.*

**Athermal Effects**

Athermal effects of radio frequency radiation are caused by low-level energy fields insufficient to cause either ionization or heating effects. Research investigations in this area relating to possible health effects of radio frequency radiation exposure has been of two types: epidemiological research and laboratory research. Epidemiologists observe health patterns of large groups of people using statistical methods. These studies look for associations between environmental factors and an observed pattern of illness. Some epidemiological studies have identified an exposure to radio frequency radiation and malignancies such as leukemia and brain cancer. A large number of equally well designed and performed studies have shown no such association.

Laboratory studies of radio frequency radiation have a similar history. Some studies have indicated the ability of low levels of radio frequency radiation to alter the human body's circular rhythms and weaken the immune system. Attempts to replicate these studies have also had mixed results.

The overall conclusion at this time regarding athermal effects of radio frequency radiation must be that adverse health effects have not been demonstrated sufficiently to establish maximum permissible exposure (MPE) limits lower than those specified for thermal affects. One factor, however, is certain lower power communication is beneficial for all effects of radio frequency radiation. For this reason, the Commission's planning efforts have continually emphasized low power transmission supported by high sensitivity reception as the key to minimizing the environmental impact of wireless communications.

**Other Environmental Impacts**

This review of the environmental effects of radio frequency radiation has concentrated exclusively on human health impacts. There are however, two other environmental consequences of radio frequency radiation that should be noted.

A major consequence of the growth of cellular wireless communications and the proliferation of cell phone users and WiFi "hot spot" locations has been radio frequency interference. The 2.4 GHz unlicensed frequency band used in WiFi networks is also used by microwave ovens and many cordless phones. WiFi systems operate in unlicensed bands which are open to all users, so that interference becomes a major issue. Private cellular networks typically employ licensed frequency bands that are exclusive for the licensed operator. These systems, because they operate at higher transmit power levels, can also be a source of interference to other frequency bands based on the harmonic signals they generate. Harmonics are integer multiples of the base frequency that are generated and transmitted along with the base frequency. For example, a 800 MHz transmitter could generate harmonics at 1600 MHz and 2400 MHz. The second harmonic at 2400 MHz could interfere with WiFi communications. Responsible communications practices recommend the conservation of transmit power in the interest of other users. The golden rule of wireless communications is to utilize only the transmit power necessary to reliably serve the network. Excess transmit power contributes to the electronic pollution of the airwaves. Radio interference is currently the limiting factor in most wireless communications systems. The low power wireless systems advocated in this plan serve to free up the airwaves for higher communication performance.

Another environmental benefit of low power communications relates to its potential use of renewable power sources. Solar panels and their associated photovoltaic cells and rechargeable batteries are particularly attractive low power sources for network access points. Small solar power units have been developed that are capable of operating in overcast weather for very extended periods. Use of solar power also provides for a lower cost, more reliable and robust network.

**Summary**

A combined theoretical and experimental investigation of the environmental impact of radio frequency (RF) radiation generated by existing and planned wireless communications systems in Southeastern Wisconsin confirms that all are in compliance with maximum permissible exposure (MPE) limit standards published by the Federal Communications Commission. These standards are based on the thermal effects of radio frequency on the human body. Some epidemiological and laboratory

investigations of athermal effects of radio frequency radiation have indicated possible adverse effects on human health, but the results of these studies have not been sufficiently confirmed to allow for standards lower than those already established for thermal effects. In the absence of conclusive recommendations on athermal effects, the Commission staff recommends the deployment of low power wireless communications systems that will not only tend to minimize radio frequency radiation effects on human health, but also reduce electronic pollution of the airwaves and allow for low power renewable energy sources such as solar cells.

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# Chapter IV

# INVENTORY FINDINGS–BACKGROUND CONDITIONS

## INTRODUCTION

Reliable planning data are essential for the formulation of workable development plans. Consequently, an inventory of existing conditions is the first step in the planning process. The crucial nature of factual information in the planning process should be evident, since no reliable forecasts can be made or alternative courses of action evaluated without knowledge of the current state of the system being planned. The necessary inventory not only provides data describing the existing conditions, but also provide a basis for identifying existing and potential problems in the planning area and opportunities for development. The inventory data are also crucial to the forecasting of future facility and service needs, formulating alternative plans, and evaluating such plans.

Information regarding existing conditions and historic trends with respect to the demographic and economic base, to certain elements of the natural environment, and to certain elements of the man-made environment of the planning area provides a sound foundation for undertaking the telecommunications planning process. The Regional Planning Commission has developed an extensive database pertaining to these and other aspects of the Southeastern Wisconsin Region, updating that database periodically. A major inventory update effort was carried out by the Regional Planning Commission in the early 2000s in support of the preparation of new land use and transportation system plans and other elements of the comprehensive plan for the Region. This section presents a summary of the results of that inventory update pertaining to the population, economy, land use pattern, natural and agricultural resource base, and the transportation system within the Region.

## DEMOGRAPHIC AND ECONOMIC BASE

### Population[1]

***Historic Trends and Distribution Among Counties***

The total resident population of the Region stood at 1,931,200 in 2000, compared to 1,810,400 in 1990. The increase of 120,800 persons, or 7 percent, in the regional population during the 1990's is substantially greater than the increase experienced during the 1970s (8,700 persons) and 1980s (45,600 persons)—but less than the increases of 333,000 persons and 182,500 persons experienced during the 1950s and 1960s, respectively (see Table 1).

In relative terms, the Region's population grew at a somewhat slower rate than the population of the State and of the United States during the 1990's. As a result, the regional share of the State population,

[1]*The Regional Planning Commission conducted a detailed inventory and analysis of the regional population in 2004 following the release of the 2000 Federal census. The findings are presented in detail in SEWRPC Technical Report No. 11 (4th Edition),* The Population of Southeastern Wisconsin, *dated July 2004.*

**Table 1**

**POPULATION TRENDS IN THE REGION, WISCONSIN, AND THE UNITED STATES: 1950-2000**

| | Region | | | Wisconsin | | | United States | | | Regional Population as a Percent of: | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Change from Preceding Year | | | Change from Preceding Year | | | Change from Preceding Year | | | |
| Year | Population | Number | Percent | Population | Number | Percent | Population | Number | Percent | Wisconsin | United States |
| 1950 | 1,240,618 | -- | -- | 3,434,575 | -- | -- | 151,325,798 | -- | -- | 36.1 | 0.82 |
| 1960 | 1,573,614 | 332,996 | 26.8 | 3,951,777 | 517,202 | 15.1 | 179,323,175 | 27,997,377 | 18.5 | 39.8 | 0.88 |
| 1970 | 1,756,083 | 182,469 | 11.6 | 4,417,821 | 466,044 | 11.8 | 203,302,031 | 23,978,856 | 13.4 | 39.7 | 0.86 |
| 1980 | 1,764,796 | 8,713 | 0.5 | 4,705,642 | 287,821 | 6.5 | 226,504,825 | 23,202,794 | 11.4 | 37.5 | 0.78 |
| 1990 | 1,810,364 | 45,568 | 2.6 | 4,891,769 | 186,127 | 4.0 | 249,632,692 | 23,127,867 | 10.2 | 37.0 | 0.73 |
| 2000 | 1,931,165 | 120,801 | 6.7 | 5,363,675 | 471,906 | 9.6 | 281,421,906 | 31,789,214 | 12.7 | 36.0 | 0.69 |

*Source: U.S. Bureau of the Census and SEWRPC.*

decreased slightly, from 37 percent to 36 percent while the regional share of the national population also declined. As indicated in Table 1, the regional share of the State and national populations has been gradually decreasing since 1960.

During the 1990s, six of the constituent counties of the Region experienced significant population growth, while Milwaukee County lost population. Waukesha County experienced the greatest gain in population during the 1990s, increasing by 56,100 persons. Kenosha, Ozaukee, Racine, Walworth, and Washington Counties gained between 9,400 and 22,200 persons each. Milwaukee County lost 19,100 persons.

The past decade saw further change in the relative distribution of the population among the counties of the Region, continuing long-term trends in this respect (see Table 2 and Figure 3). Milwaukee County's share of the regional population decreased by about 4 percentage points during the 1990s, while the share of each of the other six counties increased. Over the past fifty years, the most notable change in the distribution has been the increase in Waukesha County's share, from 7 percent to 19 percent of the regional population, and the decrease in Milwaukee County's share, from 70 percent to 49 percent.

***Components of Population Change***

Population change can be attributed to natural increase and net migration. Natural increase is the balance between births and deaths in an area over a given period of time; it can be measured directly from historical records on the number of births and deaths for an area. Net migration is the balance between migration to and from an area over a given period of time; as a practical matter, net migration is often determined as a derived number, obtained by subtracting natural increase from total population change for the time period concerned.

Of the total population increase of 120,800 persons in the Region between 1990 and 2000, 116,900 can be attributed to natural increase; the balance to modest net in-migration—about 3,900 persons. The level of natural increase in the Region has been relatively stable since the 1970s, averaging about 119,000 persons per decade (see Table 3 and Figure 4). This is significantly lower than the levels experienced during the 1950s and 1960s—which include much of the post-World War II baby-boom era—when natural increase in the Region reached very high levels of 224,500 and 202,400 persons, respectively.

As noted above, the Region experienced a modest net in-migration during the 1990s—the first decade since the 1950s that the Region as a whole experienced positive net migration. The net in-migration of 3,900 persons for the Region during the 1990s followed three decades of net out-migration—out-migrations of 81,800 persons during the 1980s, 104,400 persons during the 1970s, and 19,900 persons during the 1960s.

An important aspect of net migration is the in-migration of persons to the Region from abroad. There was a significant movement of foreign-born persons into the Region during the 1990s. About 45,400 foreign-born persons in the Region in 2000 were reported by the U.S. Census Bureau to have entered the country between 1990 and 2000; this is significantly greater than the figures ranging from 12,300 to 18,300 reported in the 1970, 1980, and 1990 censuses. The increase in the foreign born

## Table 2

## POPULATION IN THE REGION BY COUNTY: 1950-2000

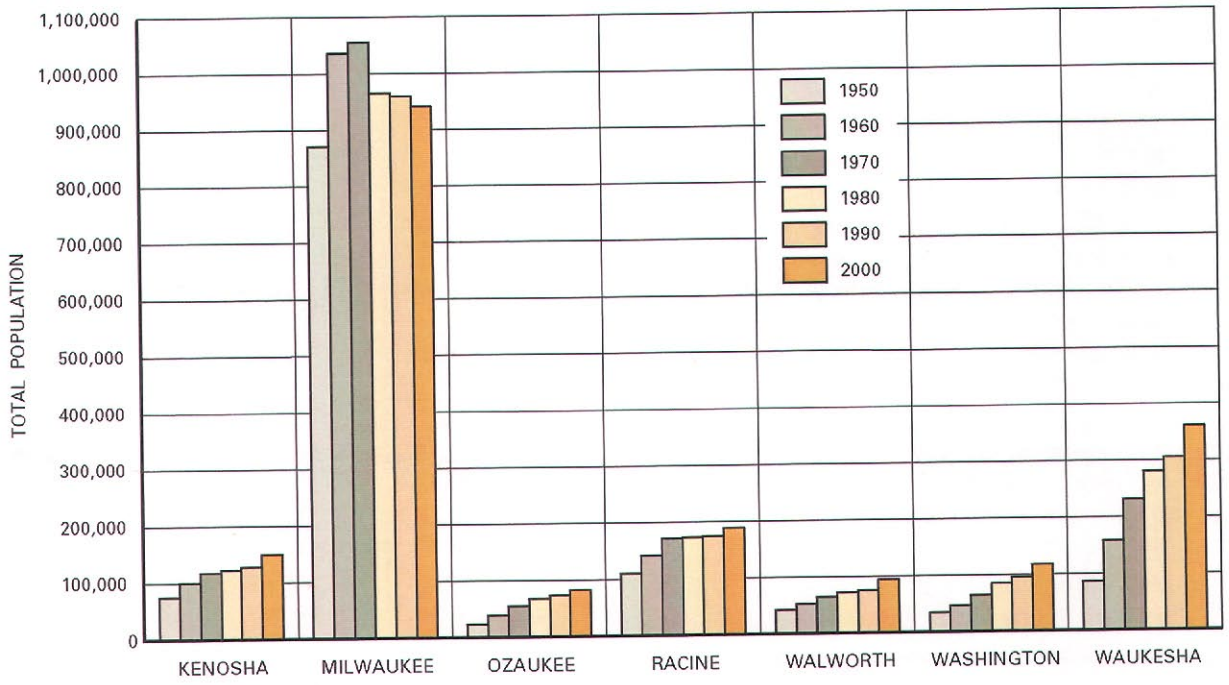
| County | Total Population | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1950 | | 1960 | | 1970 | | 1980 | | 1990 | | 2000 | |
| | Number | Percent of Total | Number | Percent of Total | Number | Percent of Total | Number | Percent of Total | Number | Percent of Total | Number | Percent of Total |
| Kenosha | 75,238 | 6.1 | 100,615 | 6.4 | 117,917 | 6.7 | 123,137 | 7.0 | 128,181 | 7.1 | 149,577 | 7.7 |
| Milwaukee | 871,047 | 70.2 | 1,036,041 | 65.8 | 1,054,249 | 60.1 | 964,988 | 54.7 | 959,275 | 53.0 | 940,164 | 48.7 |
| Ozaukee | 23,361 | 1.9 | 38,441 | 2.5 | 54,461 | 3.1 | 66,981 | 3.8 | 72,831 | 4.0 | 82,317 | 4.3 |
| Racine | 109,585 | 8.8 | 141,781 | 9.0 | 170,838 | 9.7 | 173,132 | 9.8 | 175,034 | 9.7 | 188,831 | 9.8 |
| Walworth | 41,584 | 3.4 | 52,368 | 3.3 | 63,444 | 3.6 | 71,507 | 4.0 | 75,000 | 4.1 | 92,013 | 4.7 |
| Washington | 33,902 | 2.7 | 46,119 | 2.9 | 63,839 | 3.6 | 84,848 | 4.8 | 95,328 | 5.3 | 117,496 | 6.1 |
| Waukesha | 85,901 | 6.9 | 158,249 | 10.1 | 231,335 | 13.2 | 280,203 | 15.9 | 304,715 | 16.8 | 360,767 | 18.7 |
| Region | 1,240,618 | 100.0 | 1,573,614 | 100.0 | 1,756,083 | 100.0 | 1,764,796 | 100.0 | 1,810,364 | 100.0 | 1,931,165 | 100.0 |

| County | Population Change | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1950-1960 | | 1960-1970 | | 1970-1980 | | 1980-1990 | | 1990-2000 | |
| | Number | Percent | Number | Percent | Number | Percent | Number | Percent | Number | Percent |
| Kenosha | 25,377 | 33.7 | 17,302 | 17.2 | 5,220 | 4.4 | 5,044 | 4.1 | 21,396 | 16.7 |
| Milwaukee | 164,994 | 18.9 | 18,208 | 1.8 | -89,261 | -8.5 | -5,713 | -0.6 | -19,111 | -2.0 |
| Ozaukee | 15,080 | 64.6 | 16,020 | 41.7 | 12,520 | 23.0 | 5,850 | 8.7 | 9,486 | 13.0 |
| Racine | 32,196 | 29.4 | 29,057 | 20.5 | 2,294 | 1.3 | 1,902 | 1.1 | 13,797 | 7.9 |
| Walworth | 10,784 | 25.9 | 11,076 | 21.2 | 8,063 | 12.7 | 3,493 | 4.9 | 17,013 | 22.7 |
| Washington | 12,217 | 36.0 | 17,720 | 38.4 | 21,009 | 32.9 | 10,480 | 12.4 | 22,168 | 23.3 |
| Waukesha | 72,348 | 84.2 | 73,086 | 46.2 | 48,868 | 21.1 | 24,512 | 8.7 | 56,052 | 18.4 |
| Region | 332,996 | 26.8 | 182,469 | 11.6 | 8,713 | 0.5 | 45,568 | 2.6 | 120,801 | 6.7 |

*Source: U.S. Bureau of the Census and SEWRPC.*

## Figure 3

## POPULATION IN THE REGION BY COUNTY: 1950-2000




*Source: U.S. Bureau of the Census and SEWRPC.*

**Table 3**

**LEVELS OF POPULATION CHANGE, NATURAL INCREASE, AND NET MIGRATION FOR THE REGION BY COUNTY: 1950-2000**

| County | 1950-1960 | | | 1960-1970 | | | 1970-1980 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Population Change | Natural Increase | Net Migration | Population Change | Natural Increase | Net Migration | Population Change | Natural Increase | Net Migration |
| Kenosha | 25,377 | 13,931 | 11,446 | 17,302 | 15,125 | 2,177 | 5,220 | 7,746 | -2,526 |
| Milwaukee | 164,994 | 150,141 | 14,853 | 18,208 | 122,192 | -103,984 | -89,261 | 60,105 | -149,366 |
| Ozaukee | 15,080 | 5,926 | 9,154 | 16,020 | 6,090 | 9,930 | 12,520 | 4,798 | 7,722 |
| Racine | 32,196 | 21,473 | 10,723 | 29,057 | 20,441 | 8,616 | 2,294 | 12,842 | -10,548 |
| Walworth | 10,784 | 5,733 | 5,051 | 11,076 | 4,685 | 6,391 | 8,063 | 2,451 | 5,612 |
| Washington | 12,217 | 7,501 | 4,716 | 17,720 | 8,122 | 9,598 | 21,009 | 7,163 | 13,846 |
| Waukesha | 72,348 | 19,746 | 52,602 | 73,086 | 25,699 | 47,387 | 48,868 | 18,011 | 30,857 |
| Region | 332,996 | 224,451 | 108,545 | 182,469 | 202,354 | -19,885 | 8,713 | 113,116 | -104,403 |

| County | 1980-1990 | | | 1990-2000 | | |
|---|---|---|---|---|---|---|
| | Population Change | Natural Increase | Net Migration | Population Change | Natural Increase | Net Migration |
| Kenosha | 5,044 | 8,177 | -3,133 | 21,396 | 9,365 | 12,031 |
| Milwaukee | -5,713 | 69,529 | -75,242 | -19,111 | 64,145 | -83,256 |
| Ozaukee | 5,850 | 5,141 | 709 | 9,486 | 3,916 | 5,570 |
| Racine | 1,902 | 13,720 | -11,818 | 13,797 | 11,127 | 2,670 |
| Walworth | 3,493 | 2,939 | 554 | 17,013 | 2,592 | 14,421 |
| Washington | 10,480 | 7,756 | 2,724 | 22,168 | 7,159 | 15,009 |
| Waukesha | 24,512 | 20,068 | 4,444 | 56,052 | 18,582 | 37,470 |
| Region | 45,568 | 127,330 | -81,762 | 120,801 | 116,886 | 3,915 |

*Source: U.S. Bureau of the Census, Wisconsin Department of Health and Family Services, and SEWRPC.*

population, including a significant Hispanic component, is an important aspect of the population migration pattern for the Region during the 1990s.

## Households

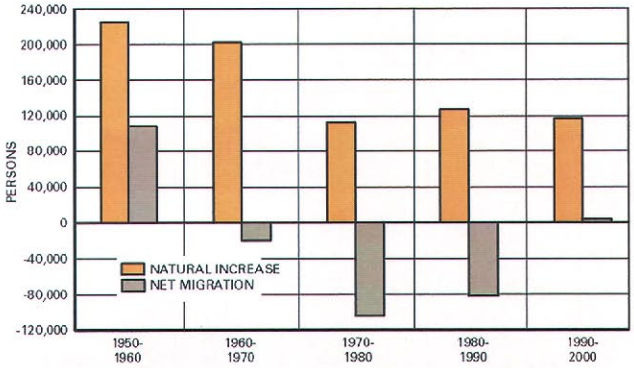
### *Historic Trends and Distribution Among Counties*

In addition to resident population, the number of households, or occupied housing units, is of importance in telecommunications planning. Households directly influence the demand for urban land as well as the demand for transportation and other public facilities and services such as telecommunications facilities and services. By definition, a household includes all persons who occupy a housing unit—defined by the Census Bureau as a house, an apartment, a mobile home, a group of rooms, or a single-room that is occupied, or intended for occupancy, as a separate living quarter.

The number of households in the Region increased by 72,900 households, or 11 percent, from 676,100 households in 1990, to 749,000 households in 2000.

**Figure 4**

**COMPONENTS OF POPULATION CHANGE IN THE REGION: 1950-2000**




*Source; U.S. Bureau of the Census, Wisconsin Department of Health and Family Services, and SEWRPC.*

This follows increases of 48,200 households during the 1980s; 91,500 households during the 1970s; 70,600 households during the 1960s; and 111,400 households during the 1950s.

During the 1990s, all counties in the Region experienced increases in the number of households, led by Waukesha County, which gained 29,200 households, an increase of 28 percent. Milwaukee County gained 4,700 households—a 1 percent increase—during the 1990s, despite experiencing a decrease in total population. Changes in the distribution of households in the Region going back 50 years are indicated in Table 4 and Figure 5. These changes are similar to the distributional changes in the total population.

***Household Size***

In relative terms, the rate of growth in households in the Region during the 1990s, 10.8 percent, exceeded the rate of growth in the total population, 6.7 percent, as well as the rate of growth in the household population, 6.6 percent. Similar patterns were observed over each of the four previous decades. For the past 50 years overall, the number of households in the Region increased by 111 percent, while the total population increased by 56 percent and the household population increased by 58 percent. These differential growth rates between households and population are reflected in a declining average household size in the Region.

For the Region as a whole, the average household size—calculated as the household population divided by the number of households—was 2.52 persons in 2000 (see Table 5). During the 1990s, the average household size in the Region decreased by about 0.10 person per household, or about 4 percent, from the 1990 figure of 2.62 persons. The decrease in household size during the 1990s represents a continuation of a long-term trend in declining average household size for the Region over the past 50 years. A particularly large decrease in the average household size for the Region occurred between 1970 and 1980. Each of the seven counties in the Region has experienced a similar long-term trend of declining household size, traceable back to the 1970 or prior censuses. The decline in household size is related in part to changing household types in the Region. Single-person households and other non-family households have increased at a much faster rate than family households in the Region over the past three decades.

**Employment[2]**

***Historic Trends and Distribution Among Counties***

Information regarding the number and type of employment opportunities, or jobs, in an area is an important measure of the size and structure of the area's economy. Employment data presented in this section pertain to both wage and salary employment and the self-employed, and include both full-time and part-time jobs.

Total employment in the Region stood at 1,222,800 jobs in 2000, compared to 1,062,600 jobs in 1990. The increase of 160,200 jobs during the 1990s compares to 114,400 during the 1980s; 163,300 during the 1970s; 111,900 during the 1960s; and 99,500 during the 1950s (see Table 6).

In relative terms, employment in the Region grew at a somewhat slower rate than both the State and the Nation during the 1990s. As a result, the Region's share of total State employment decreased from about 38 percent to about 36 percent, with the regional share of national employment also showing a slight decrease.

Historically, employment levels, both nationally and within the Region, tend to fluctuate in the short-term, rising and falling in accordance with business cycles. The long period of nearly uninterrupted job growth between 1983 and 2000 is unusual in this respect. Nationally and within the Region, total employment increased each year during that time, with the exception of a slight decrease in 1991. The extended period of employment growth in the Region ended after 2000, with total employment in the Region decreasing each year between 2000 and 2003. Estimated total employment in the Region stood at 1,179,000 jobs in 2003, about 4 percent below the 2000 level.

[2] *The Regional Planning Commission conducted a detailed inventory and analysis of the regional economy in 2004. The findings are presented in detail in SEWRPC Technical Report No. 10 (4th Edition),* The Economy of Southeastern Wisconsin, *dated July 2004.*

## Table 4

## HOUSEHOLDS IN THE REGION BY COUNTY: 1950-2000

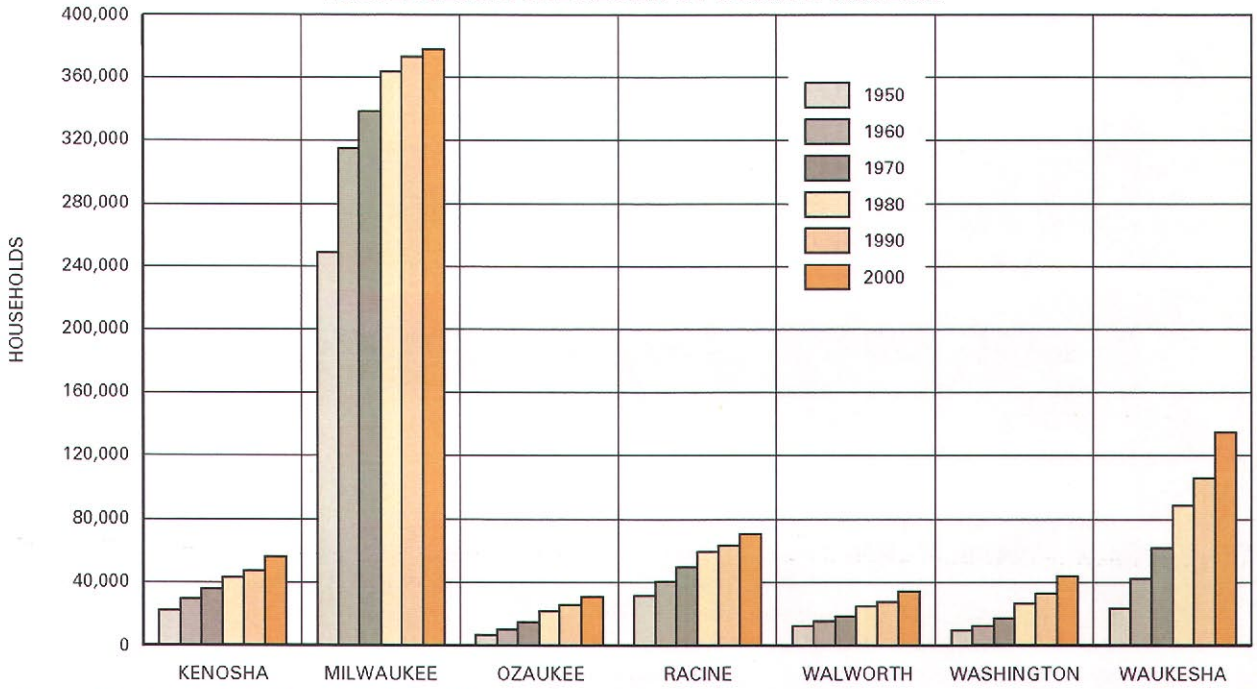
| County | Total Households | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1950 | | 1960 | | 1970 | | 1980 | | 1990 | | 2000 | |
| | Number | Percent of Total | Number | Percent of Total | Number | Percent of Total | Number | Percent of Total | Number | Percent of Total | Number | Percent of Total |
| Kenosha | 21,958 | 6.2 | 29,545 | 6.4 | 35,468 | 6.6 | 43,064 | 6.9 | 47,029 | 6.9 | 56,057 | 7.5 |
| Milwaukee | 249,232 | 70.3 | 314,875 | 67.6 | 338,605 | 63.1 | 363,653 | 57.9 | 373,048 | 55.2 | 377,729 | 50.4 |
| Ozaukee | 6,591 | 1.9 | 10,417 | 2.2 | 14,753 | 2.8 | 21,763 | 3.5 | 25,707 | 3.8 | 30,857 | 4.1 |
| Racine | 31,399 | 8.8 | 40,736 | 8.7 | 49,796 | 9.3 | 59,418 | 9.5 | 63,736 | 9.4 | 70,819 | 9.5 |
| Walworth | 12,369 | 3.5 | 15,414 | 3.3 | 18,544 | 3.5 | 24,789 | 3.9 | 27,620 | 4.1 | 34,505 | 4.6 |
| Washington | 9,396 | 2.7 | 12,532 | 2.7 | 17,385 | 3.2 | 26,716 | 4.2 | 32,977 | 4.9 | 43,843 | 5.8 |
| Waukesha | 23,599 | 6.6 | 42,394 | 9.1 | 61,935 | 11.5 | 88,552 | 14.1 | 105,990 | 15.7 | 135,229 | 18.1 |
| Region | 354,544 | 100.0 | 465,913 | 100.0 | 536,486 | 100.0 | 627,955 | 100.0 | 676,107 | 100.0 | 749,039 | 100.0 |

| County | Household Change | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1950-1960 | | 1960-1970 | | 1970-1980 | | 1980-1990 | | 1990-2000 | |
| | Number | Percent | Number | Percent | Number | Percent | Number | Percent | Number | Percent |
| Kenosha | 7,587 | 34.6 | 5,923 | 20.0 | 7,596 | 21.4 | 3,965 | 9.2 | 9,028 | 19.2 |
| Milwaukee | 65,643 | 26.3 | 23,730 | 7.5 | 25,048 | 7.4 | 9,395 | 2.6 | 4,681 | 1.3 |
| Ozaukee | 3,826 | 58.0 | 4,336 | 41.6 | 7,010 | 47.5 | 3,944 | 18.1 | 5,150 | 20.0 |
| Racine | 9,337 | 29.7 | 9,060 | 22.2 | 9,622 | 19.3 | 4,318 | 7.3 | 7,083 | 11.1 |
| Walworth | 3,045 | 24.6 | 3,130 | 20.3 | 6,245 | 33.7 | 2,831 | 11.4 | 6,885 | 24.9 |
| Washington | 3,136 | 33.4 | 4,853 | 38.7 | 9,331 | 53.7 | 6,261 | 23.4 | 10,866 | 32.9 |
| Waukesha | 18,795 | 79.6 | 19,541 | 46.1 | 26,617 | 43.0 | 17,438 | 19.7 | 29,239 | 27.6 |
| Region | 111,369 | 31.4 | 70,573 | 15.1 | 91,469 | 17.0 | 48,152 | 7.7 | 72,932 | 10.8 |

*Source: U.S. Bureau of the Census and SEWRPC.*

## Figure 5

## HOUSEHOLDS IN THE REGION BY COUNTY: 1950-2000




*Source: U.S. Bureau of the Census and SEWRPC.*

**Table 5**

**AVERAGE HOUSEHOLD SIZE IN THE REGION BY COUNTY: 1950-2000**

| County | Average Persons per Household | | | | | |
|---|---|---|---|---|---|---|
| | 1950 | 1960 | 1970 | 1980 | 1990 | 2000 |
| Kenosha | 3.36 | 3.36 | 3.26 | 2.80 | 2.67 | 2.60 |
| Milwaukee | 3.34 | 3.21 | 3.04 | 2.59 | 2.50 | 2.43 |
| Ozaukee | 3.51 | 3.65 | 3.66 | 3.04 | 2.79 | 2.61 |
| Racine | 3.37 | 3.39 | 3.35 | 2.86 | 2.70 | 2.59 |
| Walworth | 3.25 | 3.28 | 3.16 | 2.74 | 2.60 | 2.57 |
| Washington | 3.55 | 3.64 | 3.63 | 3.14 | 2.86 | 2.65 |
| Waukesha | 3.51 | 3.66 | 3.66 | 3.11 | 2.83 | 2.63 |
| Region | 3.36 | 3.30 | 3.20 | 2.75 | 2.62 | 2.52 |

*Source: U.S. Bureau of the Census and SEWRPC.*

**Table 6**

**EMPLOYMENT IN THE REGION, WISCONSIN, AND THE UNITED STATES: 1950-2000**

| Year | Region | | | Wisconsin | | | United States | | | Regional Employment as a percent of: | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Change from Preceding Year | | | Change from Preceding Year | | | Change from Preceding Year | | | |
| | Jobs | Number | Percent | Jobs | Number | Percent | Jobs | Number | Percent | Wisconsin | United States |
| 1950 | 573,500 | -- | -- | 1,413,400 | -- | -- | 61,701,200 | -- | -- | 40.6 | 0.93 |
| 1960 | 673,000 | 99,500 | 17.3 | 1,659,400 | 246,000 | 17.4 | 72,057,000 | 10,355,800 | 16.8 | 40.6 | 0.93 |
| 1970 | 784,900 | 111,900 | 16.6 | 1,929,100 | 269,700 | 16.3 | 88,049,600 | 15,992,600 | 22.2 | 40.7 | 0.89 |
| 1980 | 948,200 | 163,300 | 20.8 | 2,429,800 | 500,700 | 26.0 | 111,730,200 | 23,680,600 | 26.9 | 39.0 | 0.85 |
| 1990 | 1,062,600 | 114,400 | 12.1 | 2,810,400 | 380,600 | 15.7 | 136,708,900 | 24,978,700 | 22.4 | 37.8 | 0.78 |
| 2000 | 1,222,800 | 160,200 | 15.1 | 3,421,800 | 611,400 | 21.8 | 165,209,800 | 28,500,900 | 20.8 | 35.7 | 0.74 |

NOTE: Excludes military employment.

*Source: U.S. Bureau of Economic Analysis and SEWRPC.*

Information on current and historic employment levels is presented by county in (Table 7 and Figure 6). Each county in the Region experienced an increase in employment between 1990 and 2000. With an increase of 81,100 jobs, Waukesha County accounted for just over half of the total increase in the regional employment during the 1990s. Among the other six counties, the growth in employment during the 1990s ranged from 4,800 jobs in Racine County to 16,500 jobs in Kenosha County.

Between 1990 and 2000, Milwaukee and Racine Counties decreased in their share of total regional employment while the share of each of the other five counties increased. Over the past five decades, Milwaukee County has experienced a substantial decrease in its share of regional employment; Waukesha County has experienced a substantial increase; and Ozaukee, Walworth, and Washington Counties have experienced gradual increases. In Kenosha and Racine Counties, the share of total regional employment in 2000 was about the same as in 1950, with some fluctuations occurring over the intervening decades.

Substantial job growth has also occurred in the counties located immediately south of the Region. Employment in Lake and McHenry Counties (Illinois), combined increased by about 146,800 jobs during the 1990s. By 2000 total employment in Lake and McHenry Counties combined stood at 505,200 jobs. A significant number of Kenosha and Walworth County residents find employment in Northeastern Illinois.

## Table 7

## EMPLOYMENT IN THE REGION BY COUNTY: 1950-2000

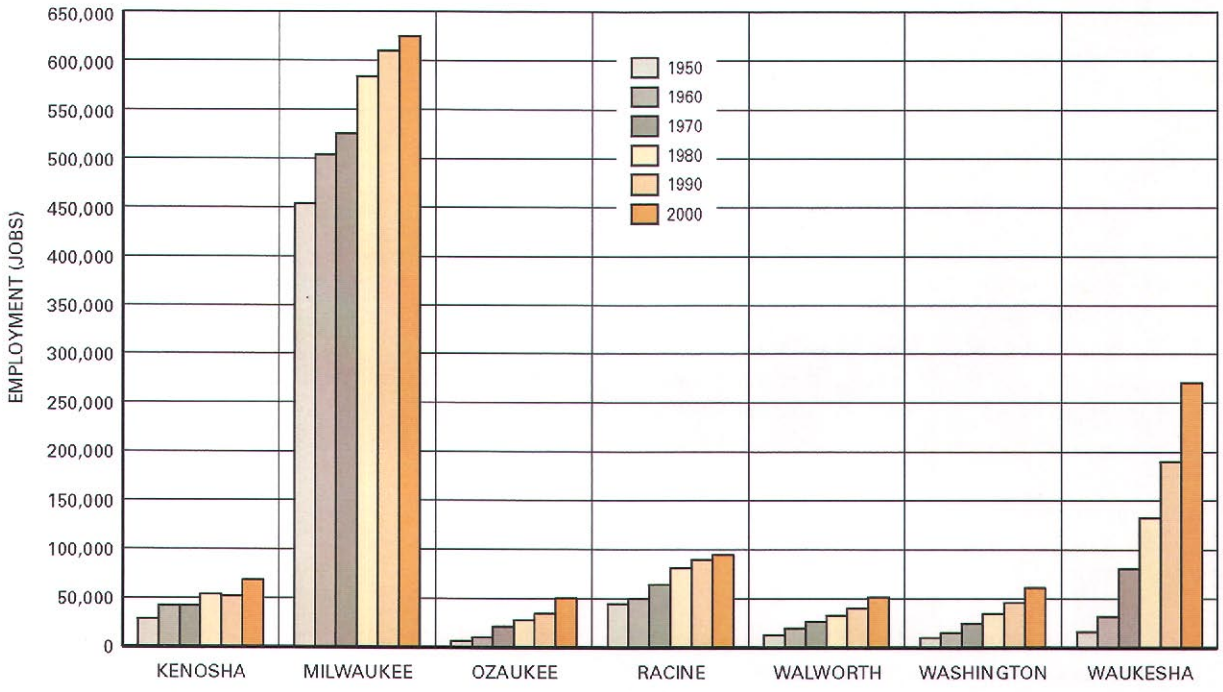
| County | Total Employment (Jobs) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1950 | | 1960 | | 1970 | | 1980 | | 1990 | | 2000 | |
| | Number | Percent of Total | Number | Percent of Total | Number | Percent of Total | Number | Percent of Total | Number | Percent of Total | Number | Percent of Total |
| Kenosha | 29,100 | 5.1 | 42,200 | 6.3 | 42,100 | 5.4 | 54,100 | 5.7 | 52,200 | 4.9 | 68,700 | 5.6 |
| Milwaukee | 453,500 | 79.1 | 503,300 | 74.8 | 525,200 | 66.9 | 583,200 | 61.5 | 609,800 | 57.4 | 624,600 | 51.1 |
| Ozaukee | 6,600 | 1.0 | 10,200 | 1.5 | 21,300 | 2.7 | 28,200 | 3.0 | 35,300 | 3.3 | 50,800 | 4.2 |
| Racine | 44,500 | 7.8 | 49,900 | 7.4 | 64,600 | 8.2 | 81,200 | 8.6 | 89,600 | 8.4 | 94,400 | 7.7 |
| Walworth | 13,200 | 2.3 | 19,600 | 2.9 | 26,400 | 3.4 | 33,500 | 3.5 | 39,900 | 3.8 | 51,800 | 4.2 |
| Washington | 10,200 | 1.8 | 15,200 | 2.3 | 24,300 | 3.1 | 35,200 | 3.7 | 46,100 | 4.3 | 61,700 | 5.0 |
| Waukesha | 16,400 | 2.9 | 32,600 | 4.8 | 81,000 | 10.3 | 132,800 | 14.0 | 189,700 | 17.9 | 270,800 | 22.2 |
| Region | 573,500 | 100.0 | 673,000 | 100.0 | 784,900 | 100.0 | 948,200 | 100.0 | 1,062,600 | 100.0 | 1,222,800 | 100.0 |

| County | Employment Change | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1950-1960 | | 1960-1970 | | 1970-1980 | | 1980-1990 | | 1990-2000 | |
| | Number | Percent | Number | Percent | Number | Percent | Number | Percent | Number | Percent |
| Kenosha | 13,100 | 45.0 | -100 | -0.2 | 12,000 | 28.5 | -1,900 | -3.5 | 16,500 | 31.6 |
| Milwaukee | 49,800 | 11.0 | 21,900 | 4.4 | 58,000 | 11.0 | 26,600 | 4.6 | 14,800 | 2.4 |
| Ozaukee | 3,600 | 54.5 | 11,100 | 108.8 | 6,900 | 32.4 | 7,100 | 25.2 | 15,500 | 43.9 |
| Racine | 5,400 | 12.1 | 14,700 | 29.5 | 16,600 | 25.7 | 8,400 | 10.3 | 4,800 | 5.4 |
| Walworth | 6,400 | 48.5 | 6,800 | 34.7 | 7,100 | 26.9 | 6,400 | 19.1 | 11,900 | 29.8 |
| Washington | 5,000 | 49.0 | 9,100 | 59.9 | 10,900 | 44.9 | 10,900 | 31.0 | 15,600 | 33.8 |
| Waukesha | 16,200 | 98.8 | 48,400 | 148.5 | 51,800 | 64.0 | 56,900 | 42.8 | 81,100 | 42.8 |
| Region | 99,500 | 17.3 | 111,900 | 16.6 | 163,300 | 20.8 | 114,400 | 12.1 | 160,200 | 15.1 |

*Source: U.S. Bureau of Economic Analysis and SEWRPC.*

## Figure 6

## EMPLOYMENT IN THE REGION BY COUNTY: 1950-2000




*Source: U.S. Bureau of Economic Analysis and SEWRPC.*

**Table 8**

**EMPLOYMENT BY GENERAL INDUSTRY GROUP IN THE REGION: 1970-2000**

| General Industry Group | Employment | | | | | | | | Percent Change in Employment | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1970 | | 1980 | | 1990 | | 2000 | | | | | |
| | Jobs | Percent of Total | Jobs | Percent of Total | Jobs | Percent of Total | Jobs | Percent of Total | 1970-1980 | 1980-1990 | 1990-2000 | 1970-2000 |
| Agriculture | 12,000 | 1.5 | 10,000 | 1.0 | 7,200 | 0.7 | 6,000 | 0.5 | -16.7 | -28.0 | -16.7 | -50.0 |
| Construction | 32,400 | 4.1 | 33,900 | 3.6 | 45,100 | 4.2 | 53,800 | 4.4 | 4.6 | 33.0 | 19.3 | 66.0 |
| Manufacturing | 254,400 | 32.4 | 264,200 | 27.9 | 223,500 | 21.0 | 224,300 | 18.3 | 3.9 | -15.4 | 0.4 | -11.8 |
| Transportation, Communication, and Utilities | 38,500 | 4.9 | 42,200 | 4.4 | 46,300 | 4.4 | 54,800 | 4.5 | 9.6 | 9.7 | 18.4 | 42.3 |
| Wholesale Trade | 37,200 | 4.7 | 46,200 | 4.9 | 55,300 | 5.2 | 64,400 | 5.3 | 24.2 | 19.7 | 16.5 | 73.1 |
| Retail Trade | 133,900 | 17.1 | 153,900 | 16.2 | 185,400 | 17.4 | 193,700 | 15.8 | 14.9 | 20.5 | 4.5 | 44.7 |
| Finance, Insurance, and Real Estate | 47,600 | 6.1 | 75,600 | 8.0 | 81,800 | 7.7 | 93,700 | 7.7 | 58.8 | 8.2 | 14.5 | 96.8 |
| Services | 141,800 | 18.1 | 216,700 | 22.8 | 304,700 | 28.7 | 406,000 | 33.2 | 52.8 | 40.6 | 33.2 | 186.3 |
| Government and Government Enterprises[a] | 84,400 | 10.8 | 101,100 | 10.7 | 106,200 | 10.0 | 114,400 | 9.3 | 19.8 | 5.0 | 7.7 | 35.5 |
| Other[b] | 2,700 | 0.3 | 4,400 | 0.5 | 7,100 | 0.7 | 11,700 | 1.0 | 63.0 | 61.4 | 64.8 | 333.3 |
| Total | 784,900 | 100.0 | 948,200 | 100.0 | 1,062,600 | 100.0 | 1,222,800 | 100.0 | 20.8 | 12.1 | 15.1 | 55.8 |

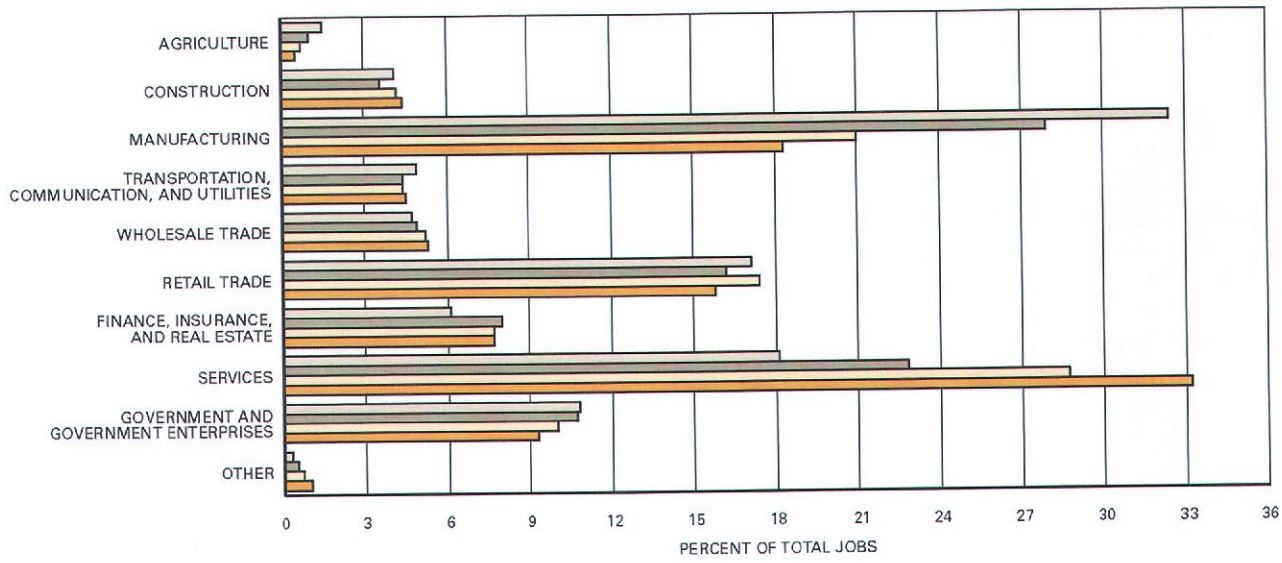
[a] *Includes all nonmilitary government agencies and enterprises.*

[b] *Includes agricultural services, forestry, commercial fishing, mining, and unclassified jobs.*

*Source: U.S. Bureau of Economic Analysis and SEWRPC.*

**Figure 7**

**PERCENT DISTRIBUTION OF EMPLOYMENT BY GENERAL INDUSTRY GROUP IN THE REGION: 1970, 1980, 1990, AND 2000**




*Source: U.S. Bureau of Economic Analysis and SEWRPC.*

### *Employment by Industry*

Information regarding employment by industry group provides insight into the structure of the regional economy and changes in that structure over time. As indicated in Table 8 and Figure 7, the services sector made up the largest proportion of regional employment in 2000, accounting for 33 percent of total employment. This was followed by manufacturing and retail trade, with 18 percent and 16 percent of total regional employment, respectively. Together, these three sectors accounted for roughly two-thirds of regional employment in 2000.

The 1990s saw a continuation of a shift in the regional economy from a manufacturing to a service orientation. Manufacturing employment in the Region was virtually unchanged during the 1990s, following a 15 percent decrease during the 1980s, and a modest 4 percent increase during the 1970s. Conversely, service-related employment increased substantially during each of the past three decades—by 33 percent during the 1990s, 41 percent during the 1980s, and 53 percent during 1970s. Due to these differential growth rates, the proportion of manufacturing jobs relative to total jobs in the Region decreased from 32 percent in 1970 to 18 percent in 2000, while service-related employment increased from 18 percent in 1970 to 33 percent in 2000. In comparison to the manufacturing and services industry groups, other major industry groups—such as wholesale trade, retail trade, government, and finance, insurance and real estate—have been relatively stable in terms of their share of total employment in the Region over the last three decades.

The State of Wisconsin and the United States have experienced a similar shift from manufacturing to service-related employment. However, the trend in manufacturing employment for the State overall has been more robust than for the Region. Manufacturing employment in the State increased by 24 percent between 1970 and 2000; the Region's manufacturing employment decreased by 12 percent during this time. While historically the Region exceeded the State in the proportion of manufacturing jobs relative to total jobs, by 2000 the Region and State had about the same proportion of jobs in manufacturing—just over 18 percent. In comparison, manufacturing jobs comprised about 12 percent of all jobs in the Nation in 2000.

## LAND USE

The Commission relies on two types of inventories and analyses in order to monitor urban growth and development in the Region—an urban growth ring analysis and a land use inventory. The urban growth ring analysis delineates the outer limits of concentrations of urban development and depicts the urbanization of the Region over the past 150 years. When related to urban population levels, the urban growth ring analysis provides a good basis for calculating urban population and household densities. By contrast, the Commission land use inventory is a more detailed inventory that places all land and water areas of the Region into one of 66 discrete land use categories, providing a basis for analyzing specific urban and nonurban land uses. Both the urban growth ring analysis and the land use inventory for the Region have been updated to the year 2000 under the continuing regional planning program.

### Urban Growth Ring Analysis

The urban growth ring analysis illustrates the historical pattern of urban settlement, growth, and development of the Region since 1850 for selected points in time. Areas identified as urban under this time series analysis include areas of the Region where residential structures or other buildings have been constructed in relatively compact groups, thereby indicating a concentration of residential, commercial, industrial, governmental, institutional, or other urban land uses. In addition, the identified urban areas encompass certain open space lands such as urban parks and small areas being preserved for resource conservation purposes within the urban areas.[3]

As part of the urban growth ring analysis, urban growth for the years prior to 1940 was identified using a variety of sources, including the records of local historical societies; land subdivision plat records; farm plat maps; U.S. Geological Survey topographic maps; and Wisconsin Geological and Natural History Survey records. Urban growth for

[3] *As part of the urban growth ring analysis, urban areas are defined as concentrations of residential, commercial, industrial, governmental, or institutional buildings or structures, along with their associated yards, parking, and service areas, having a combined area of five acres or more. In the case of residential uses, such areas must include at least 10 structures—over a maximum distance of one-half mile—located along a linear feature, such as a roadway or lakeshore, or at least 10 structures located in a relatively compact group within a residential subdivision. Urban land uses which do not meet these criteria because they lack the concentration of buildings or structures—such as cemeteries, airports, public parks, golf courses—are identified as urban where such uses are surrounded on at least three sides by urban land uses that do meet the aforereferenced criteria.*

the years 1940, 1950, 1963, 1970, 1980, 1990, and 2000 was identified using aerial photographs. Because of limitations inherent in the source materials, information presented for the years prior to 1940 represents the extent of urban development at approximately those points in time, whereas the information presented for later years can be considered precisely representative of those respective points in time.

The urban growth ring analysis, updated through 2000, is presented graphically on Map 2. In 1850, the urban portion of the Region was concentrated primarily in the larger urban centers located at Burlington, Kenosha, Milwaukee, Racine, Waukesha, and West Bend, along with many smaller settlements throughout the Region. Over the 100-year period from 1850 to 1950, urban development in the Region occurred in a pattern resembling concentric rings around existing urban centers, resulting in a relatively compact regional settlement pattern. After 1950, there was a significant change in the pattern and rate of urban development in the Region. While substantial amounts of development continued to occur adjacent to established urban centers, considerable development also occurred in isolated enclaves in outlying areas of the Region. Map 2 indicates a continuation of this trend during the 1990s, with significant amounts of development occurring adjacent to existing urban centers, and with considerable development continuing to occur in scattered fashion in outlying areas.

The urban growth ring analysis, in conjunction with the Federal censuses, provides a basis for calculating urban population and household densities in the Region and changes in density over time. Table 9 relates the urban area identified by the urban growth ring analysis with the urban population and households, going back to 1940.[4] In Table 9, the "urban population" is the total population of the Region excluding the rural farm population, as reported by the U.S. Bureau of the Census; similarly, "urban households" as reported in that table consist of all households other than rural farm households.[5]

As indicated in Table 9, the population density of the urban portion of the Region—as identified by the urban growth ring analysis—decreased significantly, from 10,700 persons per square mile in 1940 to about 5,100 persons per square mile in 1970, 3,900 persons per square mile in 1980, and 3,500 persons per square mile in 1990. During the 1990s, the urban population density decreased slightly—to about 3,300 persons per square mile in 2000. The long-term decrease in the urban population density is due in part to a trend toward lower density residential development. The decrease is also attributable, in part, to significant increases in the number of jobs—jobs having increased at a faster rate than population since 1960—and the attendant increase in commercial and industrial development in the Region. Part of the decrease in the urban population density also relates to the fact that the number of persons per household—the household being the basic unit of demand for residential development—has decreased by 25 percent since 1950.

A different density trend for the Region emerges when urban density is calculated based upon households rather than population (see Figure 8). Since 1963, the relative decrease in urban household density has been much lower than the decrease in urban population density. Between 1963 and 2000, the urban household density decreased by 23 percent, compared to a 43 percent decrease in the urban population density.

**Land Use Inventory**

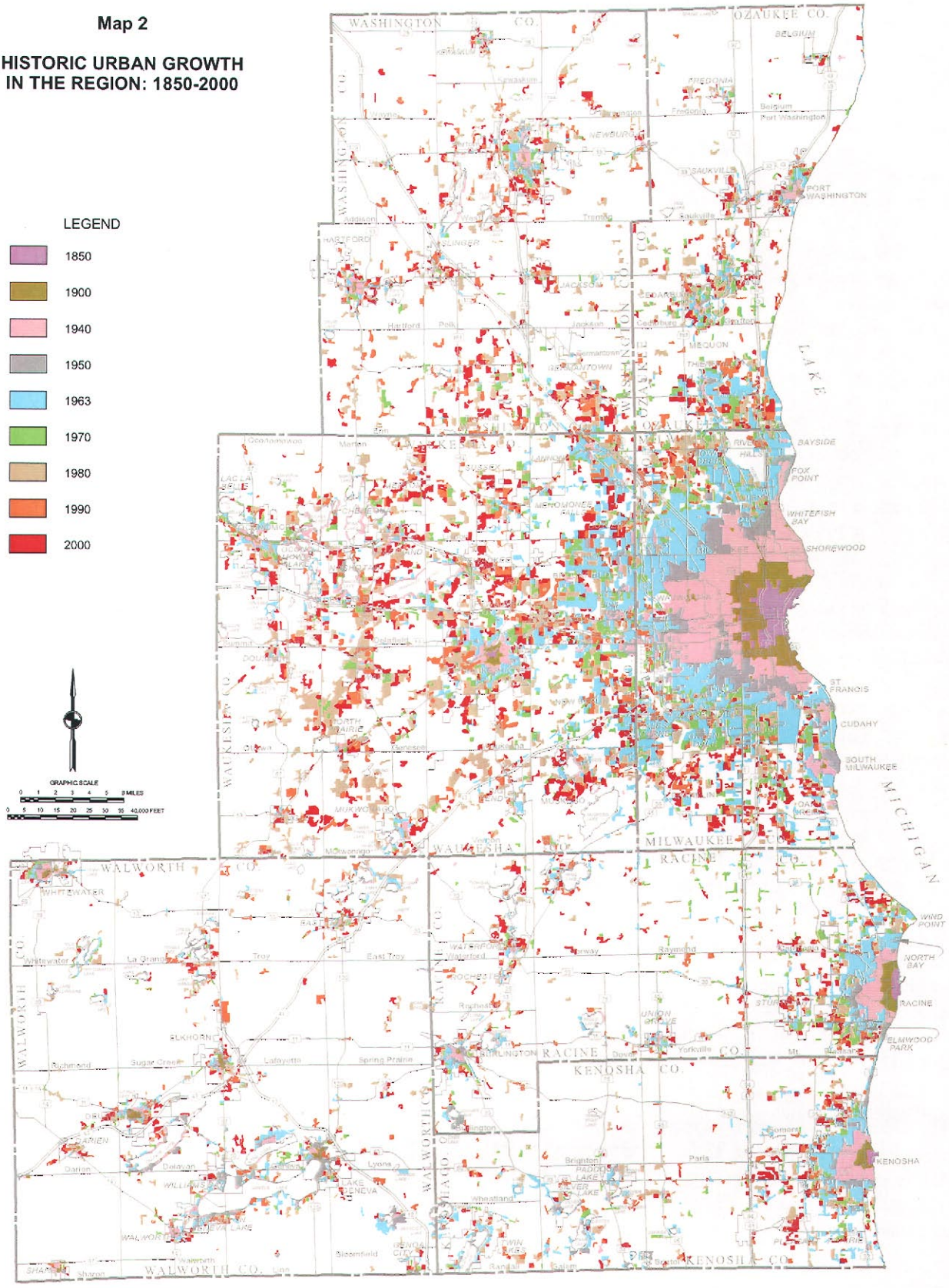
The Commission land use inventory is intended to serve as a relatively precise record of land use for the entire area of the Region at selected points in time. The land use classification system used in the inventory consists of nine major categories which are divisible into 66 sub-categories, making the

[4] *The urban growth ring analysis areas presented in Table 9 were developed using computerized map area measuring software. The area measurements presented in Table 9 differ slightly from the corresponding area measurement reported in the previous regional land use plan report, SEWRPC Planning Report No. 45, those measurements having been based on a combination of manual and computer measurement techniques.*

[5] *The Commission uses this method of approximating the population and households within the urban areas identified in the urban growth ring analysis in the absence of actual population and household counts for these areas. This method may include certain nonfarm residents living outside the identified urban areas in the estimate of the urban population and households for the Region, and, as a result, may overstate somewhat the actual urban population and household densities.*

**Map 2**

**HISTORIC URBAN GROWTH IN THE REGION: 1850-2000**




*Source: SEWRPC.*

**Table 9**

**URBAN POPULATION DENSITY AND URBAN HOUSEHOLD DENSITY IN THE REGION: 1940-2000**

| Year | Urban Area[a] (square miles) | Urban Population | | Urban Households | |
|---|---|---|---|---|---|
| | | Persons[b] | Density (persons per urban square mile) | Households[c] | Density (households per urban square mile) |
| 1940 | 93 | 991,535 | 10,662 | 272,077 | 2,926 |
| 1950 | 146 | 1,179,084 | 8,076 | 338,572 | 2,319 |
| 1963 | 282 | 1,634,200 | 5,795 | 470,856 | 1,670 |
| 1970 | 338 | 1,728,666 | 5,114 | 529,404 | 1,566 |
| 1980 | 444 | 1,749,238 | 3,940 | 623,441 | 1,404 |
| 1990 | 509 | 1,800,751 | 3,538 | 672,896 | 1,322 |
| 2000 | 579 | 1,923,674 | 3,322 | 746,500 | 1,289 |

[a] *Based upon the Regional Planning Commission urban growth ring analysis.*

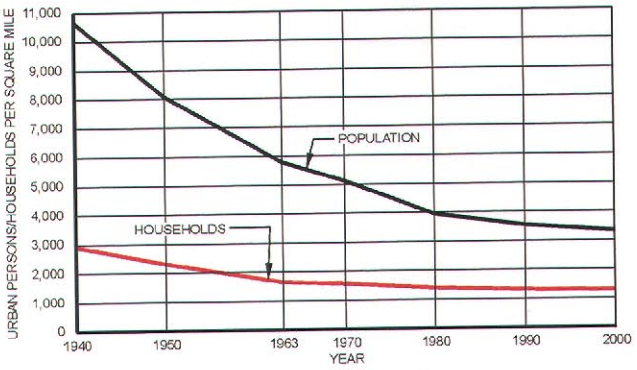
[b] *Total population, excluding rural farm population, as reported in the Federal Census; 1963 is Commission estimate.*

[c] *Total households, excluding rural farm households, as reported in the Federal Census; 1963 is Commission estimate.*

*Source: U.S. Bureau of the Census and SEWRPC.*

**Figure 8**

**URBAN POPULATION AND HOUSEHOLD DENSITY IN THE REGION: 1940-2000**




*Source: U.S. Bureau of the Census and SEWRPC.*

inventory suitable for both land use and transportation planning, adaptable to stormwater drainage, public utility, and community facility planning, and compatible with other land use classification systems. Aerial photographs serve as the primary basis for identifying existing land use, augmented by field surveys as appropriate. The most recent regional land use inventory was carried out based upon aerial photography taken in spring of 2000. The results of that inventory are summarized on Map 3 and Table 10.

***Existing Land Use: 2000***

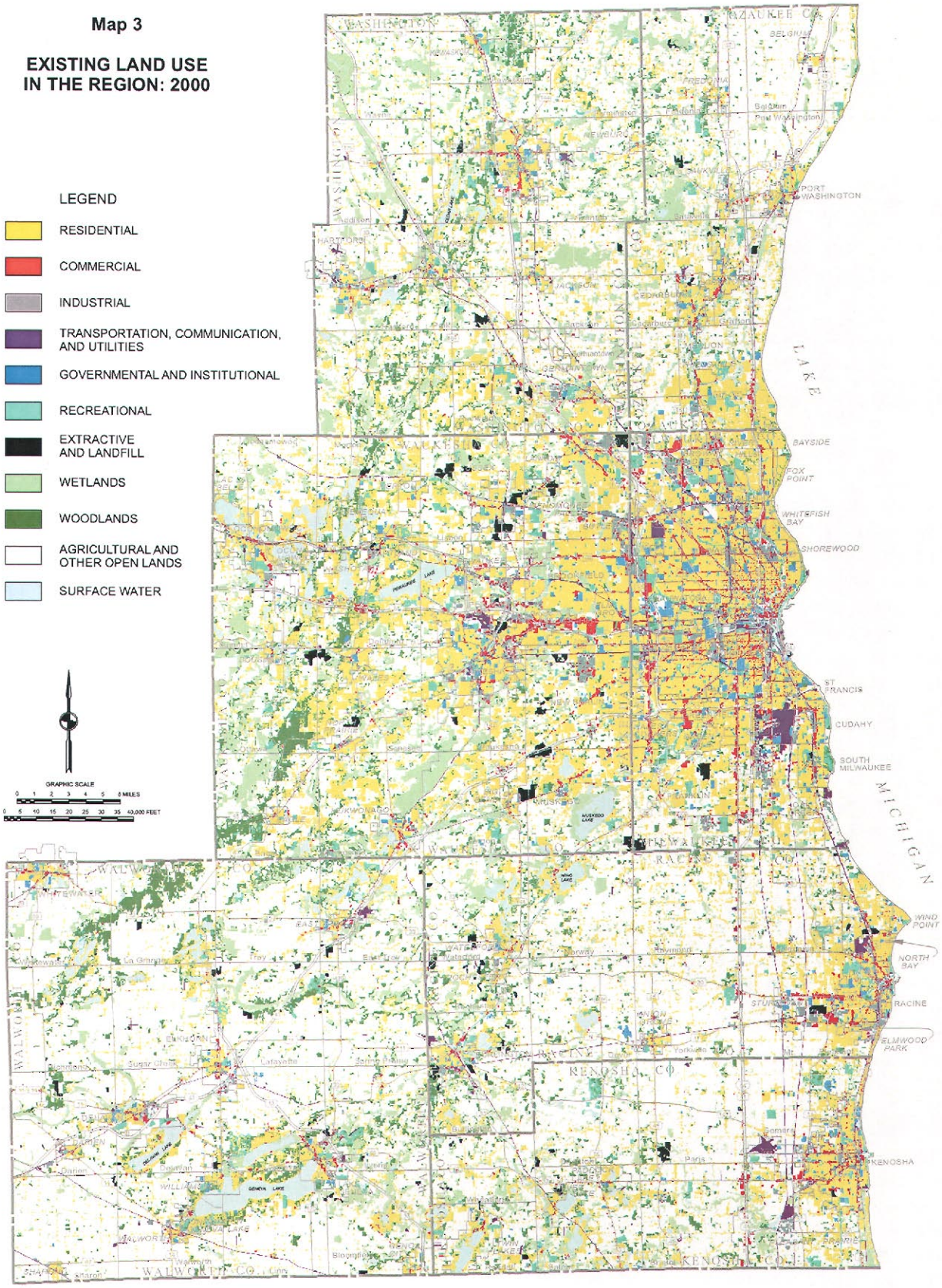
Areas considered "urban" under the land use inventory include areas identified as being in residential, commercial, industrial, transportation-communication-utility, governmental-institutional, or intensive recreational uses, along with "unused" urban lands.[6] In 2000, urban land uses as identified in the regional land use inventory encompassed about 761 square miles, or 28 percent of the total area of the Region. Residential land comprised the largest urban land use category, encompassing about 362 square miles, or about 48 percent of all urban land and about 14 percent of the overall area of the Region.[7] In combination, commercial and industrial lands encompassed about 63 square miles, or about 8 percent of all urban land and about 2 percent of the Region overall. Land used for governmental and institutional purposes encompassed 34 square miles, or 4 percent of all urban land and 1 percent of the Region overall. Land devoted to intensive recreational uses encompassed about 50 square miles, or 7 percent of all urban land and 2 percent of the Region overall. Land devoted to transportation, communication and utility uses—including areas used for streets and highways, railways, airports, and utility and communication facilities—totaled 201 square miles, or 26 percent of all urban land and 8 percent of the Region overall. Unused urban lands encompassed 51 square miles, or 7 percent of all urban land and 2 percent of the overall area of the Region (see Table 10).

[6] *Unused urban lands consist of open lands, other than wetlands and woodlands, which are located within urban areas but which were not developed for a particular use at the time of the land use inventory. Among the lands included in this category are lands where development was underway but not completed at the time of the inventory, and once-developed lands which have been cleared of development.*

[7] *As identified in the regional land use inventory, the residential land use category encompasses all residential land, including rural residential development, defined as residential development at a density of no more than one dwelling unit per five acres. It is envisioned that, utilizing property boundary information in a digital format, future regional land use inventories will specifically identify the location and extent of rural residential development, enabling the separate reporting of urban and rural residential land.*

**Map 3**

**EXISTING LAND USE IN THE REGION: 2000**




*Source: SEWRPC.*

**Table 10**

**EXISTING LAND USE IN THE SOUTHEASTERN WISCONSIN REGION: 2000**

| Land Use Category[a] | Square Miles | Percent of Urban/ Nonurban | Percent of Total |
|---|---|---|---|
| Urban | | | |
| Residential | 362.1 | 47.6 | 13.5 |
| Commercial | 30.3 | 4.0 | 1.1 |
| Industrial | 32.9 | 4.3 | 1.2 |
| Transportation, Communication, and Utilities | 200.9 | 26.4 | 7.5 |
| Governmental | 33.7 | 4.4 | 1.2 |
| Recreational | 50.4 | 6.6 | 1.9 |
| Unused Urban Land | 50.9 | 6.7 | 1.9 |
| Subtotal Urban | 761.2 | 100.0 | 28.3 |
| Nonurban | | | |
| Natural Areas | | | |
| Surface Water | 77.4 | 4.0 | 2.9 |
| Wetlands | 275.7 | 14.3 | 10.2 |
| Woodlands | 182.7 | 9.5 | 6.8 |
| Subtotal Natural Areas | 535.8 | 27.8 | 19.9 |
| Agricultural | 1,259.4 | 65.3 | 46.8 |
| Unused Rural and Other Open Land | 133.5 | 6.9 | 5.0 |
| Subtotal Nonurban | 1,928.7 | 100.0 | 71.7 |
| Total | 2,689.9 | -- | 100.0 |

[a]*Off-street parking is included with the associated land use.*

*Source: SEWRPC.*

Areas considered "nonurban" under the land use inventory include agricultural lands, wetlands, woodlands, surface water, extractive and landfill sites, and "unused" rural lands.[8] In 2000, nonurban lands as identified in the regional land use inventory encompassed about 1,929 square miles, or 72 percent of the total area of the Region. Agricultural land constituted the largest nonurban land use category, encompassing 1,259 square miles, representing about 65 percent of all nonurban land and about 47 percent of the overall area of the Region. Wetlands, woodlands, and surface water together encompassed 536 square miles, representing about 28 percent of all nonurban land and 20 percent of the Region overall. All other nonurban lands, including extractive, landfill, and unused rural lands, encompassed 134 square miles, representing about 7 percent of all nonurban land and 5 percent of the overall area of the Region.

The results of the year 2000 regional land use inventory are presented along with the results of prior land use inventories for the Region in Table 11. Table 11 indicates a significant increase in urban land uses in the Region between 1990 and 2000. As noted above, the year 2000 land use inventory indicates that urban land uses encompassed about 761 square miles in the Region in 2000. This compares to the figure of 637 square miles indicated by the 1990 land use inventory. It is estimated that about 15 square miles—or 12 percent

[8] *Unused rural lands consist of open lands, other than wetlands and woodlands, which are located within rural areas but which were not in agricultural, pasture, or related use at the time of the land use inventory.*

**Table 11**

**LAND USE IN THE SOUTHEASTERN WISCONSIN REGION AS REPORTED IN THE YEAR 2000 AND PRIOR REGIONAL LAND USE INVENTORIES**

| Land Use Category[a] | Existing Land Use in Square Miles | | | | |
|---|---|---|---|---|---|
| | 1963 | 1970 | 1980 | 1990 | 2000 |
| Urban | | | | | |
| Residential | 180.0 | 210.8 | 269.1 | 300.4 | 362.1 |
| Commercial | 11.5 | 14.8 | 19.3 | 24.7 | 30.3 |
| Industrial | 13.5 | 17.3 | 22.0 | 26.1 | 32.9 |
| Transportation, Communication, and Utilities | 134.9 | 150.0 | 166.1 | 171.8 | 200.9 |
| Governmental | 21.8 | 27.2 | 30.0 | 30.8 | 33.7 |
| Recreational | 26.0 | 33.1 | 39.3 | 42.3 | 50.4 |
| Unused Urban Land | 54.5 | 51.0 | 45.0 | 40.5 | 50.9 |
| Subtotal Urban | 442.2 | 504.2 | 590.8 | 636.6 | 761.2 |
| Nonurban | | | | | |
| Natural Areas | | | | | |
| Surface Water | 71.6 | 74.0 | 76.2 | 76.9 | 77.4 |
| Wetlands | 274.3 | 270.3 | 266.6 | 268.7 | 275.7 |
| Woodlands | 186.8 | 184.3 | 181.9 | 185.9 | 182.7 |
| Subtotal Natural Areas | 532.7 | 528.6 | 524.7 | 531.5 | 535.8 |
| Agricultural | 1,637.1 | 1,564.7 | 1,475.4 | 1,395.4 | 1,259.4 |
| Unused Rural and Other Open Land | 77.2 | 91.6 | 98.4 | 126.0 | 133.5 |
| Subtotal Nonurban | 2,247.0 | 2,184.9 | 2,098.5 | 2,052.9 | 1,928.7 |
| Total | 2,689.2 | 2,689.1 | 2,689.3 | 2,689.5 | 2,689.9 |

[a]*Off-street parking is included with the associated land use.*

NOTE: As part of the regional land use inventory for the year 2000, the delineation of existing land use was referenced to real property boundary information not available for prior inventories. This change increases the precision of the land use inventory and makes it more useable to public agencies and private interests throughout the Region. As a result of the change, however, year 2000 land use inventory data are not strictly comparable with data from the 1990 and prior inventories. At the county and regional level, the most significant effect of the change is to increase the transportation, communication, and utilities category—the result of the use of actual street and highway rights-of-way as part of the 2000 land use inventory, as opposed to the use of narrower estimated rights-of-way in prior inventories. This treatment of streets and highways generally diminishes the area of adjacent land uses traversed by those streets and highways in the 2000 land use inventory relative to prior inventories. Changes in total area may be due to this procedural change or to actual changes in the Lake Michigan shoreline.

*Source: SEWRPC.*

of the increase of 125 square miles in urban land indicated by the 1990 and 2000 inventories—is attributable to the referencing of land use delineations to real property boundaries in the 2000 inventory, particularly to the adjustment of estimated street rights-of-way to match actual rights-of-way. Thus, the actual increase in urban land uses in the Region during the 1990s, discounting the effect of procedural changes in the land use inventory, may be estimated at about 110 square miles, or 17 percent. This compares to increases of 46 square miles, or 8 percent, during the 1980s, and 87 square miles, or 17 percent, during the 1970s.

## Environmental Corridors

One of the most important tasks completed under the regional planning program for Southeastern Wisconsin has been the identification and delineation of areas of the Region in which concentrations of the best remaining elements of the natural resource base occur. It was recognized that preservation of such areas is important to both the maintenance of the overall environmental quality of the Region and to the continued provision of amenities required to maintain a high quality of life for the resident population.

Under the regional planning program, seven elements of the natural resource base have been considered essential to the maintenance of the ecological balance, natural beauty, and overall quality of life in Southeastern Wisconsin: 1) lakes, rivers, and streams, and their associated shorelands and floodlands; 2) wetlands; 3) woodlands; 4) prairies; 5) wildlife habitat areas; 6) wet, poorly drained, and organic soils; and 7) rugged terrain and high-relief topography. In addition, there are certain other features which, although not part of the natural resource base per se, are closely related to, or centered upon, that base and are a determining factor in identifying and delineating areas with recreational, aesthetic, ecological, and cultural value. These five additional elements are: 1) existing park and open space sites; 2) potential park and open

space sites; 3) historic sites; 4) scenic areas and vistas; and 5) natural areas and critical species habitat sites.

The delineation of these 12 natural resource and natural resource-related elements on maps results, in most areas of the Region, in an essentially linear pattern of relatively narrow, elongated areas which have been termed "environmental corridors" by the Regional Planning Commission.[9] Primary environmental corridors include a variety of the aforementioned important natural resource and resource-related elements and are at least 400 acres in size, two miles in length, and 200 feet in width. Secondary environmental corridors generally connect with the primary environmental corridors and are at least 100 acres in size and one mile in length. In addition, smaller concentrations of natural resource base elements that are separated physically from the environmental corridors by intensive urban or agricultural land uses have also been identified. These areas, which are at least five acres in size, are referred to as isolated natural resource areas.

The preservation of environmental corridors and isolated natural resource areas in essentially natural, open uses yields many benefits, including recharge and discharge of groundwater; maintenance of surface and groundwater quality; attenuation of flood flows and stages; maintenance of base flows of streams and watercourses; reduction of soil erosion; abatement of air and noise pollution; provision of wildlife habitat; protection of plant and animal diversity; protection of rare and endangered species; maintenance of scenic beauty; and provision of opportunities for recreational, educational, and scientific pursuits. Conversely, since these areas are generally poorly suited for urban development, their preservation can help avoid serious and costly developmental problems.

***Primary Environmental Corridors***

As shown on Map 4, the primary environmental corridors in the Region are primarily located along major stream valleys, around major lakes, and along the Kettle Moraine. These primary environmental corridors contain almost all of the best remaining woodlands, wetlands, and wildlife habitat areas in the Region, and represent a composite of the best remaining elements of the natural resource base. The protection of the primary environmental corridors from additional intrusion by incompatible land uses, degradation, and destruction is one of the key objectives of the adopted regional land use plan.

As indicated in Table 12, primary environmental corridors encompassed about 462 square miles, or about 17 percent of the total area of the Region, in 2000. As indicated in Table 13, there was a small net increase of 0.7 square mile, or 0.2 percent, in primary environmental corridor lands in the Region between 1990 and 2000. The change in area is the net result of increases in primary environmental corridor lands in certain areas of the Region and decreases in other areas. Decreases in primary environmental corridor lands occur, for the most part, as a result of conversion to urban or agricultural use. Increases may occur as a result of managed restoration efforts (e.g., wetland, woodland, or prairie restoration) and as a result of situations where lands, such as farmed floodplains or wetlands, are simply allowed to revert to a more natural condition.

***Secondary Environmental Corridors***

As further shown on Map 4, secondary environmental corridors are generally located along the small perennial and intermittent streams within the Region. Secondary environmental corridors also contain a variety of resource elements, often remnant resources from primary environmental corridors which have been developed for intensive urban or agricultural purposes.

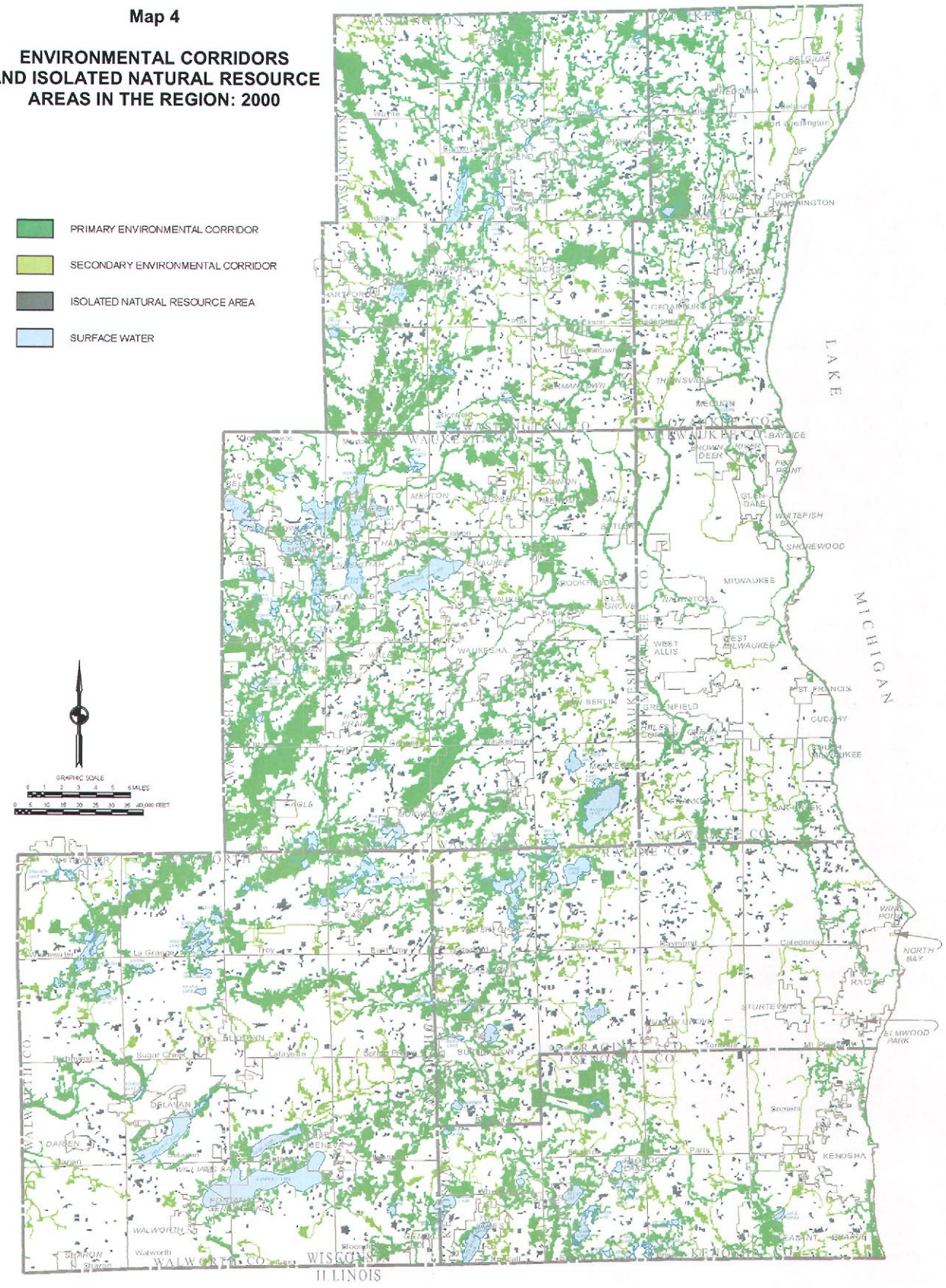
Secondary environmental corridors facilitate surface-water drainage, maintain pockets of natural resource features, and provide corridors for the movement of wildlife, as well as for the movement and dispersal of seeds for a variety of plant species.

In 2000, secondary environmental corridors encompassed about 75 square miles, or about 3 percent of the total area of the Region. There was a small net increase of 0.2 square mile, or 0.3 percent, in secondary environmental corridor lands in the Region between 1990 and 2000—also the result of increases in secondary environmental corridor lands in certain areas of the Region and decreases in other areas.

[9] *A detailed description of the process of delineating environmental corridors in Southeastern Wisconsin is presented in the March 1981 issue (Volume 4, No. 2) of the* SEWRPC Technical Record.

**Map 4**

**ENVIRONMENTAL CORRIDORS AND ISOLATED NATURAL RESOURCE AREAS IN THE REGION: 2000**




*Source: SEWRPC.*

**Table 12**

**ENVIRONMENTAL CORRIDORS AND ISOLATED NATURAL RESOURCE AREAS IN THE REGION BY COUNTY: 2000**

| County | Primary Environmental Corridors | | Secondary Environmental Corridors | | Isolated Natural Resource Areas | | Total Environmental Corridors and Isolated Natural Resource Areas | |
|---|---|---|---|---|---|---|---|---|
| | Square Miles | Percent of County/ Region | Square Miles | Percent of County/ Region | Square Miles | Percent of County/ Region | Square Miles | Percent of County/ Region |
| Kenosha | 43.8 | 15.7 | 10.0 | 3.6 | 6.0 | 2.2 | 59.8 | 21.5 |
| Milwaukee | 14.5 | 6.0 | 5.2 | 2.1 | 3.3 | 1.4 | 23.0 | 9.5 |
| Ozaukee | 32.2 | 13.7 | 7.6 | 3.2 | 5.6 | 2.4 | 45.4 | 19.3 |
| Racine | 35.5 | 10.4 | 10.8 | 3.2 | 12.0 | 3.5 | 58.3 | 17.1 |
| Walworth | 99.2 | 17.2 | 14.6 | 2.5 | 12.9 | 2.3 | 126.7 | 22.0 |
| Washington | 94.2 | 21.6 | 15.4 | 3.6 | 10.1 | 2.3 | 119.7 | 27.5 |
| Waukesha | 142.8 | 24.6 | 11.2 | 1.9 | 13.0 | 2.3 | 167.0 | 28.8 |
| Region | 462.2 | 17.2 | 74.8 | 2.8 | 62.9 | 2.3 | 599.9 | 22.3 |

*Source: SEWRPC.*

**Table 13**

**CHANGE IN ENVIRONMENTAL CORRIDORS AND ISOLATED NATURAL RESOURCE AREAS IN THE REGION: 1990-2000**

| Resource Feature | Existing 1990 (square miles) | Change: 1990-2000 | | | | Existing 2000 (square miles) |
|---|---|---|---|---|---|---|
| | | Gains (square miles) | Losses (square miles) | Net Change | | |
| | | | | Square miles | Percent | |
| Primary Environmental Corridors | 461.5 | 5.5 | 4.8 | 0.7 | 0.2 | 462.2 |
| Secondary Environmental Corridors | 74.6 | 1.9 | 1.7 | 0.2 | 0.3 | 74.8 |
| Isolated Natural Resource Areas | 63.3 | 3.0 | 3.4 | -0.4 | -0.6 | 62.9 |
| Total Environmental Corridors and Isolated Natural Resource Areas | 599.4 | 10.4 | 9.9 | 0.5 | 0.1 | 599.9 |

*Source: SEWRPC.*

### *Isolated Natural Resource Areas*

In addition to the primary and secondary environmental corridors, other smaller pockets of wetlands, woodlands, surface water, or wildlife habitat exist within the Region. These pockets are isolated from the environmental corridors by urban development or agricultural use, and although separated from the environmental corridor network, these isolated natural resource areas have significant value. They may provide the only available wildlife habitat in an area, usually provide good locations for local parks, and lend unique aesthetic character and natural diversity to an area.

Widely scattered throughout the Region, isolated natural resource areas encompassed about 63 square miles, or about 2 percent of the total area of the Region, in 2000. There was a small net decrease of 0.4 square mile, or 0.6 percent, in isolated natural resource areas in the Region between 1990 and 2000.

## AGRICULTURAL RESOURCE BASE

Agricultural land in the Region has decreased significantly over the past four decades. It is estimated that lands devoted to agricultural use decreased by 22 percent between 1963 and 2000, including a decrease of about 8 percent during the 1990s.[10] Despite this decrease, a large portion of the total area of the Region remains in agricultural use, and agriculture remains an important component of the regional economy.

Based upon the Commission's regional land use inventory, about 1,259 square miles, or 47 percent of the total area of the Region, were in agricultural use

[10] *These estimates are based upon the Commission's regional land use inventories and discount the effect of the procedural shifts made as part of the year 2000 inventory, described earlier in this chapter.*

in 2000. It should be noted that this figure includes lands actually used for agriculture—primarily cultivated lands and lands used for pasture—and excludes the wetland and woodland portions of existing farm units.

Map 5 shows the extent of agricultural land in the Region as identified in the year 2000 regional land use inventory and further identifies those areas which are covered by highly productive soils—comprised of soils in agricultural capability Class I and Class II, as classified by the U.S. Natural Resources Conservation Service. Agricultural lands covered by Class I and Class II soils encompassed about 945 square miles, or 75 percent of all agricultural land in the Region, in 2000. The adopted regional land use plan recommends the preservation of Class I and Class II soils insofar as practicable.

## TRANSPORTATION FACILITIES AND SERVICES

### Arterial Street and Highway System

The arterial streets and highways are defined as streets and highways that are previously intended to provide a high degree of traffic service, carrying relatively high volumes of traffic at relatively high operating speeds. The arterial street system may be divided into freeway facilities and nonfreeway, or standard arterial, streets and highways. A freeway is a special type of arterial providing the highest degree of mobility and the most limited degree of access. A freeway is defined as a directionally divided arterial highway with full control of marginal access and grade separation at all intersecting streets and highways. Standard arterial streets and highways may be directionally divided or undivided, with at-grade intersections, and partial or full control of marginal access to abutting property. Table 14 provides information on the mileage of arterials in the Region in 2001. Data on the existing and historic mileage of collector and land access streets and of the total street and highway system within the Region are also provided. Land access streets are primarily intended to provide access to abutting properties. Collector streets are intended primarily as connectors between the arterial and land access street systems. Streets and highways may also be classified according to jurisdiction. Jurisdictional classification establishes which level of government—State, county, or local—has responsibility for the design, construction, maintenance, and operation of each segment of the total street and highway system. Table 15 presents the distribution of existing arterial highway mileage within the Region in 2001 by State, county, and local jurisdictional classification. Map 6 shows the arterial street and highway system as it existed within the Region in 2001, by freeway and standard facility and by jurisdictional classification.

The location and configuration of the State Trunk Highway system, consisting of both freeway and nonfreeway facilities, has particular significance for telecommunications system planning. In order to provide public safety these facilities require good wireless telecommunications services.

### Arterial Street and Highway System Traffic Volume

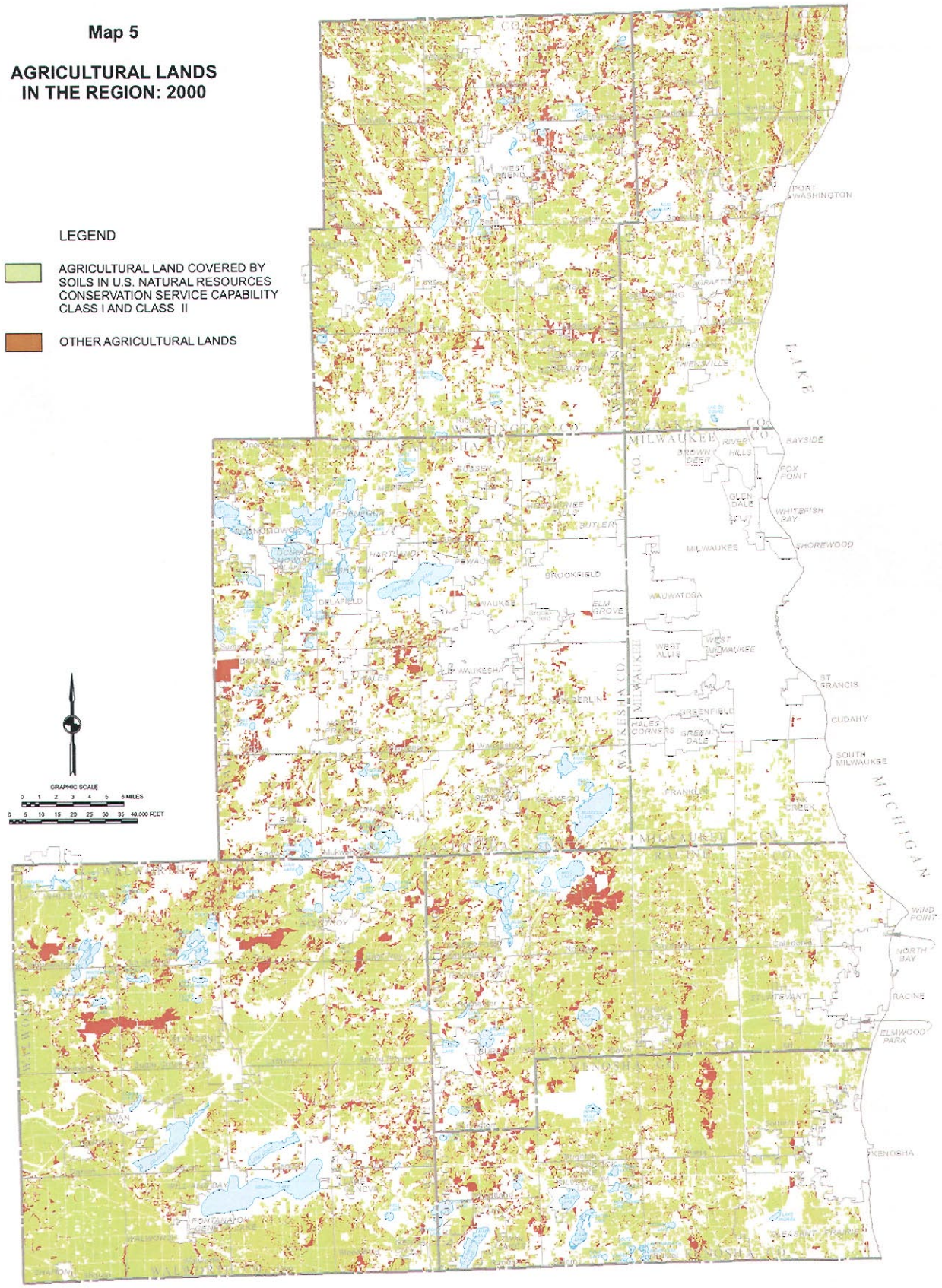
The average weekday traffic volume on each segment of the arterial street and highway system within the Region in 2001 is graphically displayed on Map 7. The magnitude of arterial street and highway traffic volume can also be measured in terms of total arterial system average weekday vehicle-miles of travel. About 40.0 million vehicle-miles of travel occurred on the arterial street and highway system within the Region on an average weekday in 2001. Freeways, which comprise about eight percent of the total arterial street mileage, carried 37.2 percent of the total arterial vehicle miles of travel which took place within the Region on an average weekday in 2001.

### Public Transit

Public transportation may be divided into service provided for the general public and service provided to special population groups. Examples of special group public transportation include yellow school bus service operated by area school districts, and fixed-route bus and paratransit van service provided by counties or municipalities for the elderly and disabled. Service to special population groups is considered only implicitly in the public transportation planning process, with the exception of paratransit operated within urban fixed-route transit service areas to meet the transportation needs of those persons who because of mental or physical disability are unable to use conventional transit service. Such service is required to be provided within fixed-route urban transit service areas under the Federal Americans with Disabilities act of 1990, and the needed configurations of such service is explicitly considered by the Commission in regional transportation system planning.

**Map 5**

**AGRICULTURAL LANDS IN THE REGION: 2000**




*Source: SEWRPC.*

## Table 14

### DISTRIBUTION OF TOTAL ARTERIAL STREET AND HIGHWAY SYSTEM MILEAGE AND VEHICLE MILES OF TRAVEL (VMT) WITHIN THE REGION BY COUNTY: 2001

| County | Total Miles | Freeway System Miles | Nonfreeway System Miles |
|---|---|---|---|
| Kenosha | 317.6 | 12.0 | 305.6 |
| Milwaukee | 781.8 | 67.8 | 714.0 |
| Ozaukee | 250.7 | 26.2 | 224.5 |
| Racine | 352.6 | 12.0 | 340.6 |
| Walworth | 436.6 | 48.9 | 387.7 |
| Washington | 406.5 | 42.8 | 363.7 |
| Waukesha | 746.0 | 60.0 | 686.0 |
| Region | 3,291.8 | 269.7 | 3,022.1 |

| County | Total VMT in Thousands | Freeway System | | Nonfreeway System | |
|---|---|---|---|---|---|
| | | VMT in Thousands | Percent | VMT in Thousands | Percent |
| Kenosha | 3,119.0 | 806 | 25.8 | 2,313 | 74.2 |
| Milwaukee | 16,666.0 | 6,895 | 41.4 | 9,771 | 58.6 |
| Ozaukee | 2,235.0 | 949 | 42.5 | 1,286 | 57.5 |
| Racine | 3,374.0 | 865 | 25.6 | 2,509 | 74.4 |
| Walworth | 2,338.0 | 763 | 32.6 | 1,575 | 67.4 |
| Washington | 3,091.0 | 1,369 | 44.3 | 1,722 | 55.7 |
| Waukesha | 9,160.0 | 3,237 | 35.3 | 5,923 | 64.7 |
| Region | 39,983.0 | 14,884 | 37.2 | 25,099 | 62.8 |

*Source: SEWRPC.*

## Table 15

### DISTRIBUTION OF EXISTING ARTERIAL STREET AND HIGHWAY MILEAGE WITHIN THE REGION BY COUNTY AND JURISDICTIONAL CLASSIFICATION: 2001

| County | State | | | County | | Local | | Total | |
|---|---|---|---|---|---|---|---|---|---|
| | Trunk Highways (miles) | Connecting Streets (miles) | Percent of Total | Miles | Percent of Total | Miles | Percent of Total | Miles | Percent of Total |
| Kenosha | 107.4 | 10.1 | 37.0 | 140.8 | 44.3 | 59.3 | 18.7 | 317.6 | 100.0 |
| Milwaukee | 175.3 | 87.3 | 33.6 | 87.7 | 11.2 | 431.5 | 55.2 | 781.8 | 100.0 |
| Ozaukee | 67.9 | 11.1 | 31.5 | 109.0 | 43.5 | 62.7 | 25.0 | 250.7 | 100.0 |
| Racine | 140.5 | 21.2 | 45.9 | 118.9 | 33.7 | 72.0 | 20.4 | 352.6 | 100.0 |
| Walworth | 193.0 | 18.4 | 48.4 | 168.9 | 38.7 | 56.3 | 12.9 | 436.6 | 100.0 |
| Washington | 173.3 | 14.4 | 46.2 | 149.8 | 36.9 | 69.0 | 16.9 | 406.5 | 100.0 |
| Waukesha | 220.5 | 18.4 | 32.0 | 351.7 | 47.1 | 155.4 | 20.9 | 746.0 | 100.0 |
| Region | 1,077.9 | 180.9 | 38.3 | 1,126.8 | 34.2 | 906.2 | 27.5 | 3,291.8 | 100.0 |

*Source: Wisconsin Department of Transportation and SEWRPC.*

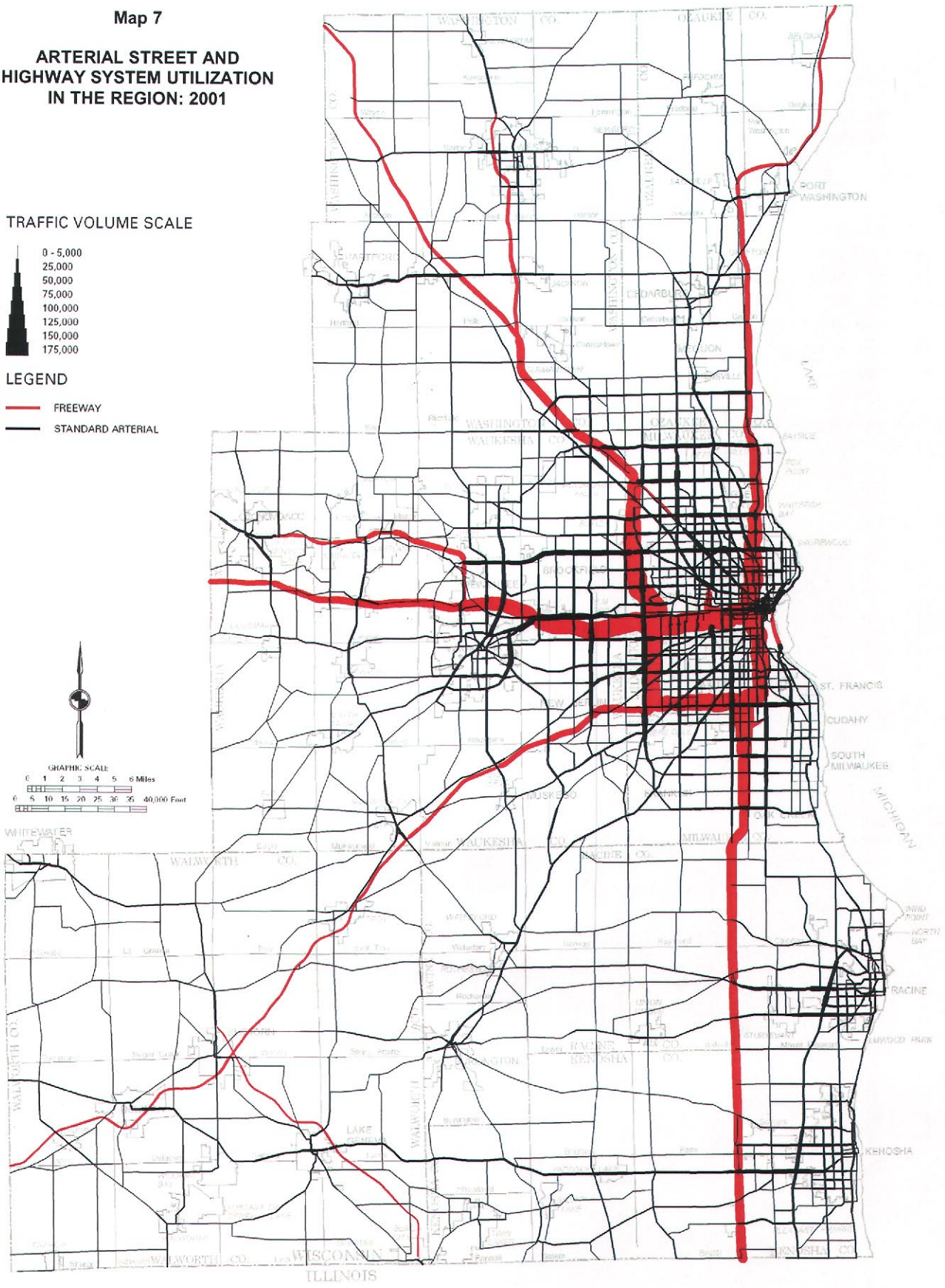
## Map 6

## ARTERIAL STREET AND HIGHWAY SYSTEM WITHIN THE SOUTHEASTERN WISCONSIN REGION: 2001


*Source: SEWRPC.*

**Map 7**

**ARTERIAL STREET AND HIGHWAY SYSTEM UTILIZATION IN THE REGION: 2001**




*Source: SEWRPC.*

Public transit service to the general public may further be divided into three categories: intercity, urban, and rural. Intercity or interregional public transportation provides services across regional boundaries and includes Amtrak railway passenger service, interregional bus service, and commercial air travel. Rural—and small urban community—public transportation provides service in and between small urban communities and rural areas, and may provide connections to urban areas. Urban public transportation, commonly referred to as public transit, provide service within and between the large urban areas of the Region. Public transit is essential in any metropolitan area to meet the travel needs of persons unable to use personal automobile transportation; to provide an alternative mode of travel, particularly in heavily traveled corridors within and between urban areas and in densely developed urban communities and activity centers; and to provide choice in transportation modes as an enhancement of quality of life and to support and enhance the regional economy.

Urban public transit may be further divided into rapid express, and local levels of service. Rapid transit is intended to facilitate relatively fast and convenient transportation along heavily traveled corridors and between major activity centers and high- and medium-density urban centers and communities within the Region. Rapid transit has relatively high average operating speeds and relatively low accessibility, with station spacing one to three miles or more apart.

Rapid transit service can be provided by commuter, heavy, or light rail operating over exclusive, grade-separated rights-of-way or by motor buses operating over exclusive, grade-separated busways. Rapid transit can also be provided by motor buses operating in mixed traffic on freeways and by light rail operating over exclusive, though not fully grade-separated, rights-of-way.

Express transit service is provided over arterial streets and highways or on exclusive rights-of-way with stops generally one-quarter to two miles apart at intersecting transit routes, intersecting arterial streets, and major traffic generators. Express transit services trips of moderate length can be provided by motor bus or by light rail operating in mixed traffic on shared right-of-way, in reserved street lanes, or on exclusive rights-of-way. Express transit service provides a greater degree of accessibility at somewhat slower operating speeds than rapid transit and may provide "feeder" service to the rapid transit system.

Local transit service is characterized by a high degree of accessibility and low operating speeds. Local service is provided over arterial and collector streets with stops generally one-eighth to one-quarter miles apart. Such service can be provided by motor bus, electric trolleybus, or streetcar. Local transit service can also be provided on a demand-responsive basis, such as with automobiles or vans operating as a shared-ride taxi.

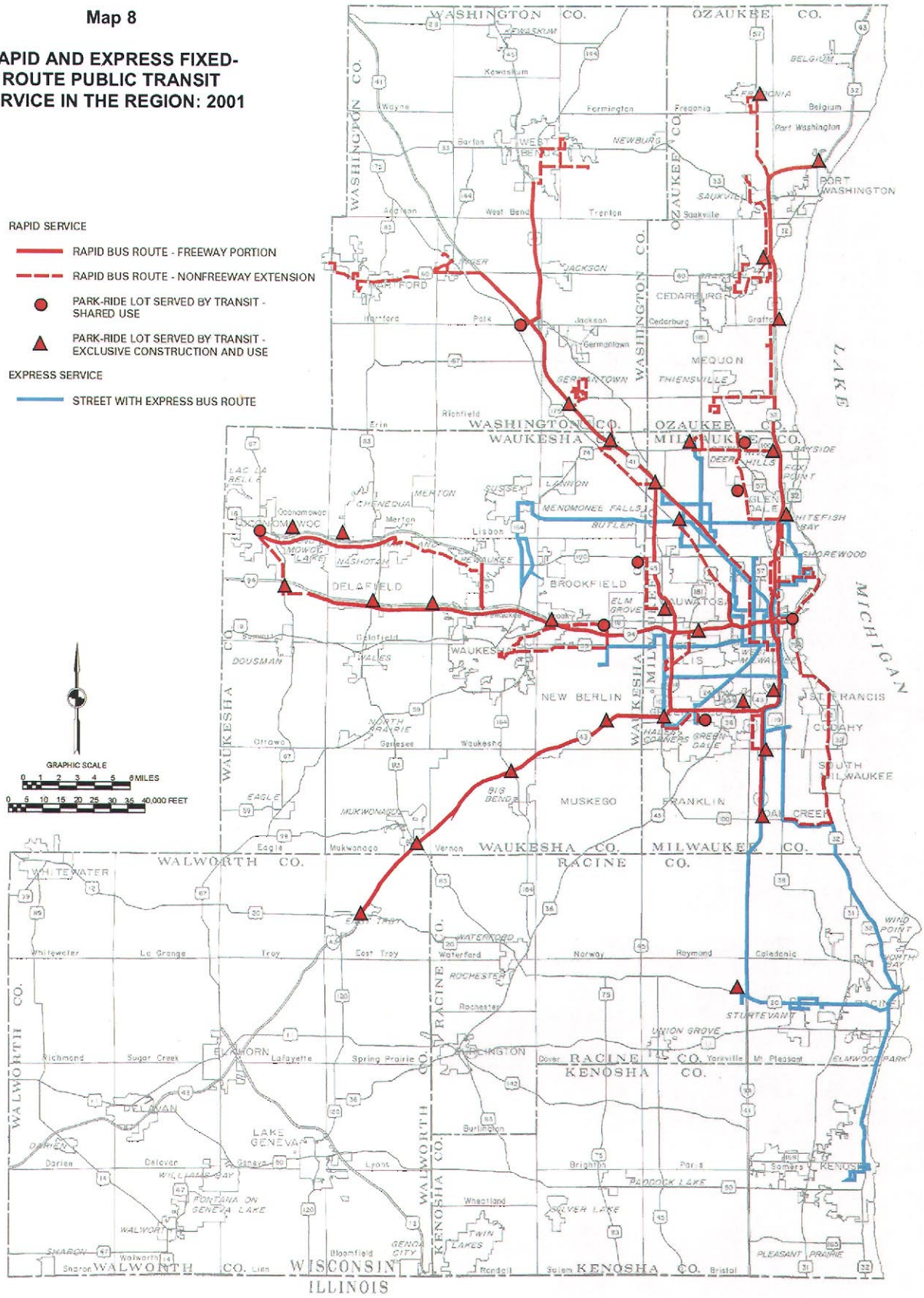
The extent of rapid and express fixed route transit service within the Region in 2001 is shown on Map 8.

***Rural and Small Urban Community Demand-Responsive Transit Service***

As shown on Map 9 demand-responsive rural public transit in the form of publicly operated shared-ride taxicab service was also provided in the Region in 2001. Shared-ride taxicab service was provided by the City of Port Washington Transport Taxi Service in Ozaukee County, and the Hartford City Taxi Service and City of West Bend Taxi Service in Washington County. These three systems served local travel in and immediately adjacent to the sponsoring municipality. In addition, both Ozaukee and Washington Counties provided shared-ride taxicab service on a countywide basis. The two county taxi systems principally served travel in the small urban communities and rural areas in each county and between the rural areas and all communities. The Ozaukee and Washington County taxi system did serve some communities located within the Milwaukee urban area including the communities of Germantown in Washington County and Mequon, Cedarburg and Grafton in Ozaukee County. These county taxi systems, however, do not serve trips that could be made on municipal systems in each county—Port Washington in Ozaukee

**Map 8**

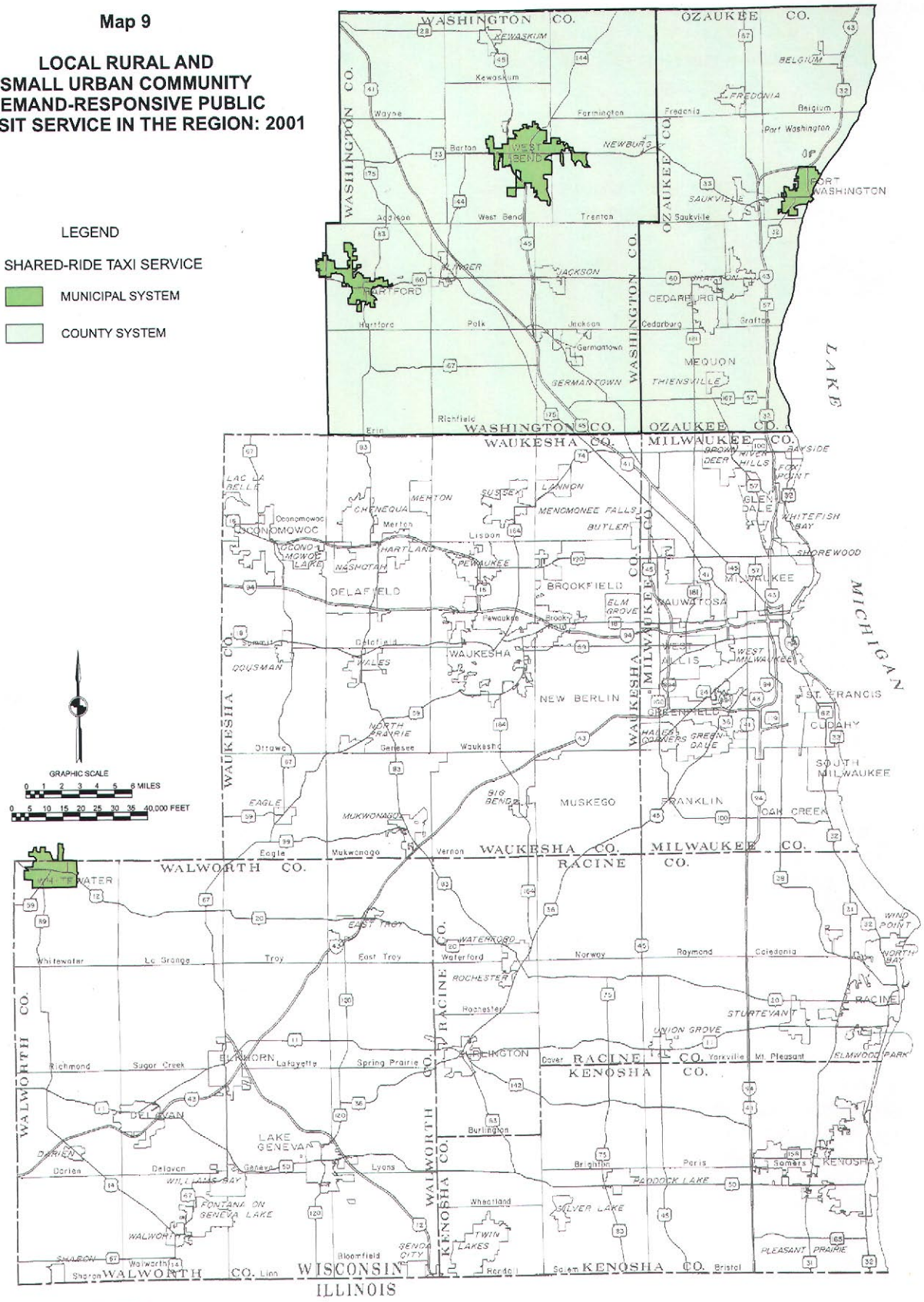
## RAPID AND EXPRESS FIXED-ROUTE PUBLIC TRANSIT SERVICE IN THE REGION: 2001




*Source: SEWRPC*

**Map 9**

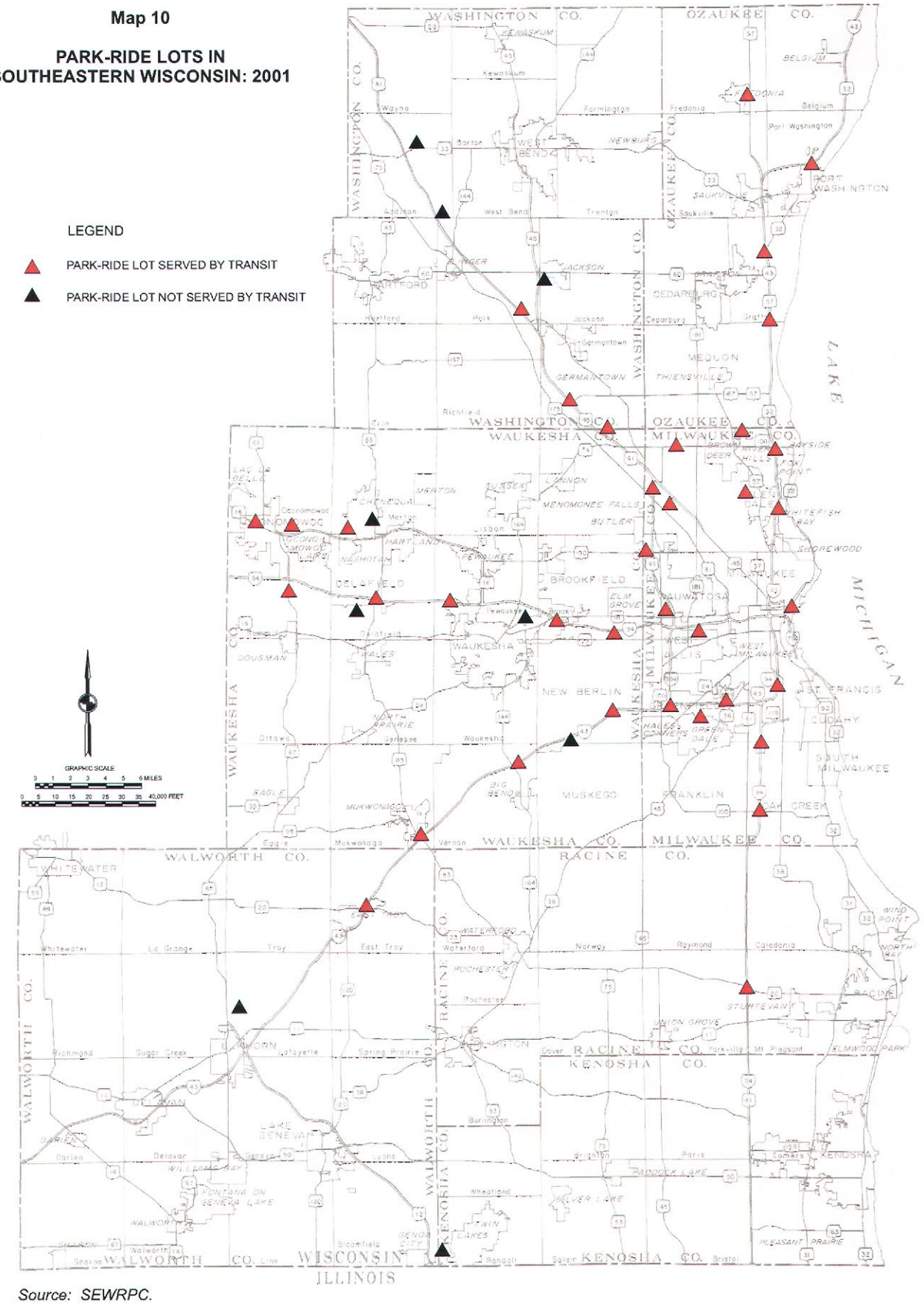
## LOCAL RURAL AND SMALL URBAN COMMUNITY DEMAND-RESPONSIVE PUBLIC TRANSIT SERVICE IN THE REGION: 2001




*Source: SEWRPC.*

**Map 10**

**PARK-RIDE LOTS IN SOUTHEASTERN WISCONSIN: 2001**




*Source: SEWRPC.*

Counties decreased in their relative share of total regional employment while the share of each of the other five counties increased.

- The 1990s saw a continuation of a shift in the regional economy from a manufacturing to a service orientation. Manufacturing employment in the Region was virtually unchanged during the 1990s, following a 15 percent decrease during the 1980s, and a modest 4 percent increase during the 1970s. Conversely, service-related employment increased substantially during each of the past three decades—by 33 percent during the 1990s, 41 percent during the 1980s, and 53 percent during 1970s. Due to these differential growth rates, the proportion of manufacturing jobs relative to total jobs in the Region decreased from 32 percent in 1970 to 18 percent in 2000, while service-related employment increased from 18 percent in 1970 to 33 percent in 2000.

**Land Use**

- Urban land uses encompassed about 761 square miles, or 28 percent of the total area of the Region, in 2000. Residential land comprised the largest urban land use category, encompassing about 362 square miles, or about 48 percent of all urban land and about 14 percent of the overall area of the Region. In combination, commercial and industrial lands encompassed about 63 square miles, or about 8 percent of all urban land and about 2 percent of the Region overall. Land used for governmental and institutional purposes encompassed 34 square miles, or 4 percent of all urban land and 1 percent of the Region overall. Land devoted to intensive recreational uses encompassed about 50 square miles, or 7 percent of all urban land and 2 percent of the Region overall. Land devoted to transportation, communication, and utility uses—including areas used for streets and highways, railways, airports, and utility and communication facilities—totaled 201 square miles, or 26 percent of all urban land and 8 percent of the Region overall. Unused urban lands encompassed 51 square miles, or 7 percent of all urban land and 2 percent of the overall area of the Region.

- Areas considered "nonurban" under the land use inventory include agricultural lands, wetlands, woodlands, surface water, extractive and landfill sites, and unused rural lands. In 2000, nonurban lands as identified in the regional land use inventory encompassed about 1,929 square miles, or 72 percent of the total area of the Region. Agricultural land constituted the largest nonurban land use category, encompassing 1,259 square miles, representing about 65 percent of all nonurban land and about 47 percent of the overall area of the Region. Wetlands, woodlands, and surface water together encompassed 536 square miles, representing about 28 percent of all nonurban land and 20 percent of the Region overall. All other nonurban lands, including extractive, landfill, and unused rural lands, encompassed 134 square miles, representing about 7 percent of all nonurban land and 5 percent of the overall area of the Region.

- Commission inventories indicate a continued significant increase in urban land uses within the Region. Urban land uses increased by about 110 square miles from 1990 to 2000, or by about 17 percent.

- The population density of the urban portion of the Region has continued to decrease from 10,700 persons per square mile in 1940 to about 5,100 persons per square mile in 1970, 3,900 persons per square mile in 1980, and 3,500 persons per square mile in 2000. During the 1990s, the urban population density continued to decrease, but at a slower rate, to about 3,300 persons per square mile in 2000. A different density trend for the Region emerges when urban density is calculated based upon households rather than population. Since 1963, the relative decrease in urban household density has been much lower than the decrease in urban population density. Between 1963 and 2000, the urban household density decreased by 23 percent, compared to a 43 percent decrease in the urban population density.

- The most important elements of the natural resource base and features closely related to that base—including wetlands, woodlands, prairies, wildlife habitat, major lakes and streams and associated shorelands and floodlands, and historic, scenic, and recreational sites—when combined result in essentially elongated patterns referred to by the Commission as "environmental corridors." "Primary" environmental corridors, which are the longest and widest type of environmental corridor, are generally located along major stream valleys, around major lakes, and along the Kettle Moraine; they encompassed 462 square miles, or 17 percent of the total area of the Region, in 2000. "Secondary" environmental corridors are generally located along small perennial and intermittent streams; they encompassed 75 square miles, or 3 percent of the Region, in 2000. In addition to the environmental corridors, "isolated natural resource areas," consisting of small pockets of natural resource base elements separated physically from the environmental corridor network, have been identified. Widely scattered throughout the Region, isolated natural resource areas encompassed about 63 square miles, or 2 percent of the Region, in 2000.

- Agricultural land in the Region has decreased significantly over the past four decades. It is estimated that lands devoted to agricultural use decreased by 22 percent between 1963 and 2000, including a decrease of about 8 percent during the 1990s. Despite this decrease, a large portion of the total area of the Region remains in agricultural use, and agriculture remains an important component of the regional economy. About 1,259 square miles, or 47 percent of the total area of the Region, were in agricultural use in 2000. Of this total, about 945 square miles, or 75 percent, were covered by highly productive soils—agricultural capability Class I and Class II soils, as identified by the U.S. Natural Resources Conservation Service.

- As of 2001, there were approximately 11,937 miles of streets and highways—land-access, collector, and arterial—within the Region. Only 28 percent, or 3,292 miles, of the street and highway system were arterials with the principal function of moving traffic. The miles of arterials within the Region have increased from 3,188 in 1963 to 3,292 miles in 2001, an increase of 100 miles or 3 percent. The freeway system in 2001 of 270 miles accounted for 8 percent of the total arterial street and highway system and 2 percent of the total street and highway system yet carried over 37 percent of the arterial vehicle miles of travel on an average weekday, with the Region.

- The extent of fixed route public transit service in southeastern Wisconsin significantly increased from 1991 to 2001 from 63,300 vehicle-miles of service on an average weekday to 79,600 vehicle-miles of service, an increase of 26 percent. The extent of fixed route service provided in 2001 was also 24 percent greater than that provided in 1972 and only 6 percent less than that provided in 1963. Demand-responsive transit service in the Region also significantly increased from 1991 to 2001, from 1,800 vehicle-miles of service on an average weekday to 7,700 vehicle-miles of service. However, since 2001, the extent of fixed route transit service has significantly declined by about 10 percent to 71,900 vehicle-miles of service on an average weekday due to the economic downturn following September 11, 2001, reduced Federal funds, and State and local budget problems.

- The number of park-ride lots enabling the transfer of mode between private vehicles and public transit and from solo driver private vehicles to carpools has increased from 8 in 1972, to 37 in 1991, and to 46 in 2001. Of the 46 park-ride lots in 2001, 37 were provided with transit service. On an average weekday in 2001, about 38 percent of the approximately 6,500 spaces at the 46 park-ride lots were estimated to be in use.

The background inventory data presented in this Chapter is of both direct and indirect use in the wireless telecommunications planning process. Population and household estimates and forecasts in regional aggregate form and distributed by existing and proposed land use patterns will provide the basis for voice, data, and video traffic demand analyses. National traffic data from the Federal Com-

munications Commission and the U.S. Bureau of Census will be allocated to the Region based on the regional share of the national population. These estimates will be verified and cross-correlated with data on state, regional, or industry levels so as to obtain the best estimate of current traffic and the framework for design year forecasts. The data to be allocated include: the number of subscribers, the average number of daily calls for each subscriber, and the average length of each call. From such data, it is possible to estimate existing and to forecast call generation for subregional areas down to the U.S. Public Land Survey system section. Most of the national call data relate to voice calls, but information on wireless data traffic is also becoming available. Wireless video traffic data, however, have not been available long enough to be meaningful. Employment data are also useful in forecasting wireless traffic from work locations. National traffic data can be allocated to the Region based on the regional share of national employment. Voice and data traffic by subregional area can be estimated and forecast based on regional employment and land use data. Land use data can also be used to differentiate as to whether population, employment, or a combination of both, should be used to determine traffic generation rates in a particular subarea of the planning Region. Areas designated as environmental corridors are generally excluded from consideration as potential antenna site locations.

A special aspect of wireless traffic generation relates to calls made during travel. Recent statistics released by the National Highway Traffic Safety Administration indicate that at any given time about eight percent of automobile drivers are using cell phones. Therefore, data on arterial street and highway traffic volumes provides an important resource for estimating and forecasting wireless traffic in the Region. Vehicular traffic volumes segregated by street and highway segments will be an important input for wireless traffic level forecasts.

All of the above uses of background data relate to the demand side of telecommunications systems. On the supply side, relating to network infrastructure design, population density or more precisely household density is an important variable to be considered in the choice of communications technology. In geographic areas with low household densities, wireless infrastructures may be more cost effective for broadband communications than wireline systems. High household density areas favor use of fiber optic cable networks.

Overall, the background data on population, households, employment, land use and transportation traffic patterns facilitates wireless network design, permitting alternative designs to be developed that can meet existing and probable future needs during the life of the network infrastructure.

*PRELIMINARY DRAFT*

**SEWRPC Planning Report No. 53,**
**A COMPREHENSIVE TELECOMMUNICATIONS PLAN**
**FOR SOUTHEASTERN WISCONSIN**

# Chapter I

# INTRODUCTION

## INTRODUCTION

The Southeastern Wisconsin Regional Planning 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, however, the preparation of spatial designs for the use of land and for supporting transportation, and other utility facilities, including telecommunications facilities.

The scope and complexity of areawide development problems prohibit the making and adopting of an entire comprehensive development plan at one time. The Commission has, therefore, determined to proceed with the preparation of individual plan elements which together can form the required comprehensive plan. Each element is intended to deal with an identified areawide developmental or environmental problem. The individual elements are coordinated by being related to an areawide land use plan. Thus, the land use plan comprises the most basic regional plan element, an element on which all other elements are based. The regional comprehensive telecommunications plan for Southeastern Wisconsin is also strongly linked to the regional land use and transportation plans based on the relationship between land use patterns, major transportation facilities, and telecommunications traffic generation.

Because regional telecommunications planning comprises an integral part of a broader regional planning program, an understanding of the need for, and objectives of, regional planning and the manner in which these needs are being met in southeastern Wisconsin is necessary for a full understanding of the telecommunications planning process and of its findings and recommendations as presented in this report. To that end, this chapter describes the need for, and status of, the regional planning effort within the Southeastern Wisconsin Region.

## NEED FOR REGIONAL PLANNING

Regional planning may be defined as comprehensive planning for a geographic area larger than a county but smaller than a state, united by economic interest, geography, and common areawide developmental and environmental problems. The need for such planning has arisen from certain important social and economic changes which, while national phenomena, have had far-reaching impacts on the problems facing local government. These changes include growth and redistribution of population and attendant urban development; changes in agricultural and industrial productivity, income levels, and leisure time; generation of mass recreational needs and pursuits; intensive use and consumption of natural resources; development of private water supply and sewage disposal systems; development of extensive electric power and communications networks; and development of limited-access highways and mass

automotive transportation. Through the effects of these changes, entire regions like Southeastern Wisconsin are being subjected to the widespread diffusion of urban development and are thereby becoming, large, mixed rural and urban socio-economic complexes. This urban diffusion, in turn, creates serious and complex areawide developmental and environmental problems.

The areawide problems which necessitate a regional planning effort in Southeastern Wisconsin all have their source in the changes in population size, composition, and distribution and in the attendant urban diffusion occurring within the Region. These area-wide problems include, among others: drainage and flooding; air and water pollution; increased demand for park and outdoor recreation facilities, sewerage and water supply facilities, and housing; traffic congestion; a growing demand for high speed, broadband telecommunications; and, underlying all of the foregoing problems, rapidly changing land use development. These problems are all truly regional in scope, transcending both the geographic boundaries and the fiscal capabilities of the local municipal units of government comprising the Region, and can be properly addressed only within the context of a continuing, cooperative, areawide, comprehensive regional planning effort.

## THE REGIONAL PLANNING COMMISSION

The Southeastern Wisconsin Regional Planning Commission was created in August 1960, pursuant to the provisions of Section 66.0303 of the Wisconsin Statutes, to serve and assist the local, state, and federal units of government in solving areawide problems and in planning for the more orderly and more economic development of Southeastern Wisconsin. The Commission's role is entirely advisory, and participation by local units of government in its work is on a voluntary, cooperative basis. The Commission is composed of 21 citizen members, three from each county in the Region. One Commissioner from each county is appointed to the Commission by the county board, one by the Governor from a list certified to him by the county board, and one by the Governor on his own motion.

The powers, duties, and functions of the Commission and the qualifications of the Commissioners are carefully set forth in the enabling legislation. The Commission is authorized to employ a staff and to appoint advisory committees to assist it in the execution of its responsibilities. Basic funding to support Commission operations is provided by the member counties, with the budget apportioned among the seven counties on the basis of relative equalized property valuation. The Commission is 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 organizational structure of the Commission and its relationship to the constituent units and agencies of government comprising or operating within the Region is shown in Figure 1.

## THE REGIONAL PLANNING CONCEPT IN SOUTHEASTERN WISCONSIN

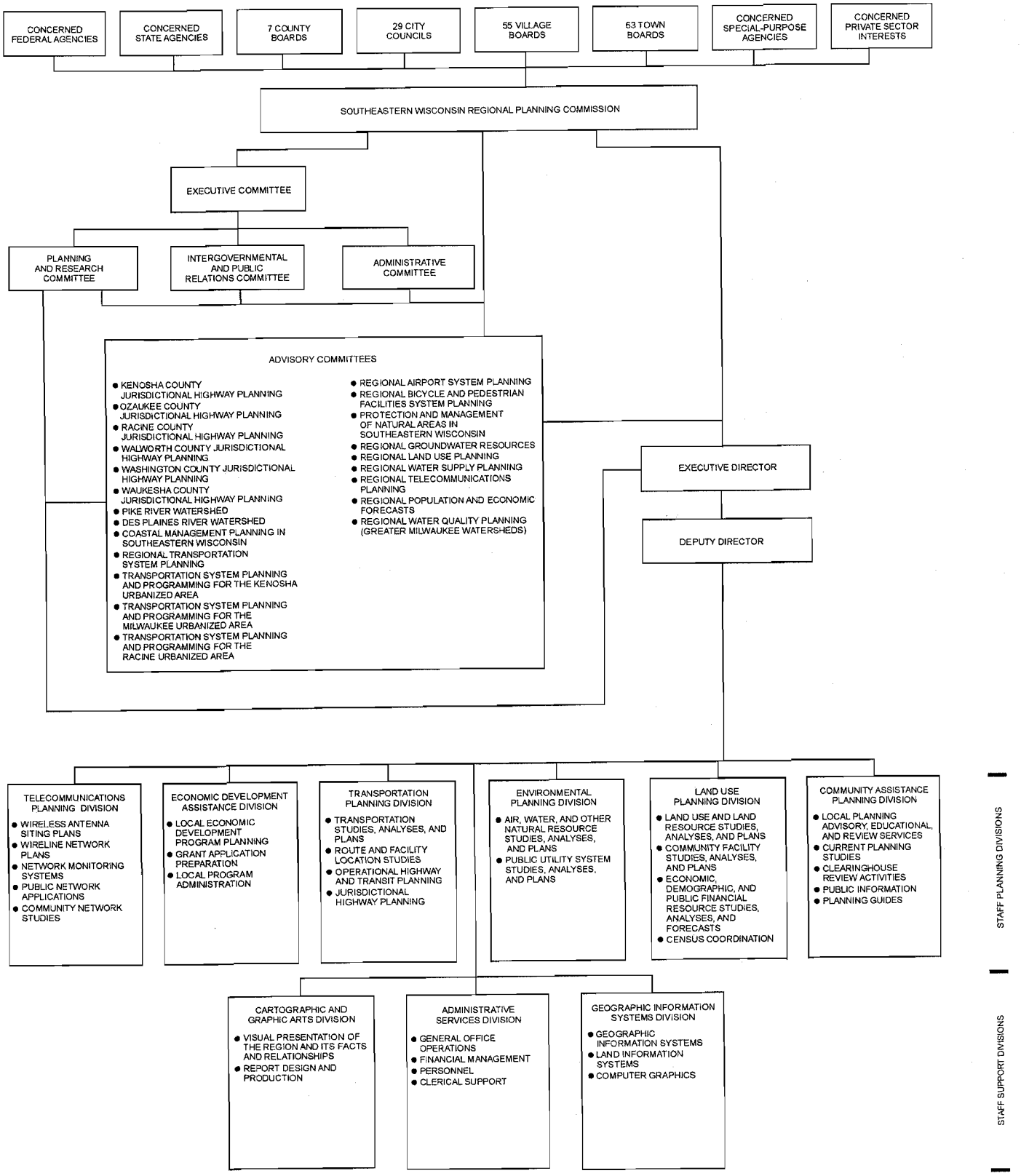
Regional planning, as conceived by the Commission, is not substitute for, but a supplement to, local, state, and federal planning. Its objective is to assist the various levels and units of government in finding cooperative solutions to areawide developmental and environmental problems which cannot be properly resolved within the framework of a single municipality or county. As such, regional planning 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 long-range plans for the physical development of the Region, these plans being limited to functional elements having areawide significance.

## Figure 1

## SEWRPC ORGANIZATIONAL STRUCTURE: 2005



3. Plan Implementation: promotion of plan implementation by providing a center to coordinate the planning and plan implementation activities of the various levels and agencies of government in the Region and by providing the introduction of information on areawide problems, recommended solutions to these problems, and alternatives thereto, as part of 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 between the governmental agencies and private enterprises responsible for the development and maintenance of land uses in the Region and for the design, construction, operation, and maintenance of the supporting public and private facilities. All Commission work programs are intended to be carried out within the context of a continuing overall planning program which provides for periodic re-evaluation 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 Southeastern Wisconsin Planning Region, as shown on Map 1, is comprised of Kenosha, Milwaukee, Ozaukee, Racine, Walworth, Washington, and Waukesha Counties. Exclusive of Lake Michigan, these seven counties have a total of 2,689 square miles, or about 5 percent of the total land and inland water area of Wisconsin, and a total resident population of about 1.97 million people. About 36 percent of the population of the State lives in these seven counties, which contain three of the fifteen metropolitan statistical areas which are wholly or partially located in Wisconsin. The seven counties provide about 1.19 million jobs, or about 36 percent of the total employment of the State. The Region contains real property valued at about $145.4 billion as measured in equalized valuation, or about 37 percent of all of the tangible wealth of the State, as measured by such valuation. The Region contains 154 local units of government, exclusive of school and other special-purpose districts, and encompasses all or parts of 11 major watersheds.

Geographically the Region is located in a relatively good position with regard to continued growth and development. It is bounded on the east by Lake Michigan, which provides an ample supply of fresh water for both domestic and industrial use, and is an integral part of a major international transportation network. It is bounded on the south by the rapidly expanding northeastern Illinois metropolitan region and on the west and north by the fertile agricultural lands and desirable recreational areas of the rest of the State of Wisconsin. Many of the most important industrial areas and heaviest population concentrations in the Midwest lie within 250 miles of the Region, and over 27.3 million people reside within this radius.

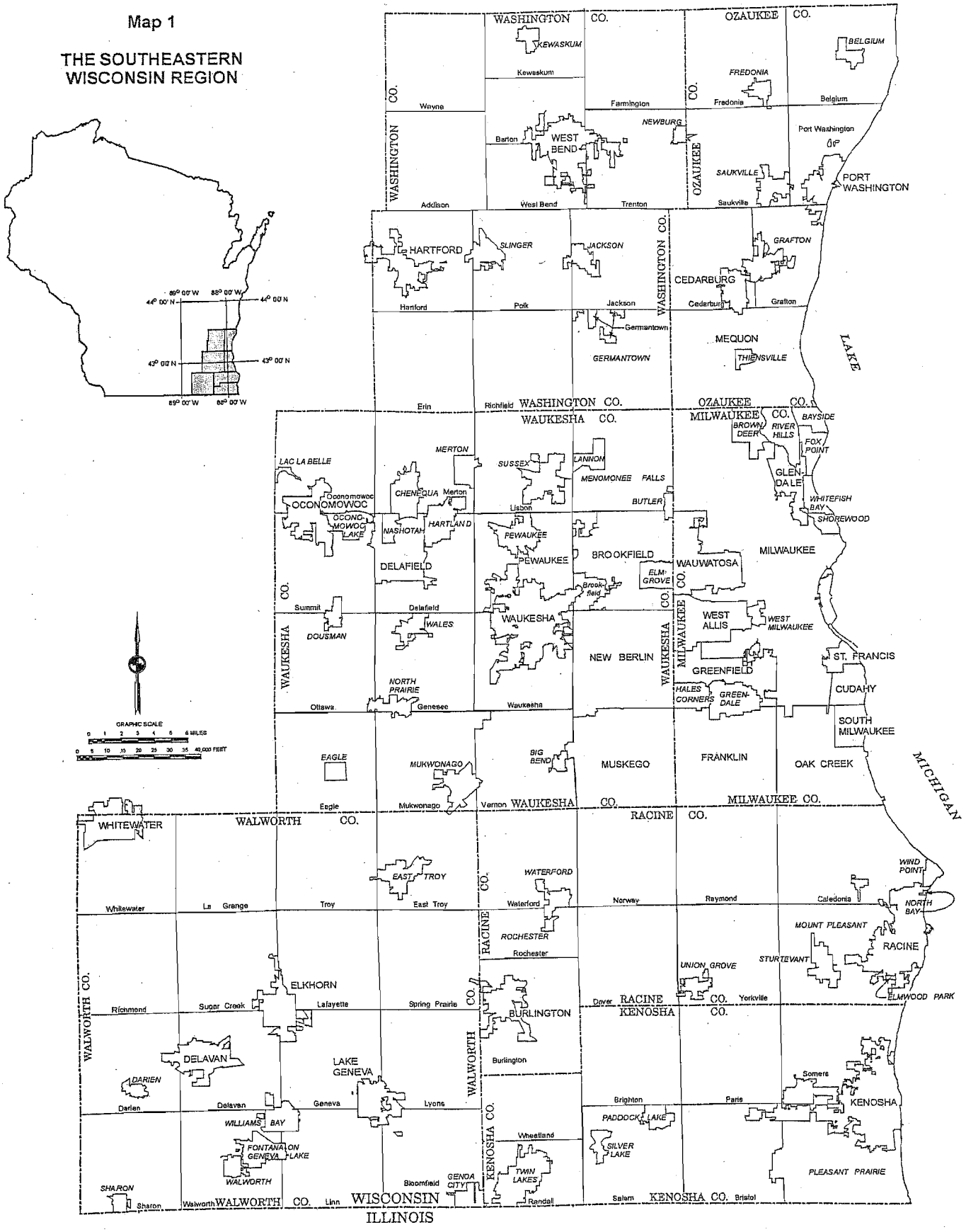
## COMMISSION WORK PROGRAMS TO DATE

Since its creation in 1960, the Regional Planning Commission has diligently pursued its three basic functions of areawide inventory, plan design, and promotion of plan implementation through inter-governmental cooperation and coordination, although the relative emphasis placed upon these functions has changed somewhat over time. Initially, major emphasis in the Commission's work program was on the inventory function, with increasing attention being placed over the years on the plan design and on the intergovernmental coordination functions.

With respect to the inventory function, the Commission's planning program, as conducted since 1961, has resulted in the creation of a data bank containing in a readily usable form the basic planning and engineering information required for sound, areawide planning. The data assembled in the regional data bank include, among others, definitive data on streamflows; floodlands; surface and groundwater quality; woodlands, wetlands, and wildlife habitat; sites having scenic, scientific, cultural, and recreational value; soils; existing and proposed land uses; travel habits and patterns; transportation system capacity and utilization; existing and proposed utility service areas; and

Map 1

THE SOUTHEASTERN WISCONSIN REGION




Source: SEWRPC.

the demographic and economic base and structure of the Region. The data base also includes an extensive topographic and cadastral base mapping and horizontal and vertical survey control file. In wireless networks, the inventories include a comprehensive layout of antenna sites in the Region along with the areal coverage of these sites for the various wireless frequency bands and radio technologies.

Some of the data in the regional planning data bank have been assembled through the collation of data collected by other agencies. Data so assembled include data on highway and transit facility capacity, use, and service levels; transportation terminal facility capacity; automobile and truck availability; and population and economic activity levels. Much of the data in the regional data bank, however, have been assembled through original inventory efforts conducted by the Commission itself. Such inventory efforts have ranged from aerial photography, large-scale topographic and cadastral base mapping, and control survey programs; through extensive land use, woodland, wetland, wildlife habitat, potential park site, and public utility system inventories; to massive travel inventory, detailed operational soil survey, and streamflow gaging and water quality monitoring efforts. Wireless inventory data sources used by the Commission include federal databases such as the Federal Communications Commission and Federal Aviation Administration; permit records of local units of government; and data from wireless service providers.

The regional planning data bank is supported by an extensive data conversion, filing, and retrieval capability which permits the basic data to be readily manipulated and tabulated by various geographic areas, ranging in size from the Region as a whole down through natural watersheds, counties, and minor civil divisions to planning analysis areas, census enumeration districts and tracts, traffic analysis zones, U.S. Public Land Survey sections and quarter-sections, and, for certain data, urban blocks and block faces. Of increasing importance in the regional planning data bank is the Commission's automated geographic information systems capability. A key regional map file consists of land use data which have been digitized, allowing for automated map reproduction and related data analysis functions. The Commission's planning data bank provides valuable points of departure for all Commission work efforts and is, moreover, available for use by the constituent agencies and units of government and the private sector.

With respect to the plan design function, the Commission has placed great emphasis upon the development of a comprehensive plan for the physical development of the Region in the belief that such a plan is essential if land use development is to be properly coordinated with development of supporting transportation, telecommunications, utility, and community facility systems; if the development of each of these individual functional systems is to be coordinated with the development of each of the others; and if serious and costly developmental and environmental problems are to be avoided and a safer, more healthful and attractive, as well as more efficient regional settlement pattern is to be achieved. Under the Commission's approach, the preparation, adoption, and use of the comprehensive plan are considered to be the primary objective of the planning process; and all planning and plan implementation efforts are related to the comprehensive plan.

Telecommunication networks have become a vital resource in the physical development of metropolitan regions. Business firms, local units of government, educational facilities, and individual households all depend on communications in the conduct of their daily lives and high speed—broadband—communications for data and video as well as voice communications is becoming an integral part of a modern society.

The comprehensive plan not only provides an official framework for coordinating and guiding growth and development within a multi-jurisdictional urbanizing region, but also provides a good conceptual basis for the application of systems engineering skills to the growing problems of such a region. The comprehensive regional plan also provides the essential framework for more detailed physical development planning at the county, community, and neighborhood levels.

As previously noted, because the scope and complexity of areawide development problems prohibit the preparation of an entire comprehensive plan at one time, the Commission has determined to proceed with the preparation of

individual plan elements which together comprise the required comprehensive plan. By the end of 2003, the adopted regional plan consisted of 29 individual plan elements. Four of these elements are land use related: the regional land use plan, the regional housing plan, the regional library facilities and services plan, and the regional park and open space plan. Twelve of the plan elements relate to transportation. These consist of the regional transportation plan including highway and transit elements, the regional airport system plan, the transportation systems management plan, the elderly and handicapped transportation plan, the regional bicycle and pedestrian facilities plan, and detailed transit development plans for the Kenosha, Racine Waukesha, and West Bend urbanized areas and for Ozaukee, Washington, and Waukesha Counties. Eleven of the adopted plan elements fall within the broad functional area of environmental planning. These consist of the regional water quality management plan, the regional wastewater sludge management plan, the regional air quality attainment and maintenance plan, and comprehensive watershed development plans for the Des Plaines, Fox, Milwaukee, Menomonee, Kinnickinnic, Pike River, Root River, and Oak Creek watersheds. The final two plan elements consist of comprehensive community development plans for the Kenosha and Racine urbanized areas.

The telecommunications planning program is new to the Commission with the initial planning studies beginning in 2004. The program initiation was in recognition of the vital role of telecommunications in the regional economy. In form, it most closely resembles transportation planning, with both relating to infrastructure networks. It differs, however, in the rapid pace of technological change and the role of private carriers in plan implementation.

The Commission also carries on an active community assistance planning program, in which functional guidance and advice on planning problems are provided to local units of government and regional planning studies are interpreted locally so that the findings and recommendations of these studies may be incorporated into local development plans and plan implementation programs. Six local planning guides have been prepared under this program to provide information helpful in the preparation of local plans and plan implementation ordinances. The subjects of these guides are land subdivision control, official mapping, zoning, organization of local planning agencies, floodland and shoreland development, and the use of soils data in development planning and control. Telecommunications planning services will also be extended to local units of government as part of the Commission's community assistance program. Beyond the questions related to antenna siting, some communities may require assistance in assessing telecommunications service levels and needs. Other communities have expressed interest in the Commission providing comprehensive telecommunications plans for expanding broadband telecommunication services in their areas.

## TELECOMMUNICATIONS— DEFINITION AND IMPORTANCE

Telecommunication networks provide the infrastructure for information interchange in all advanced societies. Such networks are vital for the efficient production and distribution of goods and services in a modern economy. Telecommunication exchanges also serve to help weave the social and political fabric of modern day life. Recent and continuing advances in communications technology have allowed for information transfer at rates considered infeasible even a decade ago. Although originally developed for voice communication only, telecommunication networks now transmit data, video, and multimedia forms of information.

Varying rates of deployment of new communications technologies in different areas of the United States and in the rest of the world have produced one aspect of the so-called "digital divide,"[1] placing areas with outmoded telecommunication technologies at a competitive disadvantage in national and global commerce. Such disadvantaged areas are also prevented from introducing communications-based advances in fields such as

[1]The term "digital divide" is commonly used to refer to the differences between households, businesses and other organizations that, for whatever reasons, have access to personal computers and the Internet and those that do not. It can also be used to distinguish between areas that are underserved in that the areas do not have high speed data service available. Such underserved—or disadvantaged—areas may exist in urban, as well as rural areas.

telemedicine, public safety, education, environmental monitoring, and transportation that have major impacts on the quality of life. For all of the above reasons, telecommunications planning should be an important concern of elected and appointed public officials in a metropolitan region such as Southeastern Wisconsin.

One mode of telecommunications, terrestrial wireless communications, is advancing more rapidly than other modes such as traditional wireline and satellite wireless communications. Although the first commercial cellular wireless network did not become operable until 1983, wireless telephony is rapidly becoming the predominant form of local and long distance voice communication in the United States and elsewhere. Some countries in Europe and Asia, have higher rates of wireless telephone usage than does the United States. With the advent of the third generation (3G) of wireless communication technology, wireless is expected to become important in data and video as well as voice transmission. Beyond 3G networks, emphasis in this regional telecommunications plan is on fourth generation networks (4G) that will allow Southeastern Wisconsin to compete in a global economy. These 4G networks support data rates exceeding 20 megabits and are characterized as "big broadband" as compared to the "little broadband" of current telephone and hybrid cable networks which generally have throughput under six megabits per second. The comprehensive telecommunications plan alternatives will feature varying proportions of wireless and fiber wireline networks in access and backhaul networks depending on population density and other socio-economic variables.

## ADVISORY COMMITTEE

The long-established practice of the Commission has been to conduct major regional planning programs with the assistance of appropriately structured advisory committees. The membership of such committees was to be drawn, as appropriate, to include knowledgeable and concerned representatives of the constituent counties and municipalities; of concerned State and Federal agencies; of the academic community; and of concerned private businesses and industries. Accordingly, an Advisory Committee on Regional Telecommunications Planning was created by the Commission to guide the preparation of the recommended plans. The Committee consists of the following members:

Kurt W. Bauer, Chairman ..... Executive Director Emeritus, SEWRPC
William R. Drew, Vice-Chairman ..... SEWRPC Commissioner; and Executive Director, Milwaukee County Research Park
Roger Caron ..... President, Racine Area Manufacturers and Commerce
Bob Chernow ..... Chairman, Regional Telecommunications Commission
David L. DeAngelis ..... Village Manager, Village of Elm Grove
Michael Falaschi ..... President, Wisconsin Internet
Barry Gatz ..... Network Supervisor, CenturyTel
Michael E. Klasen ..... Director of Regulatory Affairs, SBC
J. Michael Long ..... Attorney at Law, Murn and Martin, SC
Jeff Lowney ..... Vice President/General Manager, Time Warner Telecom
Jeff Mantes ..... Commissioner of Public Works, City of Milwaukee
Jody McCann ..... Network Domain Manager, Wisconsin Department of Administration, BadgerNet
George E. Melcher ..... Director, Office of Planning and Development, Kenosha County
Paul E. Mueller ..... Administrator, Washington County Planning and Parks Department
Rob N. Richardson ..... Director, Racine County Information Systems
Steven L. Ritt ..... Attorney at Law, Michael Best & Friedrich
James W. Romlein ..... Managing Director, MVLabs, LLC
Bennett Schliesman ..... Director, Kenosha County Emergency Management/Homeland Security
Dale R. Shaver ..... Director, Waukesha County Department of Parks and Land Use
Michael Ulicki ..... Vice President and Chief Technology Officer, Norlight Telecommunications
Darryl Winston ..... Director of Data Services, City of Milwaukee Police Department
Gustav W. Wirth, Jr. ..... SEWRPC Commissioner

Special acknowledgement is due the following former members of the Committee: Kenneth Brown, RF Engineer, Nextel Communications, Inc.; Brahim Gaddour, Director of Network Operations, Time Warner Telecom of Wisconsin; and Paul R. Schumacher, former Program Manager, TriCounty Business Partnerships.

## PROSPECTUS

On December 4, 2002 the Commission authorized the preparation of a Prospectus for a Regional Telecommunications Planning Program. During the following year the Commission staff, under the guidance of a predecessor Advisory Committee, prepared a prospectus for a regional telecommunications planning program. This prospectus described in some detail the need for, and the major work elements of such a planning program. In December 2003, the Commission approved the initiation of a Regional telecommunications planning program based on this prospectus. The prospectus envisions the regional telecommunication plan to be comprised of two elements: a wireless antenna siting and related infrastructure plan; and an overall telecommunications network plan. In addition, the preparation of a technical report presenting the findings of an inventory of the existing regional telecommunications system and system performance; and a memorandum report on public enterprise networks were envisioned.

## NEED FOR REGIONAL TELECOMMUNICATIONS PLANNING

Based upon a careful examination of the historical background and of the current state of telecommunications facilities and services within the Region, the Advisory Committee that guided the preparation of the afore-referenced Prospectus concluded that seven factors contribute to the need for the conduct of a regional telecommunications planning program and the preparation of a regional telecommunications plan for Southeastern Wisconsin. These factors are:

1. The lack of comprehensive information on the state of telecommunications facilities and services within the Region readily available to county and municipal officials, businessmen and industrialists, and concerned citizens.

   In past years, comprehensive information on the Regional telecommunications infrastructure was available from the Public Service Commission of Wisconsin (PSC). The PSC no longer has any jurisdiction over the growth areas of the telecom infrastructure, i.e. the packet-switched wireline network and all wireless networks. Without such information, public planning of any kind is not possible.

   Quality of service information on telecommunication services within the Region is also lacking. Many users of data services are often unaware of the degraded nature of transmission rates provided in some parts of the Region. Remedies for the correction of service deficiencies often take extended time periods with increasing subscriber frustration. At the same time, information on levels of service is rarely publicized. A regional network monitoring system could assist significantly in identifying network deficiencies as well as publicizing service quality levels throughout the Region.

2. The increasing need for advanced telecommunication facilities and services to support the economic development of the Region.

   Currently, primary economic competitors of the Region include countries of East Asia—South Korea, Japan and increasingly China. Manufacturing jobs especially are moving from Southeastern Wisconsin to East Asia. East Asia is reported to be ahead of the United States and the Region in broadband telecommunications services—both in terms of transmission speeds and in lower costs of these services. A regional telecommunications plan would assist Southeastern Wisconsin in recovering and maintaining its competitive position in the global economy by identifying the telecommunications infrastructure required to prosper in the current economic environment.

3. The need to address the universal provision of adequate broadband telecommunication services within the Region.

   A long term public approach to planning for the universal provision of broadband services within the Region is needed. Such an approach requires the evaluation of alternative network configurations and technologies to ascertain what is in the best socioeconomic interests of the people of Southeastern Wisconsin.

4. The need to address differences in the provision of adequate telecommunication services in rural and other underserved areas of the Region.

   The governor in 2003 called for the provision of universal broadband communication services to all areas of Wisconsin as part of a needed economic development program. Creative network design innovations are required to make such universal coverage cost-effective in rural and disadvantaged areas in a more effective manner. Such innovations can be evaluated as part of a regional telecommunications planning process.

5. The need to develop special purpose public telecommunication networks within the Region for applications such as telemedicine, public safety, transportation, environmental monitoring, and education.

   Some of the greatest benefits of advanced telecommunications technology can result from the development of special public networks in areas such as emergency telemedicine, home health care telemedicine, air and water pollution monitoring, transportation system management, and education.

   Many of these public network applications are regional in scope and planning for such would be enhanced by a regional telecommunication planning program.

6. The need to assist local units of government in telecommunication network development.

   Wisconsin municipalities have authority to provide telecommunications services, and court decisions have upheld this authority. Over 25 municipalities have been certified by the Wisconsin Public Service Commission to provide competitive telecommunications services. The Village of Jackson, within the Southeastern Wisconsin Region, is creating a broadband telecommunication utility to provide telecommunication facilities and services within the Village. Municipalities choosing this route could significantly benefit from planning assistance at the regional level. All municipalities within the Region will, however, require planning assistance with respect to telecommunication issues, particularly as related to future wireless and broadband communications services. In this respect, it should be noted that Section 66.0295(2)(d) of the Wisconsin Statutes requires that local comprehensive plans specifically address telecommunications facilities as an integral part of the utilities and community facilities element of such plans.

7. The need to develop a well-conceived comprehensive broadband telecommunications systems plan for the Region.

   Technical advances in telecommunications particularly in low cost wireless broadband networks have emphasized the need for a comprehensive telecommunications system plan for the Region. Based on detailed investigations of alternative wireless and fiber based wireline technologies, the plan will recommend broadband communication alternatives for all parts of the Region from low density rural areas to urbanized villages and cities.

**PLAN DESIGN YEAR**

The wireless antenna siting and related infrastructure plan for the Southeastern Wisconsin Region is to have a plan design year 2015. This design year was selected to correspond with the year 2015 stage of a set of new land use and transportation system plans being prepared for the Region. These plans are to have a design year 2035 with

appropriate ten year stages. The plan design year of 2015 was also selected to provide a long-range, as opposed to a short-range, basis for the planning effort. Because of the rapidly changing economic, technological, regulatory, and market conditions concerned, private sector telecommunications planning efforts tend to be relatively short range, a five year time horizon often being used. A longer time horizon—10 years—was selected for the antenna siting and related infrastructure planning effort in order to permit the planning to reflect probable new technologies, including fourth generation (4G) wireless technology, and new versions of the Internet. The designation of a design year is not intended to preclude the earlier introduction of 4G technology, but only to specify the latest date by which such technology should be in use within the Region.

## SCHEME OF PRESENTATION

The findings and recommendations of the regional comprehensive broadband telecommunications system planning program are documented in this report. Following the Introduction, Chapter II sets forth the principles and concepts underlying the comprehensive broadband telecommunications planning program and outlines the major steps in the planning process. Chapter III presents the objectives of the comprehensive planning program and the standards by which alternative plans will be judged. Chapter IV documents the demographic, economic land use and transportation system inventory findings—the background conditions for the antenna siting plan. Chapter V documents the findings of the broadband telecommunications infrastructure inventory required for the planning effort. Chapter VI will describe the network monitoring system being established to collect performance data on the regional telecommunications networks over time. Chapter VII will present numerous alternative technologies together with an evaluation of these technologies in various urban, suburban and rural settings. The technologies are evaluated for both access and backhaul or core networks. The end products of the planning sequence will be a set of alternative plans with their associated benefits and cost together with a recommended plan. Two forms of plan design will be presented in Chapter VII– one for second/third (2G, 3G) generation wireless and one for fourth generation (4G) wireless. The 2G/3G plan will be a forecast/plan with projection of existing trends linked with a rational antenna siting plan. The 4G plan will be a true futures plan moving beyond current infrastructures and trends to a vision of wireless communications in years 2010 and beyond. Chapter VIII concludes with a summary of the findings and recommendations of the antennae siting and related infrastructure planning effort. Chapter VIII will deal with plan implementation for both public enterprise and commercial networks. Chapter IX concludes with a summary of the findings and recommendations of the regional comprehensive broadband telecommunications planning effort.

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*PRELIMINARY DRAFT*

**SEWRPC Planning Report No. 53,**
**A COMPREHENSIVE TELECOMMUNICATIONS PLAN**
**FOR SOUTHEASTERN WISCONSIN**

# Chapter II

# BASIC PRINCIPLES AND CONCEPTS

## INTRODUCTION

In the preparation of a the comprehensive telecommunications system plan, the Regional Planning Commission followed a systematic planning approach that combined traditional regional planning procedures with well established telecommunications system engineering procedures. This chapter describes the approach followed by the Commission in preparing the comprehensive telecommunications system plan. More specifically, this chapter details the major elements of the planning process and how the telecommunications system engineering was integrated into the regional planning process. Definitions are provided for the various technologies concerned, both wireless and wireline, together with the descriptive parameters that characterize the applications of these technologies.

## BASIC PRINCIPLES UNDERLYING THE REGIONAL PLANNING PROCESS

The planning process applied in the regional telecommunications planning effort is based on four basic principles. These are:

1. Telecommunications planning must be regional in scope. The need for and demand in telecommunication services develops over the entire urban region without regard to corporate limit lines. Thus, telecommunications planning cannot be accomplished successfully within the confines of a single municipality or a single county if that municipality or county is a part of a larger urban complex. The regional telecommunications system, which is comprised of wireless and wireline facilities and attendant services, must form an interoperable system over the entire region, a system which can adequately serve the developing telecommunication needs of the developing region.

2. Telecommunications planning must be conducted concurrently with and cannot be separated from land use planning. The land use pattern determines the amount and spatial distribution of the need and demand for telecommunication services; and for wireless communications, local use development has a major impact on radio propagation patterns.

3. Telecommunications planning must be comprehensive, considering in an integrated manner access, distribution and core networks using various wireless and wireline technologies for multiple service applications and media.

4. Private sector companies are significant providers of telecommunications services within the Region. These private sector companies independently prepare plans for the development of their networks; independently develop their own levels of service; and independently provide competitive services. Meaningful public telecommunication planning effort must recognize the existence of these private sector planning efforts; and pursue the public planning effort in close cooperation with the private providers, actively involving these providers in the public planning process.

## PLANNING PROCESS

The planning process used consisted of the following sequential work elements:

1. Formulation of Objectives and Standards
   A set of telecommunications facility and service objectives and standards were formulated. These objectives and standards emphasize the provision of areawide, low-cost, fixed, nomadic (laptop computer) and mobile broadband telecommunications facilities and services. The objectives are supported by a set of standards that provide quantifiable measures of availability, response time, throughput, and accuracy, the parameters that define the performance of a communications system that will meet the agreed upon objectives.

2. Conduct of Facilities and Services Inventory
   A sound planning process must be based upon factual data about the existing state of the system being planned. Such data are provided by an inventory function that for the communications infrastructure planning process includes the collation and collection of definitive information on the location of existing telecommunications infrastructure and on the technical specifications of the facilities. The inventory data are then used as inputs to the telecommunications network infrastructure planning process providing information on both communication needs and the ability of existing networks to service these needs. A second dimension to the inventory relates to network performance. A network monitoring system has been established at the Commission offices that provides a means for measuring the quality of the existing network services. A central server computer located at the Commission offices scans remote site transceivers located at various changing locations throughout the Region. The data collected from these scans is used to compile data on the quality of service within the Region.

   In order to be comprehensive, the inventory, in addition to infrastructure providing commercial service, also includes facilities that provide public support services.

3. Analyses and Forecasts
   Spatial forecasts of potential subscribers and the attendant call generation characteristics are based upon the year 2000 existing land use inventory and future land use plans prepared and maintained by the Commission. The basic areal unit of analysis is the U.S. Public Land Survey section, and approximately one square mile area.

4. Plan Design
   Plan designs are primarily generated based on two communications technologies: broadband wireless and broadband fiber wireline. These technologies compete in both access and core networks. The challenge of broadband communications system design is to select and deploy the most cost effective technology in urban, suburban and rural areas. Low density rural areas will generally favor wireless access networks with their low infrastructure cost and geographic coverage. High density urban areas, depending on their socio-economic characteristics, may support fiber-to-the premises networks. Business organizations with their

high volume data requirements are also strong candidates for ultra-high speed fiber communications. In plan design, studies of various land use categories will be made to establish the basis for selected wireless and wireline networks throughout the Region.

5. Plan Test and Evaluation
   A number of means exist for plan test and evaluation. The most commonly used is system simulation in which a dynamic model of the network is used to simulate the performance of the existing system—or of alternative planned systems—on a computer. Such simulation can take place at varying levels of detail from high level evaluations of system capacity based on statistical estimates of subscriber usage, to detailed investigations of network packet transmissions. Interest at the regional system planning level emphasizes models that view a network as a service provider. The objective of a modeling effort is to determine the system coverage and capacity and the level of service possible at various traffic loadings.

6. Plan Selection And Implementation
   Following public informational meetings and hearings on alternative wireless network plans, one of the alternative plans, or some composite version of these plans, will be adopted to help guide the short and long-range development of the regional telecommunications infrastructure within Southeastern Wisconsin. In presenting the alternative plans for public informational meetings and hearings, strong emphasis will be placed on the performance standards characterizing each alternative plan and how these standards relate to the capital investment and operating costs implicit in implementing each plan. Since one of the alternative plans will always represent a no-plan projection of current trends, these performance standards data will play a critical role in plan selection and adoption.

## INVOLVED TECHNOLOGIES

Although the above description of the planning process delineates the basic work elements of regional telecommunications planning, it does not define the various technologies and provider networks that will establish the scope of the planning program. This section describes these technologies and networks as well as the frequency bands involved in wireless planning in Southeastern Wisconsin.

### Mobile Wireless Networks

The major antenna site users—owners or renters—in Southeastern Wisconsin are the mobile cellular/ Personal Communication System (PCS) service providers such as Cingular, Sprint/Nextel and Verizon. Based on the Commission inventory data there were, in 2005, 1,010 antenna sites within the Region. These sites are a resource not only for their present applications in second generation (2G, 2.5G) networks, but also as a resource for co-location of 3G and 4G networks.

The emphasis for wireless 2G, 2.5G and 3G infrastructure planning will be on a regional set of antenna sites that will provide adequate coverage, capacity, and quality of service for the Region as such coverage, capacity and quality of service are defined by objectives and standards set forth in this report. Second generation networks are already in place. Planning issues will relate mostly to coverage and quality of service. Third generation networks are just coming on the scene in Southeastern Wisconsin. Primary planning decisions here relate to planned coverage of the various service providers and their selection of antenna sites.

Fourth generation (4G) wireless infrastructure planning will proceed with significantly different objectives and procedures. The primary objective of the 4G plan is to present an imaginative, big broadband (20-100 megabits/second) fixed and mobile wireless plan for the Region that provides universal, region-wide coverage at affordable costs to all citizens of the Region. Current mobile cellular networks operate in the 800-900 MHz frequency bands. PCS networks utilize the 1900 MHz band. Although 3G networks will continue to operate in these same bands, 4G systems will move to higher frequencies such as the 5.2-5.9 GHz range.

**Fixed Wireless Networks**

Fixed wireless networks in the Region are currently small in size as compared to their mobile cellular/PCS counterparts. They are, however, expected to expand rapidly in the next few years, particularly with the advent of WiMAX technology. Most fixed wireless systems are now managed by Internet Service Providers (ISPs). Because they operate in higher frequency ranges (2.4 GHz or 5.7 GHz), their radius of coverage is limited to about 3 miles from each base station. Since they serve subscribers at fixed locations, there is no need to provide wide coverage, but instead they locate in areas with higher population densities to enhance their revenue potential. Most fixed wireless operators deploy proprietary systems such as the Motorola Canopy System. They tend to serve local areas mostly within a single county. In the future, however, it is expected that larger scale fixed wireless networks will be deployed by larger service providers offering a region-wide broadband service alternative. The advent of WiMAX (IEEE 802.16)technology is expected to lead to a merger of fixed and mobile communications networks all based on Internet operation. Although wireless communications networks, fixed and mobile, are now generally confined to frequencies below 6 GHz, future systems, particularly mesh network systems, are expected to employ higher frequencies up to and including the 60 GHz band because of the faster transmission rates possible at these frequencies. Although shorter in range coverage and subject to strong atmospheric alternation, these frequency bands will play a role in multi-hop mesh network and other configurations. In some deployments, even free space near infrared optical links can expand performance capabilities.

**SUMMARY**

Regional planning for regional communications infrastructure development combines traditional planning procedures with the methodology of communications systems engineering. A six-step process is followed: beginning with the formulation of objectives and standards, and a determination of the current state of the system in terms of both infrastructure and performance. These two initial steps are followed by the preparation of forecasts of probable future demand for services which establishes the requirements for network coverage and capacity. Alternative plans meeting these requirements are then prepared, tested, and evaluated. The plan test involves computer simulation modeling that permits the evaluation of each alternative plan in terms of ability to meet the objectives and standards. The best plan is then selected for adoption and implementation. Implementation takes place in the form of guidance to private service providers and regulatory agencies concerned; or directly through public sector applications. The regional telecommunications planning process encompasses both fixed and mobile wireless in both their present second (2G) and (3G) generations and fourth generation (4G) technology that merges fixed and wireless telecommunication into one Internet based infrastructure.

**SEWRPC Planning Report No. 53,**
**A COMPREHENSIVE TELECOMMUNICATIONS PLAN**
**FOR SOUTHEASTERN WISCONSIN**

# Chapter III

# OBJECTIVES, PRINCIPLES, AND STANDARDS

## INTRODUCTION

Planning is a rational process for formulating and meeting objectives. Therefore, the formulation of objectives is an essential task which must be undertaken before a comprehensive plan can be prepared and evaluated. Objectives guide the preparation of plans and, when converted to specific measures of plan effectiveness, termed standards, provide the structure for evaluating how well the plan meets planning objectives. Because planning objectives provide this basis for plan preparation and evaluation, the formulation of objectives is a particularly important step in the planning process.

Accordingly, a set of recommended objectives with supporting principles and standards was formulated as a part of the telecommunications infrastructure planning effort. The associated standards perform an important function in plan design since they provide the basis for relating the objectives to alternative plan configurations.

It is important to note that the objectives, principles, and standards presented herein are intended to serve as a basis for determining desired alternative and recommended telecommunications infrastructure. The standards, particularly, must be applied with judgment in the more detailed public and private planning and engineering studies which will be needed during plan implementation. The objectives, principles, and standards formulated herein relate to all portions of the comprehensive regional telecommunications plan to be prepared by the Regional Planning Commission. The comprehensive plan will include both wireless and wireline elements relating to core as well as access networks. The objectives, principles, and standards presented herein will also apply to all segments of the comprehensive plan.

It is also important to note that the objectives, principles, and standards presented herein were formulated within the context of other objectives, principles, and standards previously adopted by the Regional Planning Commission. These other objectives, principles, and standards relate to socio-economic, land use, transportation, and sewerage system development within the Region and to environmental protection and enhancement. As such, the telecommunications system development objectives, principles, and standards are intended to support these other regional development objectives, principles, and standards.

## DEFINITIONS

The terms "objective," "principle," "standard," "plan," "policy," and "program" are subject to a range of interpretations. To clarify their meanings, the Regional Planning Commission has defined these terms as they are used within the context of this planning process as follows:

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

2. Principle: A fundamental, 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 with only the first four of these terms, an understanding of their interrelationship and the concepts they represent is essential to the following discussion of objectives, principles, and standards.

To be useful in planning, objectives must be logical and clearly stated. The consideration of objectives for plan design and evaluation is facilitated by complementing each objective with one or more quantifiable standards. These standards are, in turn, directly related to a planning principle which supports the objective. The objectives relate primarily to the provision of wireless broadband telecommunications services within the Region, and to the desired performance of the system, its availability, and the overall quality of service. Each objective, together with its supporting principle and standards, is given in the following section. The following objectives, principles and standard, or standards are intended to be used in the formulation and evaluation of alternate telecommunications infrastructure plans and in the preparation of a recommended plan that will provide 4G wireless telecommunication services within the Region.

In considering the objectives and supporting standards set forth in this Chapter, it should be recognized that those objectives and supporting standards are intended to be applied at the system planning level, and that the effect of individual facilities on each other, or on the system as a whole, requires the application of mathematical models to quantitatively test alternative systems, thereby permitting adjustment of the subsequent configuration of the system concerned to meet the existing and forecast demand. It should also be recognized that an overall analysis of each alternative system plan considered must be made on the basis of cost. Such an analysis may show that the attainment of one or more of the standards is beyond economic practicality, and that the standard or standards concerned cannot be achieved and must be either reduced or eliminated. It should also be recognized that it is unlikely that any one plan proposal will meet all of the standards fully; and the extent to which each standard is met, exceeded, or violated must serve as a measure of the ability of each alternative plan considered to achieve the specific objectives which the given standard or standards compliment. It should be further recognized that certain objectives and standards inherently may be in conflict, requiring resolution through compromise; and that meaningful alternative plan evaluation can only take place through comprehensive assessment of each alternative plan considered against all of the objectives and standards. The selected plan will thus represent a compromise with respect to meeting conflicting objectives supporting standards. Finally, it should be recognized that the standards must be judiciously applied to areas which are already partially or fully served in order to avoid any unreasonable extensive reconstruction programs. Given the important role of the private sector in providing telecommunications facilities and services within the Region, and given the concern of these providers about the continued freedom to operate independently in a competitive market, it is important to note that the following objectives, principles, and standards are not intended to have any regulatory implications, but are intended for use solely in plan preparation and evaluation.

## OBJECTIVES, PRINCIPLES, AND STANDARDS

### Objective No. 1—Broadband Telecommunications Performance

A level of broadband telecommunications performance that is competitive in a global economy and supports cost effective enhancements of public sector services.

### Principle

High quality telecommunication services are vital to the expeditious conduct of national and international business and industrial transactions, and to prompt responses to emergencies. To be competitive in a global economy, the Region requires advanced, low cost broadband telecommunications services, which can be provided by either wireline or wireless telecommunications technology. The services should have a level of availability and continuity which facilitate business and industrial transactions, but which also ensure prompt responses to emergencies.

### Standards

- Broadband wireless services should provide a transmission rate in the range of 20 to 200 megabits per second.[1]
- Broadband wireless communication networks should be available 99.9 percent of the time.[2]
- Voice service should be provided at a minimum MOS Standard Value of 4.0.[3]

### Objective No. 2—Universal Wireless Broadband Telecommunications Services

The provision of broadband wireless telecommunication services to all geographic areas of the Region.

### Principle

Residents and organizations of the Region, regardless of geographic location, should be offered an equal access to broadband telecommunications services in order to promote the social and economic welfare of the Region.

### Standards

- Broadband wireless network coverage should be provided in all geographic areas of the Region and should be available to all residences, businesses, industries, and organizations of the Region.

### Objective No. 3—Redundancy

The provision of alternative transmission paths through the individual providers of telecommunication networks so as to minimize network congestion, reduce susceptibility to interference, and provide high immunity to catastrophic failure.

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[1]The generally accepted range for both IEEE 802.16a, d and 4G wireless networks is 20 to 100 megabits per second. The high end target value was raised to meet the needs of high definition television on demand.

[2]While wireline telephone service has a general availability standard of 99.999 percent (equivalent to a total of 3 minutes down time per year), wireless service availability has not yet reached this level. The standard of 99.9 percent (equivalent to a total of 8.6 hours of down time per year) is believed to represent an achievable goal by the plan target year 2015.

[3]Mean Opinion Score, (MOS) was originally defined based upon a subjective evaluation of voice quality by a group of listeners. It is now objectively defined as an ITU-T P.800 specification, and is determined from a standard formula based upon signal to noise ratio (SNR), line delays, and other factors. The value ranges from 1.0 to 5.0, corresponding to lowest and highest levels of voice quality satisfaction.

**Principle**
Robust and reliable networks are required in a communications dependent economy and society and in emergency situations.

**Standard**

- Redundancy is measured based on the average number of alternative transmission paths between users in a network. Desirably, the ratio of the average number of alternative transmission paths to the total number of links in the network should be at least 20 percent.[4]

**Objective No. 4—Antenna Site Number Optimization**
The number of wireless antenna site locations within the Region should be optimized.

**Principle**
Optimization of the number of antenna sites within a planning area is consistent with minimization of infrastructure investment costs, with the provision of redundancy in the service of each individual provider, and with promotion of environmental protection and the pursuit of a high aesthetic quality in the land and cityscape.

**Standard**

- The number of antenna sites should be the smallest number that provide universal coverage and quality of service within the Region.

**Objective No. 5—Serve Most Demanding Application**
Telecommunications systems should be designed to serve the most demanding expected system application, thereby permitting all applications to be accommodated.

**Principle**
The planned telecommunication system should not preclude needed applications of the system.

**Standard**

- The planned network bandwidth should be the broadest possible with projected technologies within the planning period; approximately 200 megabits per second.

**Objective No. 6—Network Infrastructure Cost Minimization**
Achieve the provision of wireless telecommunication networks which are both economical and efficient, meeting all other objectives at the lowest cost possible.

**Principle**
Minimization of capital and operating costs conserves limited public and private capital resources. Any undue investment in telecommunication facilities and services must occur at the expense of other public and private investment; therefore, total telecommunication costs should be minimized for the desired level of service.

[4] This standard value was based on partial mesh paths in a full mesh topology where the number of links L=N(N-1))/2; and N=number of nodes in network.

**Objective No. 7—Antenna Site Aesthetics and Safety**

A high aesthetic quality and safe design in the telecommunication antennae and supporting structures and equipment with proper visual relation to land and cityscape.

**Principle**

Beauty and safety in the physical environment are conducive to the physical health and well-being of people; and as major features of the land and cityscape, telecommunication facilities have an important impact on the aesthetic quality of the total environment. In order to ensure public safety, careful attention must always be given to structural design principles and practices, including careful conformance to existing regulatory codes.

**Standards**

- Telecommunication facilities should be located to avoid the destruction of visually pleasing buildings, structures, and natural features, and to avoid interference with visitors to such features.
- Co-location on existing antenna sites is preferred over new antenna support structure deployment.
- Antenna locations on existing buildings, or other existing structures are preferred over new antenna tower construction.
- Antenna structures should be designed, constructed and maintained to insure a safe environment.
- Antenna support structure heights should be minimized consistent, however, with maximizing the potential for antenna co-location, and with providing a potential for height extension and capacity expansion.

**Objective No. 8—Preference For Use In Public Safety Emergencies**

A broadband telecommunications network that assures capacity for, and provides preference to police, fire, emergency medical, and homeland security agencies for use in times of public emergencies.

**Principle**

The potential for interagency communication by police, fire, emergency medical, and homeland security agencies in times of public emergencies—such as national disasters including flooding and wind, snow and sleet storms, and freezing rain, and in times of culturally related disasters such as fire, explosions, nuclear electric power generation plant failures, and terrorist attack, must be protected and preserved.

**Standard**

Public safety related multi-media traffic should be assigned the highest priority based on network port designation and assignment.

## UNIVERSAL BROADBAND SERVICE AND AFFORDABILITY

The Commission Advisory Committee recognized the need to define universal broadband telecommunications service in terms of affordability as well as geographic coverage. The Committee could not, however, agree on the percentage of gross monthly household income which should as a maximum be allocated to broadband telecommunication service. The Committee concluded that the issue of affordability needs to be addressed by the Congress and the President at the national level and that adoption of an affordability standard by the Commission should await action at the national level.

## APPLICATION—SPECIFIC REQUIREMENTS

The wireless communications performance standard of 20 to 200 megabits per second specified above is ultimately justified based on network applications. The term broadband is often confusing to many as a measure of data transmission rate since it is measured in Hertz (cycles per second). Data transfer rate, however, is measured in bits per second or more typically in megabits (millions of bits) per second. The term broadband derives from the radio frequency spectral bandwidth licensed to a particular service provider or unlicensed to the general public. This bandwidth is measured in Hertz or in the broadband range megahertz (millions of cycles per second) or gigahertz (billions of cycles per second). High data transfer rates require wide or broadband widths. The ratio of data transfer rate to bandwidth expressed in percentage is spectral efficiency. With 100 percent spectral efficiency, 100 megahertz of bandwidth allows for a data transfer rate of 100 megabits per second.

Wide bandwidths and fast data transfer rates are important only as they relate to applications. DSL and cable broadband are often sold to consumers based on faster downloads of Web pages many of which contain images and video. The objectives and standards for this wireless infrastructure plan must also consider other potential public sector and private sector applications that create the need for broadband telecommunication networks.

The dominant underlying media in all advanced broadband applications is video. A brief summary of the bandwidth requirements of the three predominant media reveals the sharp differences in media bandwidth requirements:

1. Voice—64 kilobits per second

2. Data—1 megabit per second

3. Video—5 to 200 megabits per second

Even though many applications require a mix of media to be effective, video bandwidth needs are so much larger that they predominate in multimedia bandwidth specifications. Video band width requirements are a function of: format resolution, frame rate, modulation methods, and compression technology.

For one form of video communications, video conferencing, a range of bandwidth requirements based on international standard H.323 are:

1. VCR Quality Resolution: 352 x 288 pixels—3.8 megabits per second

2. TV Quality Resolution: 740 x 480 pixels—13.4 megabits per second

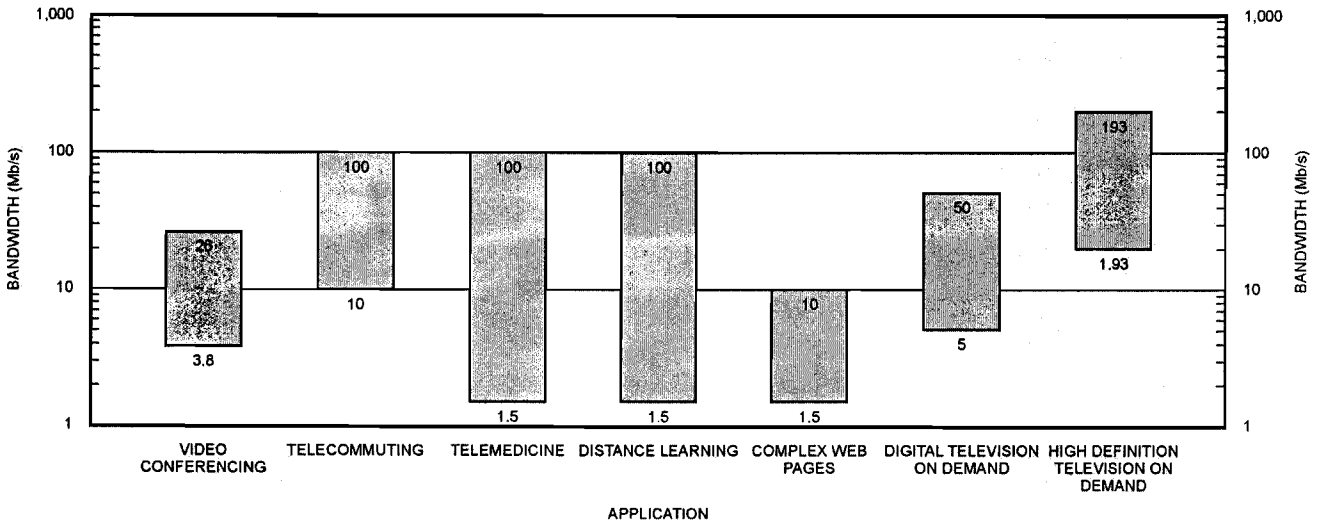
Video teleconferencing plays a key role in many public and private applications of broadband including areas such as telecommuting, home healthcare, and distance learning. It, therefore, represents a key capability in terms of broadband performance. It may, in fact, be the primary application for public sector, business and professional uses of the system.

In the consumer domain, television in both its standard and high definition formats is the equivalent driving force for major broadband capabilities. To accommodate 10 channels of high definition digital television on demand, a network with a bandwidth of about 193 megabits per second will be required. Such an Internet based capacity would allow potential users to purchase televised entertainment services from any content provider serving the Internet.

These two primary examples are given to illustrate the need for a "big broadband" communications capability. It is not possible, or appropriate, to review all potential broadband applications. To indicate the future scope of broadband communications, however, a display of a number of applications and the attendant bandwidth needs are shown in Figure 2.

**Figure 2**

**APPLICATIONS SPEED MATRIX**

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# WISP'ers

Wireless Internet Service Providers

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## Concordia Res Parvae Crescent

**Headline News:**



## *General News*

### EarthLink fires up Anaheim CA.

The same day EarthLink announced its Muni-Wi-Fi network, EarthLink's executive for Municipal Networks, Olivia Hecht got an earful from PART-15.ORG's Chairman Michael Anderson regarding the interference issues and other concerns associated with Muni Wi-Fi. Organizers of WCA 2006 provided an opportunity to examining Muni Models and other public safety deployments.

Anderson appeared to be the only one on the panel with concerns about interference in the Wi-Fi spectrum, while other panel members seemed more ready to sell their wares to the audience. Anderson also relayed to the attendees of the importance not to rely on LE spectrum for municipalities first choice for emergency services

Steve Lowe from Tropos Networks explained features of it's dual-band radios which provide 4.9GHz (Government use only spectrum) backhauls and Wi-Fi for community access. However, Anderson spoke up and mentioned that it would be a violation of FCC rules for the municipality to allow public access over the Wi-Fi system if it was being backhauled over the government (4.9GHz) spectrum.

Panel members included: Dr. Weston E. Vivian, President, Vivian & Associates, former Member, U.S. Congress & Member, Michigan's Washtenaw County "Wireless Washtenaw" Business Plan Committee, Moderator; Olivia Hecht, EarthLink Municipal Networks; Martin Suter, CEO, Cohda Wireless; Michael Anderson, Chairman, Part-15.ORG & CIO, PDQLink (Illinois) & Member, FCC "Independent Panel Reviewing The Impact Of Hurricane Katrina Communications Networks"; and Steve Lowe, Vice President, Tropos Networks