

MINUTES OF THE SEVENTEENTH MEETING
REGIONAL TELECOMMUNICATIONS PLANNING
ADVISORY COMMITTEE (Reconstituted)

DATE: February 6, 2007

TIME: 2:00 P.M.

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

Members Present

Kurt W. Bauer	Executive Director Emeritus, SEWRPC
Chairman	
William R. Drew	Vice-Chairman, SEWRPC; Executive Director, Milwaukee County
Vice Chairman	Research Park
Bob Chernow	Chairman, Regional Telecommunications Commission
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
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
Dale R. Shaver	Director, Waukesha County Department of Parks and Land Use
Michael Ulicki	Vice President and Chief Technology Officer, Norlight Telecommunications
Gustav W. Wirth, Jr.	SEWRPC Commissioner

Members Absent

Roger Caron	President, Racine Area Manufacturers and Commerce
David L. DeAngelis	Village Manager, Village of Elm Grove
Jeff M. Lowney	Vice President/General Manager, Time Warner Telecom
Jeff Mantes	Commissioner of Public Works, City of Milwaukee
Bennett Schliesman	Director, Kenosha County Emergency Management /Homeland Security
Darryl Winston	Director of Data Services, City of Milwaukee Police Department

Staff

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.

Chairman Bauer noted that with a memorandum dated January 29, 2007, all Committee members had received a revised agenda for the meeting. He noted that the original agenda for the meeting had been transmitted to all Committee members on January 5, 2007, with the notice of the meeting. The revised agenda, he noted, added an item of business to the original agenda, namely, Agenda Item No. 5: consideration of the draft of an outline for Chapter VII of SEWRPC Planning Report No. 53.

CONSIDERATION OF THE MINUTES OF THE MEETING OF NOVEMBER 14, 2006

Chairman Bauer noted that copies of the minutes of the sixteenth meeting of the Reconstituted Regional Telecommunications Planning Advisory Committee held on November 14, 2006, had been distributed to all members of the Committee for review prior to the meeting. He asked the Committee to consider approval.

There being no corrections or additions, on a motion by Mr. Wirth, seconded by Mr. Melcher, and carried unanimously, the minutes of the meeting of November 14, 2006, were approved as submitted.

CONSIDERATION OF REVISED PRELIMINARY DRAFT OF CHAPTER V "TELECOMMUNICATIONS BROADBAND INFRASTRUCTURE INVENTORY FINDINGS" OF SEWRPC PLANNING REPORT NO. 53, *A REGIONAL COMPREHENSIVE BROADBAND TELECOMMUNICATIONS PLAN FOR SOUTHEASTERN WISCONSIN*.

Chairman Bauer noted that a preliminary draft of Chapter V "Telecommunications Broadband Infrastructure Inventory Findings" of SEWRPC Planning Report No. 53, *A Regional Comprehensive Broadband Telecommunications Plan For Southeastern Wisconsin*, had been reviewed by the Committee at its meeting held on November 14, 2006. At that meeting, the Committee had directed that a number of changes be made in the draft and had acted to postpone approval of the Chapter to its next meeting. He noted that a copy of a revised preliminary draft of Chapter V had been provided to all members of the Committee for review prior to the meeting. The revised draft, he noted, was intended to reflect all of the changes which the Committee directed be made to the preliminary draft. He noted further that in accordance with the Committee's direction, certain of the revisions had been submitted to Messrs. Gatz and Klasen for review and comment, and that the revised draft was also intended to reflect the comments of that review.

Chairman Bauer then asked Dr. Schlager to undertake a review of the revised preliminary draft with emphasis upon the changes made in the preliminary draft in response to the Committee's initial review of this Chapter. The following comments were made, questions were raised, and actions were taken in the course of the review.

With respect to page 2, Mr. Klasen noted that the staff, as requested by the Committee, had added a fourth technology to the list set forth in the last sentence of the first paragraph on the page. He noted that the introductory phrase of that sentence, however, still referred to three technology categories, and that this should be changed to four. He indicated that the same change should be made to the first paragraph under the heading, "Broadband Wireline Service Area Inventory," on page 3.

Mr. Klasen noted that Map 4 on page 9 had been quite properly revised to show that the service areas concerned did not as a general rule extend past exchange area boundaries. He noted that there was,

however, one exception to that rule relating to the service area in the Muskego area of Waukesha County. In this case, he said, the service area boundaries concerned should extend into the adjacent central office service area. He indicated that this exception would also affect Map 5, and the percentage service area coverage given the text.

In answer to a question by Mr. Chernow, Mr. Klasen indicated that AT&T was providing fiber optic cable service directly to the premises for the Pabst Farms development of Waukesha County. He indicated further, that the company was also deploying fiber optic cable service directly to the premises for certain new subdivision developments; and that presently at least 24 new subdivisions within the Region were receiving, or were scheduled to receive, such direct service.

Mr. Klasen suggested that given the changes made to Maps 4 and 5, the percentage figures given in the first paragraph on page 14 be checked and revised as necessary, and that the numbers given on page 14 be reconciled and made consistent with the numbers given on pages 7 and 10.

Mr. Chernow suggested, and the Committee agreed, that the text on page 34 concerning satellite broadband telecommunication service be expanded to reference the service provided by geosynchronous satellites.

[Secretary's Note: A geosynchronous (GEO) satellite is a satellite whose orbital track on the Earth repeats regularly over points on the Earth over time. If such a satellite's orbit lies over the equator, it is called a geostationary satellite. Such satellites to be geosynchronous must orbit at an altitude of 22,369 miles so as to have an orbital period of 23 hours and 56 minutes, the same as the Earth's rotation period.

A geostationary satellite appears to be fixed in one location above the equator. Other GEO satellites are stationary over other locations on the earth's surface. All GEO satellites have an inherent time delay of about 0.25 seconds for a round trip to and from the satellite. Such delays preclude their use in voice communications. GEO systems also require the use of expensive, bulky directional antennas that must be pointed and calibrated to acquire a satellite. Low earth orbit (LEO) satellites, in contrast, use small omnidirectional antennas that do not require calibration. GEO satellites also do not interface well with the Internet and its TCP/IP protocol. For all of these reasons, GEO satellites are best used for television broadcasting and high-speed data transmission.]

Mr. Klasen indicated that, in his opinion, the section on enterprise networks required major expansion. He noted that the primary reason that the Commission has given for undertaking a telecommunications planning effort was to ensure the continued economic viability of the Region and to enhance the ability of the Region to compete with other Regions of the United States and world for economic development. Chapter V is focused almost entirely, he said, on providing, ubiquitously, broadband service to households, and lacked identification of the infrastructure required and provided to serve high-end customers -- customers that need enterprise network service -- and that are the primary drivers of economic development within the Region. He indicated that in his opinion, the Commission should be concerned about how this Region compares to other major urban regions in this respect. By not including a "points of presence" inventory for use by institutions that require enterprise networks, a significant body of information is missing from the Chapter. The sole concern, he said, about service to individual households left a major aspect of the availability of broadband service within the Region unaddressed. Finally, he indicated, that in his opinion the Commission staff could obtain the data needed from the

Federal Communications Commission database and from data sources available off the Internet. The omission, he concluded, was a major flaw in the presentation, since that presentation purports to present a comprehensive inventory of land line service provided within the Region.

A lengthy discussion ensued in which Mr. Chernow agreed with Mr. Klasen's observation. Mr. Klasen observed that the fact that there are within the Region multiple providers of the facilities and services required for enterprise networks may, in fact, make this Region competitive with respect to other regions of the United States. Mr. Richardson also agreed with Mr. Klasen's observation, noting that the Racine area had lost some potential new economic enterprises because of a lack of the type of service being discussed.

Dr. Schlager indicated that conduct of the type of inventory being discussed would constitute a major undertaking. Mr. Klasen reiterated his observation that the Commission claims to be putting forth a planning document which identifies unmet telecommunication needs within the Region, but which ignores an important consideration in the location of major economic enterprises.

Mr. Evenson observed that Mr. Klasen's comments were well taken, but Commission staff response would depend upon the availability of the data required. Mr. Klasen responded that he would be willing to commit to a review of the data provided to the Federal Communications Commission with respect to the recent merger creating the AT&T in order to determine how much of that data was in the public domain and could be provided to the Commission. That, he said, may provide one source of the needed data, but there may be a number of other sources that are designed to assist economic enterprises in considering locations between, and within, metropolitan areas.

Mr. Ulicki observed that there were important considerations other than the availability of telecommunication services that determine the location of large and small economic enterprises between, and within, metropolitan areas.

In answer to a question by Mr. Wirth, Mr. Klasen indicated that he believed that institutions that need enterprise networks do have a number of very good options to choose from within this Region; there being an extensive network of fiber optic cables in place, and that with some effort the information that would allow the Commission to make some statements about how well this area is able to meet the needs of institutions that need enterprise networks, as compared to other metropolitan areas, can be collected.

Mr. Falaschi observed that the proposed inventory would be complex and require detail knowledge about the core networks of the Region. What is needed, he said, is such information about the core networks as: where are the fiber optic cables located, where are the junction points, and where are the points of presence -- information that enterprise network customers require in making location decisions.

Upon conclusion of the discussion it was the consensus of the Committee that the staff should expand the section of the Chapter dealing with enterprise networks, to include -- to the extent practicable -- the information required by economic and other institutions that desire to have enterprise networks in considering locations within the Region. The result of the staff effort, Chairman Bauer said, would be reported in a text addition provided to the Committee for review at its next meeting as a part of the minutes of this meeting.

There being no further questions or comments, on a motion by Mr. Chernow, seconded by Mr. Melcher, and carried unanimously, Chapter V "Telecommunications Broadband Infrastructure Inventory Findings" of SEWRPC Planning Report No. 53, *A Regional Comprehensive Broadband Telecommunications Plan For Southeastern Wisconsin* was approved as amended, and subject to the provision by the staff in the minutes of the meeting of an expanded text on enterprise networks which would provide -- to the extent

practicable -- data on the core optical fiber networks serving the Region, that would be useful to economic and other major enterprises and institutions that desire to utilize private enterprise networks in their operations in making location decisions.

[Secretary's Note: The following text beginning on page 35 replaces in its entirety the second paragraph on page 35 as provided in the preliminary draft of Chapter V.

The regional telecommunications planning program was originally envisioned to address telecommunications networks that either performed governmental functions, such as public safety, or offered services to the general public. Enterprise networks were not intended to be addressed except peripherally. Maintaining the economic viability and competitiveness of the Southeastern Wisconsin Region, however, was a major objective of the planning program. And, the availability of fiber optic cable core network facilities is an important factor in regional economic development. For this reason, an attempt was made in the planning program to map the location and geographic availability of the existing fiber optic cable core network serving in the Region.

In this respect, it is important to note the somewhat divergent needs of small, medium and large scale businesses and industries within the Region. Small businesses generally rely on residential telecommunications networks for reasons of cost, scale and geographic availability. For this reason, universal geographic availability of broadband communications is an important factor in regional economic development. Data published by the U.S. Small Business Administration (SBA) indicate that over 50 percent of all small businesses may be expected to be home-based and therefore widely distributed geographically. Other small business enterprises also tend to be similarly widely dispersed geographically throughout an urban region. Small businesses play a vital role in the growth of the regional economies. Data published by the SBA indicate that from 1996 to 2006, 60 to 80 percent of net new jobs created annually at the national level were created by small business enterprises. Many of these businesses are based on new technologies. SBA data also indicate that small businesses produce 13 to 14 times more patents per employee than larger businesses that are active in patenting. An increasing number of these small businesses are information-oriented, and have need for high performance broadband communications. Given their home-based, or small facility-based, nature and their wide dispersion throughout an urban region, small businesses may be expected to benefit from broadband communications networks that cover the entire Region. Accordingly, the Commission telecommunications planning effort focused on services provided to the general public.

The importance of small business enterprises to economic development within the Region is confirmed by the following excerpts from the Jobs in the New Millennium report of the Wisconsin Policy Research Institute for the period 1999 through 2003.

1. Small Business

In the Metropolitan Milwaukee area -- Milwaukee Waukesha, Ozaukee and Washington Counties --small business employs 76.6 percent of all of the 799,690 private sector employees in the area. In Racine and Kenosha counties, the corresponding small business percentages are 78.7 percent, and 83.9 percent respectively. Nationally, small business provides about 50 percent of all private sector jobs.

2. Employment gains from 1999 through 2003 were confined to establishments with under 100 employees. Large businesses -- over 500 employees -- accounted for 60 percent of the employment losses even though they represented only 21.3 percent of the workforce.

The relatively higher percentage of small business employees in Southeastern Wisconsin along with their recent position as the only source of job growth make wide coverage regional broadband communications a high economic priority.

Medium and large-scale organizations present a somewhat different set of telecommunication requirements than small businesses. Such medium and large-scale organizations typically design and operate their own enterprise networks. The trend toward enterprise networks began with the breakup of the Bell System in 1984, and accelerated with the growth of large-scale national and international data networks. Although enterprise networks are typically designed and installed in cooperation with communications equipment vendors such as Cisco or Nortel Networks, all such networks have the need for land-line fiber optic cable links that provide the required bandwidth capacity to serve the communication needs concerned. Such core network service is typically arranged with core network carriers such as AT&T, Time Warner Telecom, Norlight Communications, or others within the Region. The capacity of the optical fiber cable network generally is not an issue. Most fiber core networks within the United States and the Region are underutilized. The real issue is geographic availability. Fiber optic cable core facilities do not exist in many parts of the Region. For this reason, a definitive, comprehensive map of the Regional fiber optic core network within the Region would provide a valuable resource.

The acquisition of such network layout information requires the cooperation of the core network providers themselves. At the small business level, broadband communications is synonymous with the residential networks. The telephone system Incumbent Local Exchange Carriers (ILECs), and the two regional cable companies, Time Warner Cable and Charter Communications, own the majority of the fiber optic cable facilities required for broadband connection. Although earlier attempts under the regional planning program to obtain detailed information on the core fiber optic cable networks were unsuccessful, the Commission in February 2007 determined to again seek the cooperation of the core optic cable facility providers in mapping those facilities.

In 2007, the major carriers serving the enterprise network fiber optic core network market within the Region included the following: 1.) AT&T; 2.) Time Warner Telecom; 3.) Norlight Telecommunications; 4.) TDS Metrocom; and 5.) Midwest Fiber Networks. The latter firm provides "dark" cable that must be equipped and activated by the user.

The remaining core networks service providers are smaller ILEC carriers that offer core network services only in their own ILEC service areas. These in 2007 included: 1.) Verizon North; 2.) Century Tel; 3.) State Long Distance (Elkhorn); and 4.) Sharon Telephone Company.

An unsuccessful search was made of the Federal Communication Commission and Wisconsin Public Service Commission data bases to obtain definitive information on the location of the core optic fiber facilities within the Region. The Commission on February 21, 2007, sent letters to all known fiber optic core network carriers operating within the Region requesting definitive information on the cable networks locations. As of March 21, 2007, replies were received only from Verizon, politely declining cooperation. Apparently -- barring State legislation -- the necessary information will become publicly available only when the carriers see it to be in their own interest to cooperate with public bodies such as the Commission in developing a core network infrastructure inventory.

Lacking comprehensive fiber optic core network location information for the Region, the Commission selected to work with core network providers in plan design and implementation on a project-by-project basis. Such an approach allows for the implementation of specific advanced broadband communications system plans based on core, network connections specified for a given geographic area. In such a working relationship, the core network carrier would typically offer a number of possible Internet locations, so that a selection could be made that would maximize the performance versus cost of the new network infrastructure design. To date, two core network carriers, Charter Communications and Time Warner Telecom, have demonstrated a willingness to cooperate in this critical aspect of plan implementation. Attempts will be made to expand this group of carriers so that all parts of the Region will achieve broadband communications coverage.

CONSIDERATION OF PRELIMINARY DRAFT OF CHAPTER VI "TELECOMMUNICATIONS BROADBAND PERFORMANCE INVENTORY FINDINGS" 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 VI "Telecommunications Broadband Performance Inventory Findings" 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. The following comments were made, questions were raised, and actions were taken in the course of the review.

Mr. Klasen called attention to Figure 5 on page 7, noting that the title was in error in that the data referred not to a 2000/768 service category, but to a 3000/768 service category. In answer to a question by Mr. Mueller concerning the meaning of the abscissa of this Figure, Dr. Schlager indicated that the units represented the hours of the day with respect to the type of data displayed; in the case of Figure 5, that data being aggregate national data on the throughput speeds provided by Warner Cable Road Runner service.

Mr. Falaschi expressed concern over the manner in which the data displayed by the performance charts included in the Chapter were collected; indicating that, in his opinion, valid data required that the reported performance was monitored under consistent conditions -- namely by use of the same origins, destinations, and routing for comparisons. Dr. Schlager responded that the performance data presented were statistical averages of literally thousands of observations of individual communications with different sources, destinations and routings; and having been collected at the users terminals, the data did validly represent the average service levels provided by each of the networks concerned.

Mr. Mueller noted that Map 6-1, on page 24, did not portray the most recent U.S. Postal Service Zip Code areas. Chairman Bauer indicated that Mr. Mueller was correct, and that the staff was in the process of compiling an updated map showing those area boundaries.

Mr. Klasen called attention the second paragraph on page 26 and indicated that he did not agree that, as indicated in the text, the difference in the performance levels displayed on Figure 36 for the West Bend area with those displayed on Figure 37 for an area on the near south side of the City of Milwaukee were due to the age of the copper cable lines concerned. He indicated that AT&T replaces its cable lines as necessary to meet company standards. He indicated further that the difference in performance was more probably due to the fact that the company would have installed a larger number of remote terminals in the larger West Bend service area than in the smaller Milwaukee service area concerned. Accordingly, more of the customers in the West Bend area were located closer to the electronic equipment required and thus were receiving higher-end service than was the Milwaukee area concerned. He indicated that he also disagreed with the conclusionary statement made in the last sentence of the paragraph concerning the AT&T Project Lightspeed.

A discussion ensued at the conclusion of which it was agreed that the staff would rewrite the paragraph concerned in response to Mr. Klasen's objections.

[Secretary's Note: Data for zip code area 53207 as shown on Map 6-1 representing an area in the South Side of the City of Milwaukee as given in Figure 37 indicates a lower level of performance than another AT&T site in West Bend. Comparing the performance provided in the south side of Milwaukee with that provided for West Bend as given in Figure 36, performance in the West Bend area is about 30 percent faster than in the selected area of Milwaukee using the same broadband DSL technology. This performance difference is probably best explained by the presence of multiple remote terminals in the West Bend area because of its size and newly developed subdivisions. Remote terminals enhance performance by bringing greater fiber optic bandwidth closer to the user DSL performance degrades with distance from either the Central Office or fiber-linked terminals.]

Mr. Klasen called attention to the first paragraph on page 30 and asked that the term "communities" within that paragraph be defined. Mr. Evenson indicated that properly, the term communities should be struck and replaced with the term municipalities. Mr. Evenson indicated further that the last sentence of

the paragraph should be revised to read: "there are no publicly available higher throughput broadband plans for the Time Warner Cable or Charter communications cable networks."

Mr. Klasen indicated that he would check the number of deployment plans – given in the paragraph as 25, providing to the staff a more current number as may be appropriate. Chairman Bauer observed that it would be helpful if AT&T provided the Commission with a map showing the location of the 25 or more areas to which the company is proposing to provide Project Lightspeed service.

In answer to a question by Mr. Ritt, Mr. Klasen indicated that Project Lightspeed service would not necessarily be ubiquitous, either within the company service area, or within a municipality.

There being no further questions or comments, on a motion by Mr. Chernow, seconded by Mr. Wirth, with Mr. Klasen voting no, Chapter VI "Telecommunications Broadband Performance Inventory Findings" of SEWRPC Planning Report No. 53, *A Regional Comprehensive Broadband Telecommunications Plan For Southeastern Wisconsin* was approved as amended with Mr. Klasen voting no. Mr. Evenson expressed surprise at Mr. Klasen's vote in that Chapter VI was an inventory and not a plan presentation Chapter. Mr. Klasen responded that the Chapter was not viewed as such by his company which, he said, had consistently objected to the Commission's preparation of a telecommunications plan for the Region.

CONSIDERATION OF OUTLINE FOR CHAPTER VII "A REGIONAL COMPREHENSIVE BROADBAND TELECOMMUNICATIONS PLAN FOR SOUTHEASTERN WISCONSIN" OF SEWRPC PLANNING REPORT NO. 53, *A REGIONAL COMPREHENSIVE BROADBAND TELECOMMUNICATIONS PLAN FOR SOUTHEASTERN WISCONSIN*.

Consideration of preliminary draft of outline for Chapter VII "A Regional Comprehensive Broadband Telecommunications Plan for Southeastern Wisconsin" 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 VII had been provided to all members of the Committee for review prior to the meeting.

Chairman Bauer then asked Dr. Schlager to undertake a review of the draft with the Committee. The following comments were made, questions were raised, and actions were taken in the course of the review.

In answer to a question by Mr. Ritt, Dr. Schlager indicated that Alternative Plan One was the wireless service plan documented in SEWRPC Planning Report No. 51, and as such had been approved by this Committee and by the Commission. He noted that since the publication of that plan, the Commission had prepared refined plans for the Towns of Addison and Wayne in Washington County, and was engaged in preparing a refined plan for the seven North Shore communities in Milwaukee County, these communities being the City of Glendale and the Villages of Bayside, Brown Deer, Fox Point, River Hills, Shorewood, and Whitefish Bay. Moreover, he said, requests for refined wireless service plans had been requested by a number of additional communities, including the City of Lake Geneva, City of Waukesha, Village of Hartland, and the Village of Thiensville. In answer to a further question by Mr. Ritt, Mr. Evenson indicated that the Commission's work referred to by Dr. Schlager was intended to assist local communities within the Region in implementing the now adopted Regional Wireless Service Plan. He noted that the plan implementation steps involved were clearly set forth in SEWRPC Planning Report No. 51, (see Chapter VIII of SEWRPC Planning Report No. 51 entitled: "Regional Wireless Network Plan Implementation") and that those steps had been discussed at length within this Committee which had, acted to approve the Chapter. (See minutes of May 23, 2006, meeting.) In answer to a further question by Mr. Ritt, Mr. Evenson indicated that requests from communities for assistance in plan implementation

must be submitted by cognizant officials in writing to the Commission, and that such letter requests served to initiate the more detailed planning efforts.

Mr. Wirth noted that the requests for assistance mentioned did not include -- perhaps even more importantly -- requests for assistance in more detailed planning for the public safety communication networks within the Region. Dr. Schlager agreed, noting that the City of Waukesha had requested a demonstration of the application of broadband service to police and fire department telecommunications needs. In answer to a question by Mr. Falaschi, Dr. Schlager indicated that the type of mobile service equipment was selected by the City staff, and was purchased by the City for the demonstration, using a police squad car. In answer to a further question by Mr. Falaschi, Dr. Schlager indicated that the Commission would, if requested, assist municipalities in preparing requests for proposals to implement a local system plan prepared by the Commission and adopted by the municipality.

Mr. Chernow observed that the procedure being followed by the Commission to implement its adopted wireless service plan was no different than the procedure which the Commission has used since its inception to provide community level planning services that serve to implement regional plans. He noted that the Commission's procedure is orderly, and that the Commission services are much sought after by its constituent counties and municipalities. Chairman Bauer agreed, noting that the demand for Commission community assistance planning services greatly exceeds the available Commission's staff resources; therefore, communities must often decide whether to wait, perhaps as much as several years, for a specific service, or proceed to retain private consultants to perform those services.

Mr. Ritt referred to Alternative Plan Two as listed in the outline and asked for clarification about the meaning of the referenced use of 100 foot antenna base stations. Dr. Schlager indicated that this alternative was intended to differentiate between the antenna locations and heights proposed in Alternative Plan One, and indicated that a more disciplined reference would be to tall antenna towers and attendant base station equipment.

Mr. Gatz called attention to Alternative Plan Number Five and, asked, if indeed, that alternative proposed expanding AT&T Project Lightspeed service to the entire Region. Dr. Schlager indicated that the intent was to incorporate, in this alternative plan, fiber optic cable service to the neighborhood, and reference should not have been made to AT&T Project Lightspeed. Chairman Bauer observed that in any case, the wording was misleading since the type of service envisioned -- fiber optic cable to the neighborhood -- would be proposed only for the urban areas of the Region. Mr. Evenson noted that the intent was that under this alternative all Incumbent Local Exchange Carriers (ILECs) would mimic what AT&T is attempting to do through its Project Lightspeed.

In answer to a question by Mr. Ritt, Dr. Schlager indicated that capital and operating costs data adequate for system level planning is readily available within the professional literature. In answer to a further question by Mr. Ritt, Dr. Schlager indicated that the level of detail presented in the alternative plans would be similar to that provided in SEWRPC Planning Report No. 51 for the adopted regional wireless network plan. Chairman Bauer noted that in any case, the capital and operating cost data attendant to each alternative plan to be considered would be presented -- as always -- to this Committee for review and approval.

Mr. Evenson suggested, and the Committee concurred, that Chapter VII be broken into two chapters. Chapter VII including the presentations envisioned under outline Items A through D; and Chapter VIII consisting of the information envisioned under outline Item E, a description of the recommended regional plan -- together with a section on plan implementation.

There being no further questions or comments, on a motion by Mr. Melcher, seconded by Mr. Chernow, and carried, with Messrs. Falaschi, Gatz, Klasen, and Ritt voting no. The four dissenting members indicated that the reason for their vote was that the companies which they represented objected to the Commission preparing a telecommunications plan.

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, March 27, 2007, 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. Melcher, and carried unanimously, the meeting was adjourned at 4:20 PM.

Respectfully Submitted,

Lynn G. Heis
Committee Secretary

KWB/lgh
03/30/07
#124252 V1 - T/C - Minutes 17th Meeting

PRELIMINARY DRAFT

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

Chapter V

**TELECOMMUNICATIONS BROADBAND
INFRASTRUCTURE INVENTORY FINDINGS**

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.

Chapter IV presented data on the existing demography and economy; the existing land use pattern; and the existing transportation system of the planning area. These factors provide the setting for the telecommunication facilities and services of an area, and affect the configuration of the demand upon those facilities and services, and the configuration of the facilities and services themselves. The sound development of a telecommunications facilities and services plan must also consider: telecommunications technologies currently employed within the Region; emerging technologies that may displace these current technologies; the planimetry and hypsometry of the Region that has a major impact on the deployment of wireless communications systems displayed as canopy data; and the existing telecommunications infrastructure within the Region. The performance of that existing infrastructure must also be monitored. The results of the monitoring is reported in a later chapter.

SEWRPC Planning Report Number 51, *A Wireless Antenna Siting and Related Infrastructure Plan for Southeastern Wisconsin*, dated September 1, 2006 previously published presenting the findings of a wireless infrastructure inventory conducted by the Commission. The inventory consisted of a compilation of antenna sites that serve mobile cellular/PCS and fixed users within the Region. This inventory data will not be republished herein. This report will focus on an inventory of the geographic areas of the Region serviced by either wireless or wireline broadband communications services. Broadband wireline services were inventoried under ~~three~~ *four* technology categories: (1) Digital subscriber line (DSL) services provided by telephone incumbent local exchange carriers (ILECs) and competitive local exchange carriers (CLECs) in the Region; (2) Hybrid fiber coaxial cable services provided by cable companies in the Region; (3) fiber-to-the-premises; and, (4) fiber-to-the-node.

Wireless broadband communication service may also be provided through high speed, satellite-based, facilities. Although generally slower and more expensive than other available alternatives, satellite broadband service has the advantage of universal coverage. All areas in the Region may be serviced by satellite broadband. Such coverage is particularly important in rural areas where no other alternative broadband service is available. It is reasonable to expect however, that rural parts of Southeastern Wisconsin will eventually be offered other wireless, or wireline, broadband communication services. The satellite alternative is referenced here only to provide a comprehensive description of all of the broadband technologies available within the Region.

The inventory of interest in this chapter pertains only to the geographic coverage of each of the above technologies. The performance of these three classes of communications technology will be inventoried in a subsequent chapter based upon standard measurements of availability, throughput, response time, and accuracy. These same four performance parameters will be used to evaluate both the wireline and wireless networks.

Each of the service area inventories has its limitations based on the accuracy of the data sources used in its compilation. The broadband cable service area inventory is based on a combination of comprehensive infrastructure and service information for a single community – the Town of Ottawa, Waukesha County – an inventory of community cable service franchise agreements within the Region, and an historic urban growth map of the Region that indicates areas that meet widely accepted economic criteria for broadband cable deployment. This approach to the inventory of cable service deployment resulted from the refusal of either of the two cable service providers to make available maps of the areas in which they actually provide service, the providers regarding such maps as comprising confidential, competitive information. Having comprehensive cable service layout information for a typical urban fringe area community provided a check

on the validity of the urban growth approach to defining cable service areas. The procedure also had the advantage that it can be used to forecast future potential broadband cable service deployments.

Telephone line-based digital subscriber line (DSL) broadband service areas were developed indirectly based on telephone company central office locations. A generally accepted service radius of 18,000 feet centered on the central office locations was used to define DSL service areas. DSL providers have extended their service areas beyond these radii by providing fiber-linked remote terminals. Requests for the location of these remote terminals were made by the Commission to all incumbent local exchange carriers and (ILEC) DSL service providers, but the requests were uniformly denied.

BROADBAND WIRELINE SERVICE AREA INVENTORY

There are ~~three~~ *four* types of broadband wireline service networks deployed within the Region: hybrid fiber coaxial; provider based DSL broadband services; *fiber to the node*; and fiber to the premises.

Hybrid Fiber Coaxial Networks

In 2006, the technology for broadband services in Southeastern Wisconsin with the largest market share was hybrid fiber coaxial cable. This technology, as the name implies, involves a combination of fiber optic and coaxial cabling with the bandwidth capability necessary to achieve throughput as high as five megabits per second in the download direction, and 384 kilobits per second in the upload direction. Performance of these cable networks, however, varies significantly with network loading. The architecture of these cable networks requires a reduction of bandwidth to each user as more users access the medium. Current network performance is described in Chapter VI of this report.

Cable networks were originally designed to deliver broadcast television signals to subscribers' homes. To provide data services, cable operators have invested heavily to convert one-way cable television signal delivery systems into modern two-way networks to support broadband, high-speed Internet access. It is estimated that by 2004, cable operators within the United States had upgraded over 90 percent of the homes served to support Internet access. To provide broadband cable communications services to an area, the cable operator must deploy this advanced form of cable services to each subscriber.

Determining the broadband cable service areas for Southeastern Wisconsin required the multi-path approach described previously. Implementation of this approach involved the following activities:

1. **Franchise Area Mapping**

The lists of the communities serviced by each of the two regional carriers operating within the Region, Time Warner Cable and Charter Communications, were obtained and mapped. It is important to note that the mapped areas represent potential service areas, not actual service areas, since the carriers are not legally obligated to serve all of their franchise areas.

2. Comprehensive Analysis of a Franchised Cable Community

Since unserved, and under-served, subscribers located within the franchise areas tend to be concentrated in rural areas of the Region, a single cable service-franchised civil division, the Town of Ottawa in Waukesha County, was studied in some detail to determine the basis for broadband cable deployment by the major cable operator within the Region. More specifically, the Town was studied to determine the economic basis of new cable deployment in terms of population density. The decision rule concerned is set forth in Section 22.25 of the Town franchise agreement which reads as follows:

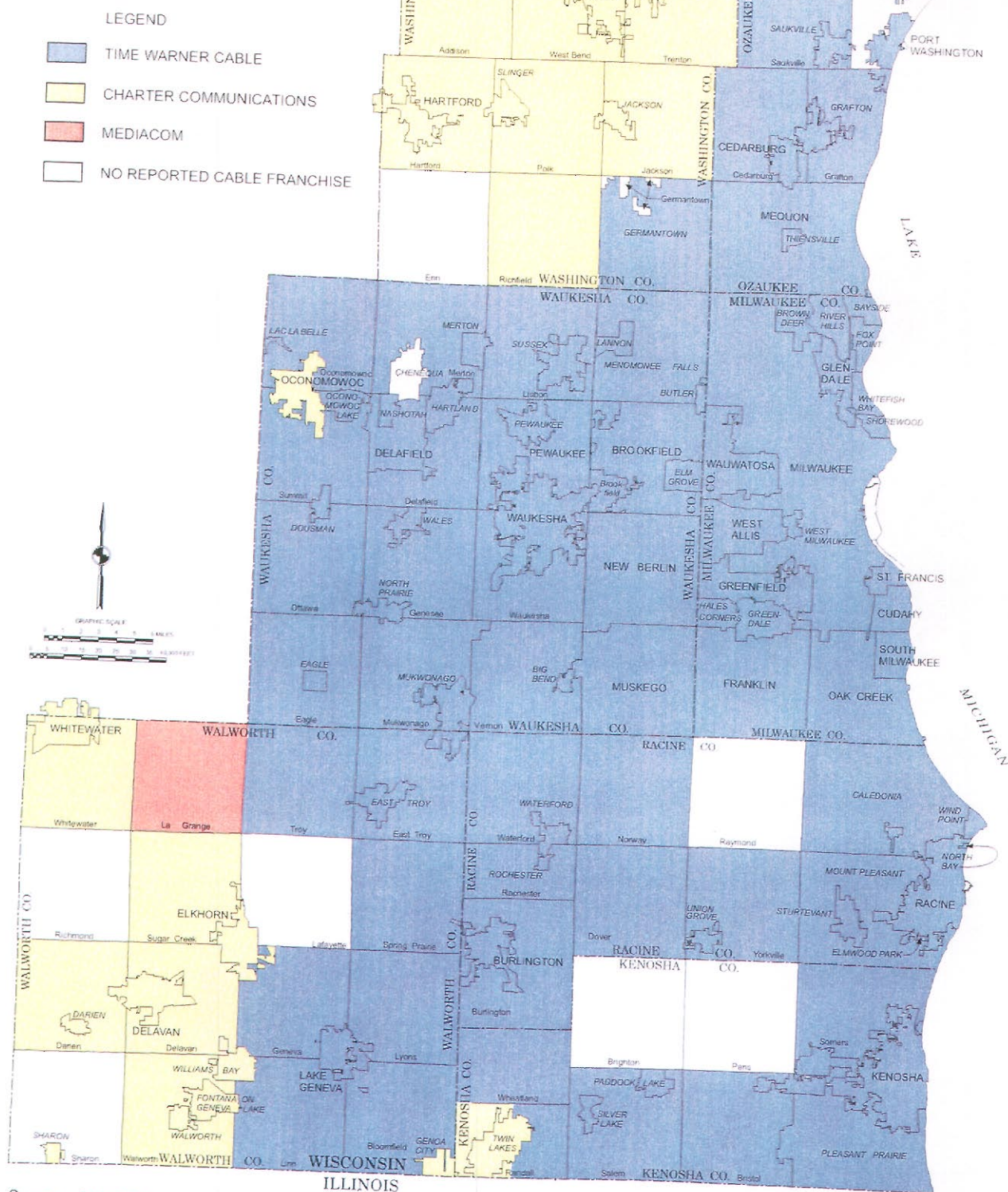
Conditions of Required Line Extensions

- a. Grantee shall, within sixty (60) days of the acceptance of this franchise, file a plan with the Town for the initial installation of cable. Following such initial installation, the Grantee shall not be obligated to extend its cable network to additional subscribers, unless the proposed subscribers shall be located within thirty (30) feet of the existing network or at least nineteen (19) additional subscribers will be serviced per mile of cable extension required. It should be noted that the application of the afore-referenced criteria is community specific, and not universal, depending upon the existence and conditions of contracts entered into between cable service providers and the municipal governments concerned.
- b. In instances where the Grantee is not required to provide service pursuant to this section, the Grantee and subscriber may nevertheless contract to have service provided on terms and conditions agreeable to both the subscriber and Grantee.

Based upon the conditions set forth in the Town of Ottawa franchise agreement -- conditions which further have been confirmed with a selected sample of fringe area civil divisions within the Region - indicated that similar decision rules were employed by the carriers concerned in approving areas of new cable deployment.

The regional broadband cable franchise areas for Time Warner Cable, Charter Communications, and Mediacom are shown on Map 1. Time Warner Cable is the dominant cable service provider in the Region. It is important to reemphasize that franchise areas do not equate with service areas. This disparity is illustrated in the Waukesha County Town of Ottawa where complete information on cable deployment is available for this community. Map 2 illustrates the urban growth pattern for the year 2000 as determined by Commission inventories within the Town of Ottawa together with the broadband cable deployment.

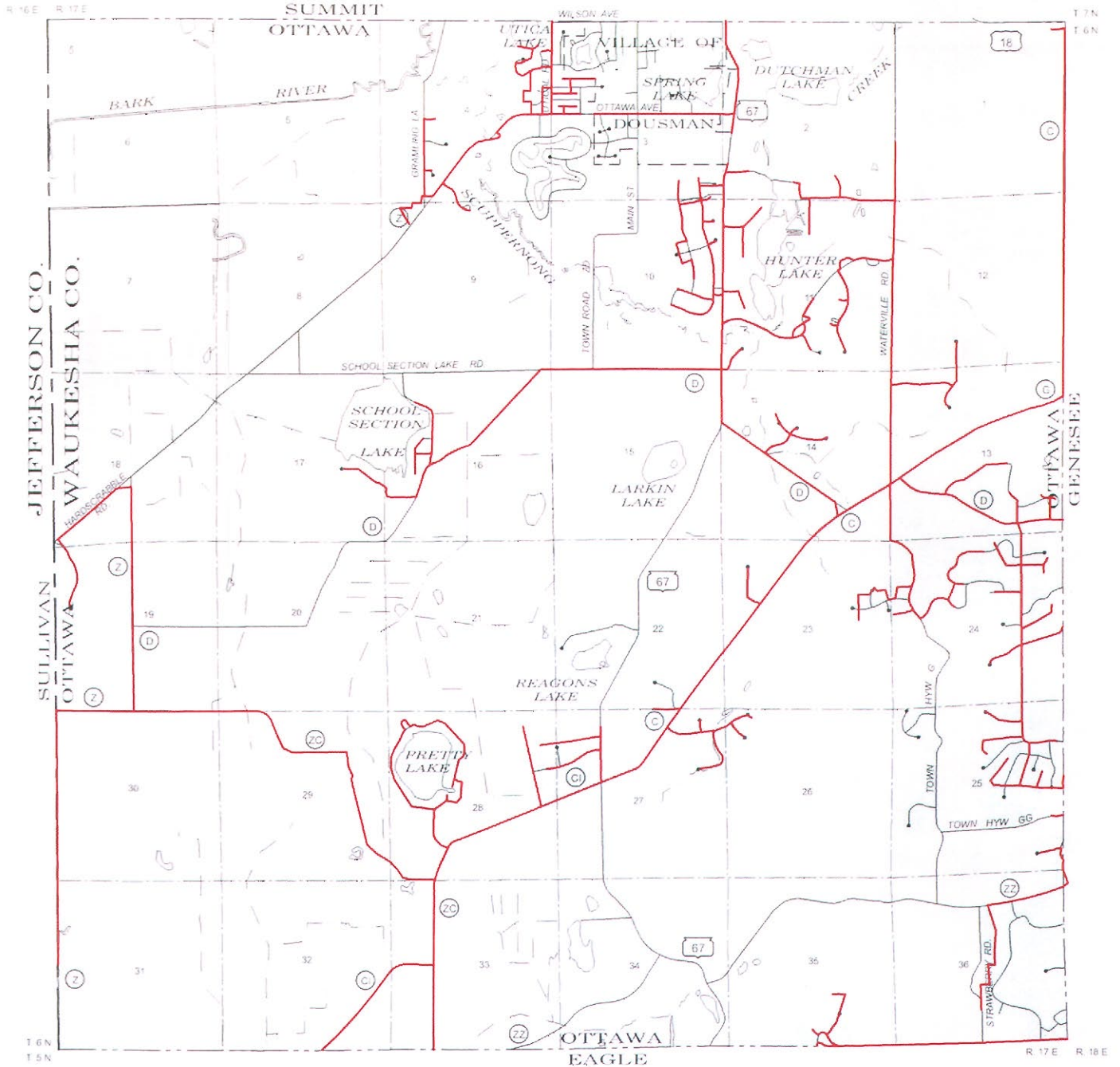
BROADBAND CABLE FRANCHISE
AREAS IN SOUTHEASTERN
WISCONSIN: 2006



PRELIMINARY DRAFT

Map 2

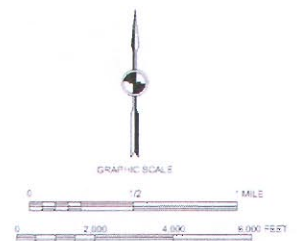
URBAN GROWTH PATTERN, AND BROADBAND CABLE SERVICE DEPLOYMENT
TOWN OF OTTAWA, WAUKESHA COUNTY, WISCONSIN: MAY 2000



LEGEND

- AREAS OF URBAN DEVELOPMENT 2000
- CABLE DEPLOYMENT 2006

Source: SEWRPC.



PRELIMINARY DRAFT

The growth pattern correlates well with the broadband cable service coverage in the Town. Lacking definitive service coverage information from the two regional cable providers, this correlation between urban growth patterns and broadband cable coverage was used as a basis for estimating the geographic extent of broadband cable coverage within the Region. Map 3 indicates the urban development pattern within the Region as of the year 2000, and is believed to represent an approximate delineation of the current areas served by broadband cable coverage within the Region. Whatever the precision and accuracy of these map estimations, it is evident that broadband cable did not provide universal broadband coverage for the Region. Provision of universal broadband communication service must therefore, look to other communication technologies.

Telephone Provider Based DSL Broadband Services

Regional telephone companies provide a broadband data communication service known as Digital Subscriber Line (DSL) of which the most common form is ADSL where the prefix A indicates asymmetrical data throughput. ADSL service, like broadband cable service, is not symmetrical with download speeds much faster than upload speeds by a factor as high as ten to one.

Six Incumbent Local Exchange Carrier (ILEC) telephone companies provide broadband DSL services in the Region:

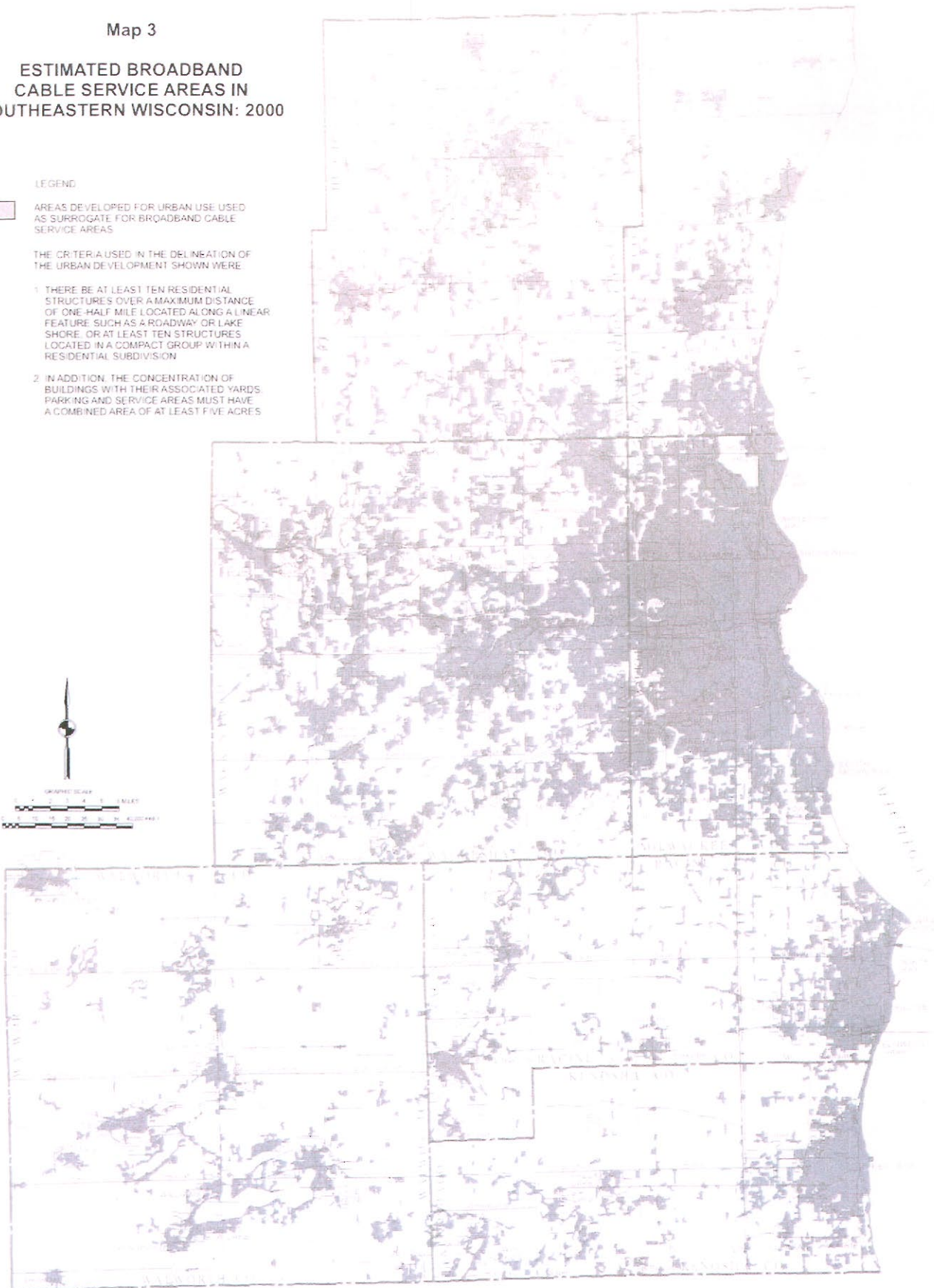
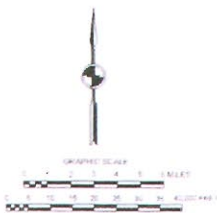
1. AT&T
2. Century Tel
3. Verizon North
4. Telephone and Data Systems, Inc.
5. State Long Distance Telephone Co.
6. Sharon Telephone Co.

AT&T is the major Incumbent Local Exchange Carrier (ILEC) telephone and DSL broadband service provider in the Region, providing service in parts or all of the seven counties, and in total services about ~~73~~ 61 percent of the land area of the Region. Citing concerns regarding making competitive information public, neither AT&T nor any of the other five regional ILECs agreed to provide maps of their DSL service coverage areas. Four of the six carriers - excluding Verizon and Telephone and Data Systems, Inc. - provided estimates of the percentage DSL coverage of their ILEC areas. Lacking DSL service area information from most ILECs, a Regional DSL coverage map was prepared as Map 4 which delineates the DSL coverage areas of all regional carriers based on 18,000 foot radius circles around each of the

Map 3

**ESTIMATED BROADBAND
CABLE SERVICE AREAS IN
SOUTHEASTERN WISCONSIN: 2000**

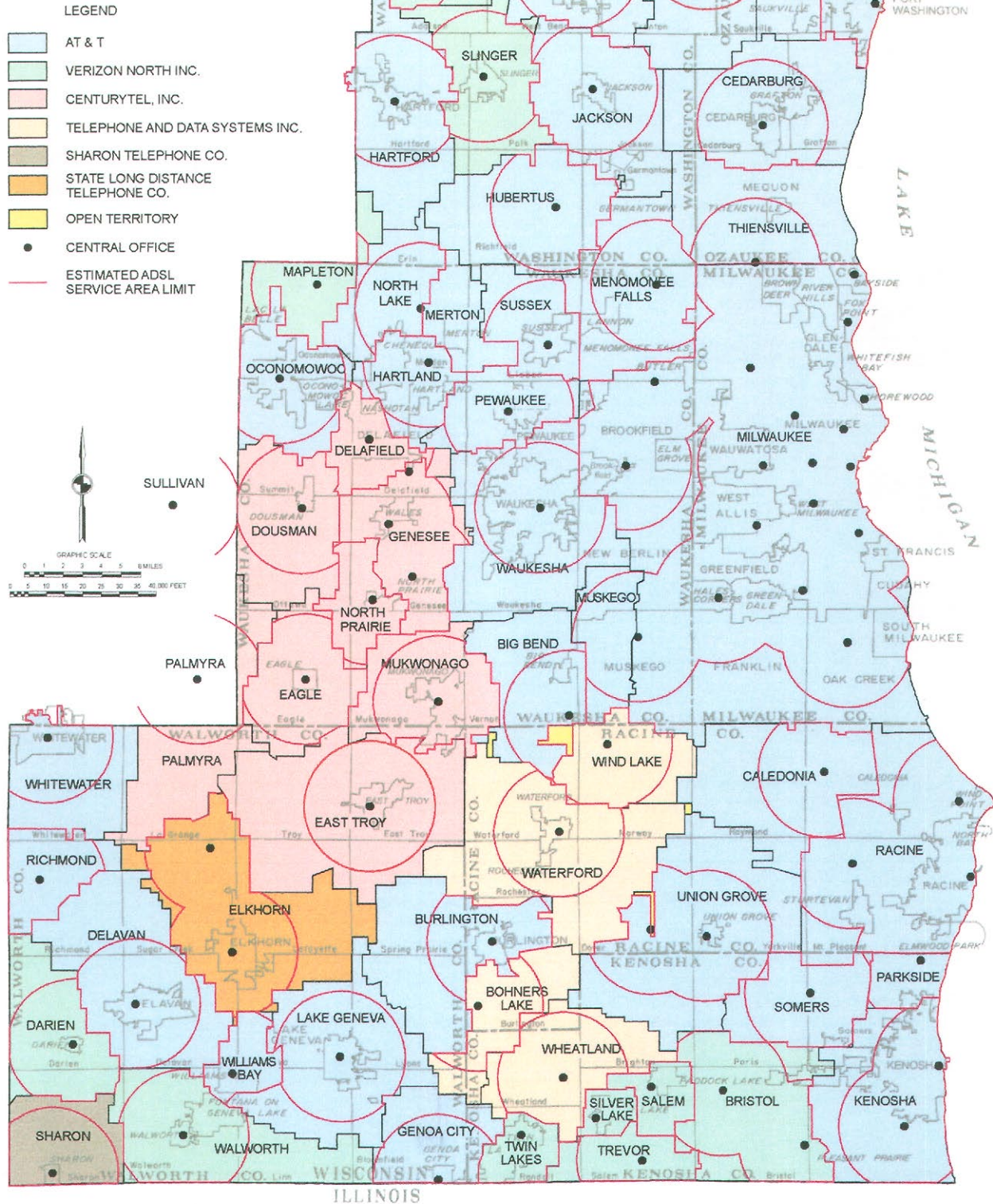
- LEGEND
-  AREAS DEVELOPED FOR URBAN USE, USED AS SURROGATE FOR BROADBAND CABLE SERVICE AREAS
- THE CRITERIA USED IN THE DELINEATION OF THE URBAN DEVELOPMENT SHOWN WERE:
1. THERE BE AT LEAST TEN RESIDENTIAL STRUCTURES OVER A MAXIMUM DISTANCE OF ONE HALF MILE LOCATED ALONG A LINEAR FEATURE, SUCH AS A ROADWAY OR LAKE SHORE, OR AT LEAST TEN STRUCTURES LOCATED IN A COMPACT GROUP WITHIN A RESIDENTIAL SUBDIVISION
 2. IN ADDITION, THE CONCENTRATION OF BUILDINGS WITH THEIR ASSOCIATED YARDS, PARKING AND SERVICE AREAS MUST HAVE A COMBINED AREA OF AT LEAST FIVE ACRES



Source: SEWRPC.

Map 4

**ADSL BROADBAND DEPLOYMENT
IN SOUTHEASTERN WISCONSIN: 2006**



Source: Wisconsin Department of Administration Office of Land Information Services and SEWRPC.

central offices of the various providers. DSL coverage for all providers based on central offices locations approximates 64 percent of the total area of the Region. For AT&T, central office-based DSL coverage is estimated at about ~~55~~ 66 percent of the total AT&T service area, and about 40 percent of the total area of the Region. Map 5 provides additional graphic information concerning the AT&T service area.

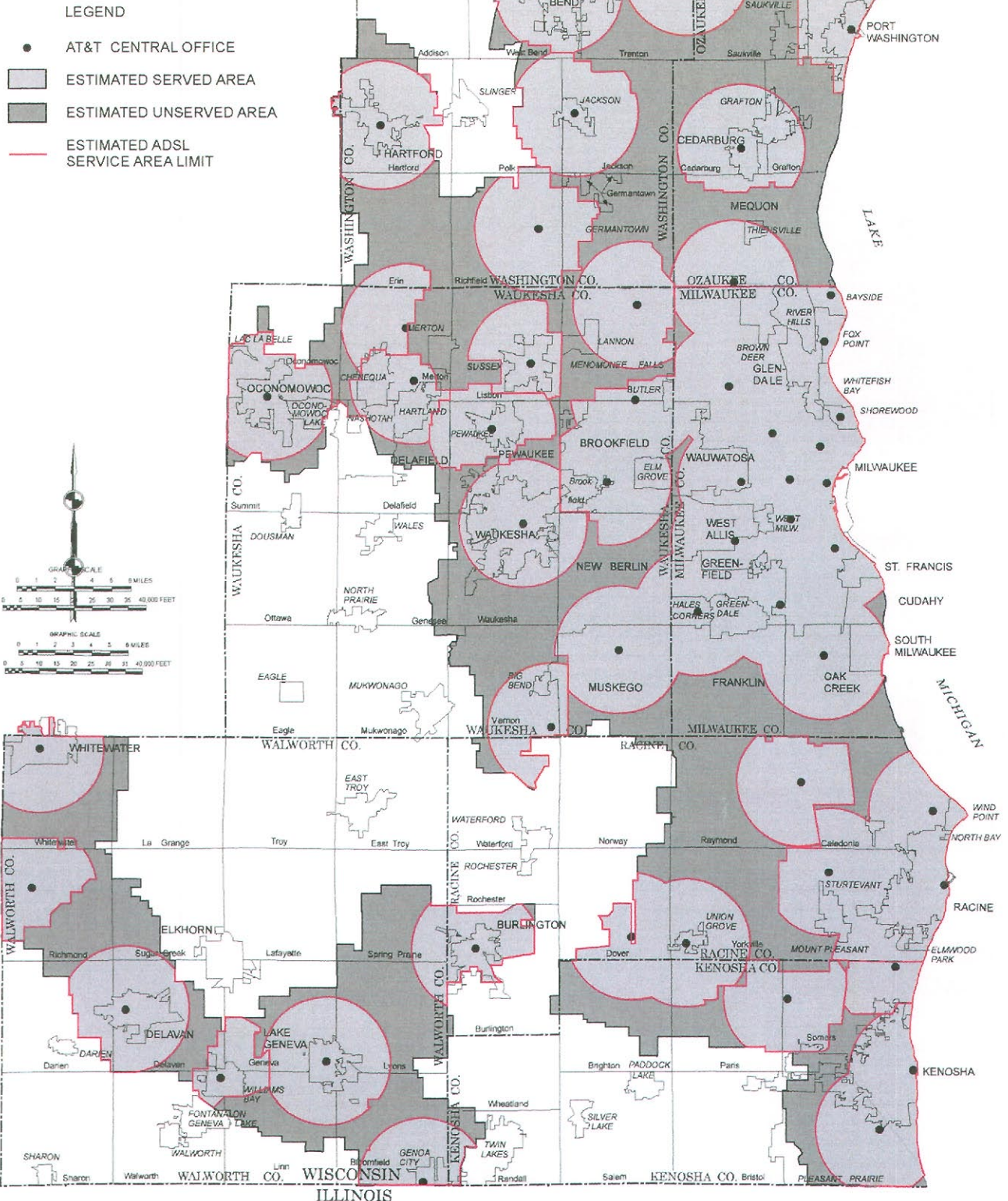
It is recognized that the 18,000 foot radius centered on central offices as a basis for the delineation of DSL service represents an over-simplification of the actual situation. Asymmetric digital subscriber line (ADSL), which represents the predominant version of DSL service, is a distance sensitive technology. Signal quality and throughput decrease as the connection length increases. The distance limit for DSL service, however, is typically defined as 18,000 feet to be consistent with the downstream speeds of 1.5 megabits per second generally offered to DSL users.

At shorter connection lengths, signal levels will be elevated, and faster throughput speeds are possible. For example, at distances of about 6,000 feet, downstream data rates of 8 megabits per second may be achieved. ADSL performance is governed by the same Shannon's Law previously referenced in this report with respect to wireless communication links. This law identifies bandwidth and signal/noise ratio as the primary determinants of channel capacity. In DSL, as in wireless links, signal quality -- signal-to-noise ratio -- varies with link distance. The 18,000 feet link distance defines a level of signal quality consistent with upstream and downstream data rates defined as the service offering by the wireline carrier. Distances longer than 18,000 feet will result in signal quality levels and channel capacities below this service quality standard. Other versions of DSL are sometimes offered by wireline carriers. One version, very high bit rate digital subscriber line (VDSL) service, is capable of higher data rates but at reduced link distances. Other versions of DSL, such as rate-adaptive digital subscriber line, adjust link speeds depending on the length and quality of the connection.

Century Tel is the second largest ILEC DSL service provider in the Region, covering parts of Waukesha County and Walworth County. With their ~~44~~ 9 central offices in the region, the company covers over ~~72~~ 65 percent of their ILEC area. ~~An~~ *Two additional central offices are located outside of the Region one near Palmyra provides additional coverage in Walworth County and one in Sullivan provides additional coverage in Waukesha County.* Based on information from the Company, DSL coverage has been extended to cover additional territory based on deployed fiber-linked remote terminals, known as Digital Subscriber Line Access Multiplexers (DSLAMs) that extend DSL coverage to previously unserved areas. The company estimated that in 2006 about 81 percent of the Century Tel territory is eligible for DSL service. Uncovered areas are limited to parts of the Towns of Ottawa, Troy and East Troy.

Map 5

**ESTIMATED AT&T CENTRAL OFFICE
BASED ADSL SERVICE AREA IN
SOUTHEASTERN WISCONSIN: 2006**



Source: Wisconsin Department of Administration Office of Land Information Services and SEWRPC.

Verizon North, Inc. is the ILEC service provider in many urban fringe areas located along the extreme north and south boundaries of the Region as shown in Map 4. Verizon purchased these properties from General Telephone and Electronics (GT&E) when Verizon was formed as part of the merger between Bell Atlantic and NYNEX in 1997. Operating 47 13 central offices in the Region, Verizon could offer DSL service in about ~~60-57~~ percent of 16 service areas concerned.

Telephone and Data Systems, Inc. would not furnish any information for this inventory. Based on central office locations, TDS should offer service to about ~~67-57~~ percent of its ILEC area.

State Long Distance Telephone Company is a local provider headquartered in Elkhorn (Walworth County). It was cooperative in providing DSL coverage information for this inventory. Based on central office locations alone, the Company could offer service to about ~~60-73~~ percent of its ILEC area. Deployment of remote DSLAMs has increased coverage to about 95 percent of their ILEC area.

Sharon Telephone Company was also cooperative in providing information on their DSL deployment. From Map 4, it is evident that this single central office of this provider is able to serve over ~~90-74~~ percent of their ILEC area. Company management stated that these unserved areas will be provided DSL service within the next six months.

The foregoing description of DSL deployment in Southeastern Wisconsin deals only with the services provided by Incumbent Local Exchange Carriers (ILECs). ILEC is an acronym derived from the Telecommunications Act of 1996 to describe existing local telephone companies such as AT&T, Century Tel or Verizon North. The term also includes smaller regional service providers such as the Sharon Telephone Company. ILEC service providers typically own the wireline network infrastructure with particular emphasis on the connections from the various central offices to DSL subscribers.

A second class of wireline service providers was created by the Telecommunications Act of 1996, the Competitive Local Exchange Carrier or CLEC. The CLEC concept involved the authorization of new local telephone companies that would compete with the incumbents in the telephone service market place. CLECs were granted access to the ILEC's infrastructure including the connections to each subscriber. This leased infrastructure was termed unbundled network element (UNE) and was intended to allow the CLEC to compete on an equal basis with the ILEC. The concept behind the Act also contemplated the development of new CLEC infrastructure as the CLECs prospered as economically viable local telephone and data service competitors. The reality in practice was quite different. CLECs found it very difficult to market an undifferentiated service with only a marginal price advantage. The end result was that most of the CLEC telephone companies failed, and CLEC competitive offerings are no longer a major factor in the regional end user communications marketplace. Some of the CLEC service providers created their own network

facilities, while others operated as re-sellers of services using ILEC facilities. The former were generally more successful in the marketplace. Even those CLECs that provided their own central office facilities did not create any new access network infrastructure, the primary focus of this planning report.

Nevertheless, a competitive wireline infrastructure has been created in the form of core networks. Companies such as Time Warner Telecom and Norlight have deployed high capacity fiber optic networks that can serve as alternative Internet connection vehicles for new broadband wireless networks that may be developed within the Region.

Fiber to the Premises Broadband Deployment

Major wide area deployments of fiber to the premises broadband services are currently underway by Verizon Communications in the eastern parts of the United States. Such deployments are typically confined to metropolitan areas such as Boston, New York or Philadelphia. Some small communities in the Midwest, particularly in Minnesota, have deployed fiber to the premises networks. Reedsburg, Wisconsin deployed such a fiber network in 2003. The only known residential deployment of fiber to the premises in Southeastern Wisconsin is by AT&T in the new Pabst Farms Subdivision in the Oconomowoc area of Waukesha County. The company, however, is planning to deploy such access networks to an additional 24 land subdivision developments within the Region. Current services offer throughput performance of 2 to 4 megabits per second. This fiber network is based on architecture known under the designation PON -- for passive optical network. Such networks provide faster service than cable networks that feature a tree-like architecture that requires primary fiber links to be shared with multiple users. Such fiber network architectures are in contrast with AON -- active optical networks -- topologies that provide a direct fiberlink to every subscriber.

Although the Pabst Farms development in Waukesha County may be the only publicly disclosed Fiber-To-The-Premises (FTTP) broadband access network service area in Southeastern Wisconsin, AT&T, the major ILEC in the Region, has initiated the deployment of FTTP and Fiber-To-The-Node (FTTN) access network service to other as yet undisclosed areas within Southeastern Wisconsin. Based on documents furnished by AT&T, this service provider is following a mixed FTTN-FTTP broadband deployment strategy within the Region. In the Fiber-To-The-Node approach being developed by AT&T, fiber optic cables are extended out to neighborhood locations providing nodes which can then service a significant number of copper wire-linked users with higher speed versions of DSL having throughputs as high as 25 megabits per second in a service area lying within a radius of approximately 3,000 feet of a node. The FTTN approach significantly reduces the capital investment required, while still offering the bandwidth necessary for high speed voice, data and various forms of video services. At the same time, an FTTN broadband deployment allows for

later expansion to a full scale FTTP network in which fiber-based bandwidth is deployed directly to user premises.

Wireline Broadband Inventory Summary

DSL broadband wireline coverage of the Region is broad and comprehensive since all of the incumbent telephone-based carriers have offered DSL services in their respective ILEC areas. As already noted, potential coverage based on original central office locations is estimated at ~~73~~ 64 percent of the total area of the Region. Deployment of DSLAM remote terminals is estimated to have expanded that coverage to an estimated 82 percent overall. Century Tel reports its DSL areal coverage at an estimated 81 percent. AT&T, the major ILEC in the Region also reports a current DSL coverage figure of 81 percent. Since their original central office coverage was estimated at ~~72~~ 66 percent, the incremental addition from DSLAM deployment is about 9 15 percent. Smaller carriers such as Sharon and State (Elkhorn) tend to service their areas earlier and more completely than the larger carriers with both reporting coverage over 90 percent.

Cable service providers utilize a hybrid fiber coaxial (HFC) cable network topology, in which the user connection is provided by a coaxial cable link. Fiber optic lines are brought to a geographic area in the same manner as the telephone system Fiber-To-The Node (FTTN) configuration described above. The HFC cable method differs from the FTTN network structure in that it does not provide a direct nodal connection to each user in the manner of FTTN. Rather the HFC cable network deploys a bus type architecture in which a node – known as a “headend” -- is provided to serve a set of subscribers through an access line – known as a “bus” – serving a number of subscribers through coaxial cable connections from the bus. Such an architecture has the disadvantage of any shared medium in that performance degrades as more subscribers share the common lines – the bus. The fiber link serving the headend is also shared, but a fiber channel has such great capacity that it does not limit system performance. Cable service providers do not generally provide direct fiber links to individual subscribers.

Broadband cable coverage presents a much different situation. Ten townships representing about 324 square miles or about 12 percent of the land area of the region are without any cable service lacking a franchise agreement with any cable provider. An additional eleven townships with population densities under 100 persons per square mile tend to be underserved even though they have franchise agreements. These underserved areas accrue to a total of about 700 square miles, or about 26 percent of the Region. Prospects for further broadband cable franchising and coverage depend on future residential urban development.

Referencing the fourth generation communications standards set forth in Chapter III of this report, none of the cable broadband networks are capable of achieving the throughput standard of 20 megabits per second. The hybrid fiber coaxial networks of the cable providers are, moreover, filling up and slowing down under a heavy load of users. A throughput standard of 20 megabits per second is still modest compared to Japan’s 2008 target standard of 100 megabits per second for every potential user in that country. Current ADSL

cable network technologies are reaching, or have reached, the limit of their performance capabilities. AT&T, however, has announced a new program called Project Lightspeed that is intended to upgrade ADSL technology in the form of VDSL technology which will provide throughput speeds of 20 megabits per second.

The next step in the wireline broadband access evolution may be expected to be a combination of fiber-to-the-node and fiber to the premises technologies. Such deployments would represent major investments on the part of telephone and cable providers. If universal broadband coverage is to be achieved, as received by the standard set forth in Chapter III, then the Region must evaluate other broadband telecommunications alternatives to provide the desired universal coverage within the Region. The Region must take a proactive stance, and plan an aggressive broadband deployment program in both wireline and wireless broadband communications.

BROADBAND WIRELESS SERVICE AREA INVENTORY

The wireless service area inventories require explanation from two viewpoints:

1. **Broadband Performance Standard**

The FCC defines of broadband service as service providing a throughput exceeding 200 kilobits per second. Some of the wireless service areas do not meet this performance standard. All of the wireless carriers however, are either contemplating, or executing third generation (3G) conversion plans which will comply with the FCC broadband standard. These 3G conversions will be based primarily on existing antenna base station sites. For these reasons, the defined service areas will represent a mixture of 2G and 3G performance, trending, however toward broadband communications standards.

2. **Network Parameters**

The wireless geographic service areas herein presented are based on radio propagation modeling. Accurate results from such modeling requires information on the power output and sectoral organization as well as the height and location of the antennae comprising the network. The height and location data are well known for the great majority of antenna sites. Technical data on radiated power and sectoral organization on specific sites are less well known and are guarded as confidential data by the cellular-PCS carriers. The wireless communications technologies are well understood, however, so that radio coverage maps prepared with estimated average power levels should closely approximate wireless carrier service areas.

Infrastructure Inventory Data Sources and Models

The comprehensive telecommunications infrastructure inventory compiled in this report is based on a combination of wireless and wireline telecommunications data sources. The original wireless data sources used in the antenna site and related infrastructure inventories presented in SEWRPC Planning Report No. 51 were also utilized in the geographic service inventory reported here. These sources include:

1. **FCC Database**

This database provided the starting point for the antenna site inventory, particularly with respect to the cellular 800-900 MHz band. It was less useful and comprehensive for the higher 1900 MHz PCS band.

2. **Local Units of Government**

The county and municipal governments provided the primary and most dependable source for antenna site location and height data. These sources, however, were not able to provide much data on the technical characteristics of the antenna and the supporting base station.

3. **Wireless Service Providers**

Wireless service providers in general were unwilling to provide antenna site and related infrastructure data for their antenna base station sites. Exceptions were Sprint and Nextel. Sprint PCS furnished network site all for all counties except Kenosha which is managed as part of their Chicago region. Nextel, which is now part of Sprint furnished geographic site data but no attendant technical data on all of the Region.

Data from the afore referenced sources were compiled into the antenna site and related infrastructure inventory reported in SEWRPC Planning Report Number 51. These data were then used in radio propagation simulation modeling to appropriate the geographic coverage provided by each of the antenna base station sites.

To understand the basis of the mapped wireless geographic service areas, it is necessary to understand radio propagation modeling in a functional sense with respect to the inputs, processes and outputs involved. Avoiding a technical discussion of the theory of radio wave propagation or the mathematical aspects, it is possible to appreciate basic model operation and to make judgments concerning the validity of the coverage maps produced.

The radio propagation modeling used was based on the EDX Signal Pro™ software package provided by EDX Wireless of Eugene, Oregon. This software package provides for a variety of radio propagation model-based area coverage, point-to-point path analysis and route studies for use in wireless network design. The area coverage studies were considered applicable for the generation of the geographic area

maps developed for this planning report. To develop a geographic service area map for a set of wireless antenna base station sites, the following mathematical model and data inputs that model were required.

1. Propagation model used:

The Anderson 2Dv1.00 model was used. This is a physical model used by wireless communications engineers world wide.

2. Quality of service level selection

This model input determines the percentage of time the signal level and the resulting quality of service will be provided. The 90 percent level was selected.

3. Topographic database

With a choice of terrain data, clutter loss data, or canopy data, the clutter database was selected for use with the model. This data base most realistically reflects the radio propagation environment, since it provides for signal attenuation due to trees and structures.

4. Transmitter site data

The data required for each transmitter site – base station – included: site elevation; antenna height; site coordinates expressed in State Plane Coordinates, North American Datum of 1927; antenna type - sectoral or omnidirectional; antenna sectoral orientation; transmitter power; antenna pattern; and receiver parameters.

5. Remote site data

The data required for each remote site – included: site elevation; antenna height; site coordinates expressed in State Plane Coordinates, North American Datum of 1927; antenna type - sectoral or omnidirectional; antenna sectoral orientation; transmit power; antenna pattern; antenna gain; and receiver parameters.

Based on the afore listed input data, the selected radio propagation model will generate a geographic service coverage area map for each antenna base station site. This coverage map will indicate the radio frequency signal level at various distances from the antenna site. Because of terrain and ground clutter variations, these signal levels will not be uniform in all directions from the antenna site. Areas characterized by dense woodlands or extensive building structures will attenuate signal levels within the areas concerned and beyond. In extreme circumstances, the signal level may drop below the noise floor preventing effective communication in a given area.

Employing the infrastructure data collected and analyzed in SEWRPC Planning Report No. 51, supplemented by estimates of data on antennae transmitter powers and patterns, the wireless service area maps herein presented were developed.

Mobile Cellular/PCS

Geographic Coverage Inventory

The mobile cellular geographic coverage inventory defines the signal level coverage of each of six wireless service providers operating within Southeastern Wisconsin. Based on these signal levels, the 90 percent availability and quality of service level and upon the capabilities of user cell phone devices, the border lines of service areas may be delineated. The defined coverage areas will provide the specified quality of service for both data and voice services. Based on earlier experience with both the Sprint and Nextel networks, estimated service levels were delineated showing levels of good service, marginal service and no service. These radio propagation maps together with the original signal level propagation maps for each provider defines cellular-PCS service levels in the Region.

Base station locations and antenna heights for all six cellular-PCS providers are fairly well known from the antenna site and related infrastructure inventory. Technical data on radiated power levels and sectoral orientations are known only for Sprint. Estimated power levels and 120 degree sectoral orientations were used for the other five providers based on their individual technologies -- CDMA, GSM or iDEN. A justification for the common treatment of all wireless providers with some modification for wireless lies in the limiting factor present in all wireless networks – the user equipment, here the cellphone. Limited in both receiver sensitivity and transmitter power, the cellphone establishes the limits of cellular coverage. While there are differences in cell phone technology and performance, transmitter power is limited by FCC regulation to 0.6 watts and receiver sensitivity differences are believed to be small.

Regional Wireless Service Coverage – Sprint

Sprint was selected first for evaluation because Commission staff had access to definitive network information for this carrier, has worked with the Company on an antenna site location project, and understands some of carrier's criteria for site selection. Sprint employs CDMA technology and operates in the 1931 to 1935 MHz frequency band. A transmit power of 2.4 watts was used in the modeling for all base stations with antenna gains of 15.5 to 22.5 – (dBi). Map 6 indicates the regional signal level coverage starting with an initial signal level over –76.9 dBmW and ending with a signal level less than –109.1 dBmW. The color pattern on Map 6 indicates the signal level range within the Region. Map 7 provides a simplified view of service quality at three levels:

1. Green for good service
Signal over –91.9 dBmW
2. Yellow for marginal service
Signals between –91.9 dBmW and –109.1 dBmW
3. White for no service
Signals below –109.1 dBmW

LEGEND

RECEIVED POWER AT REMOTE

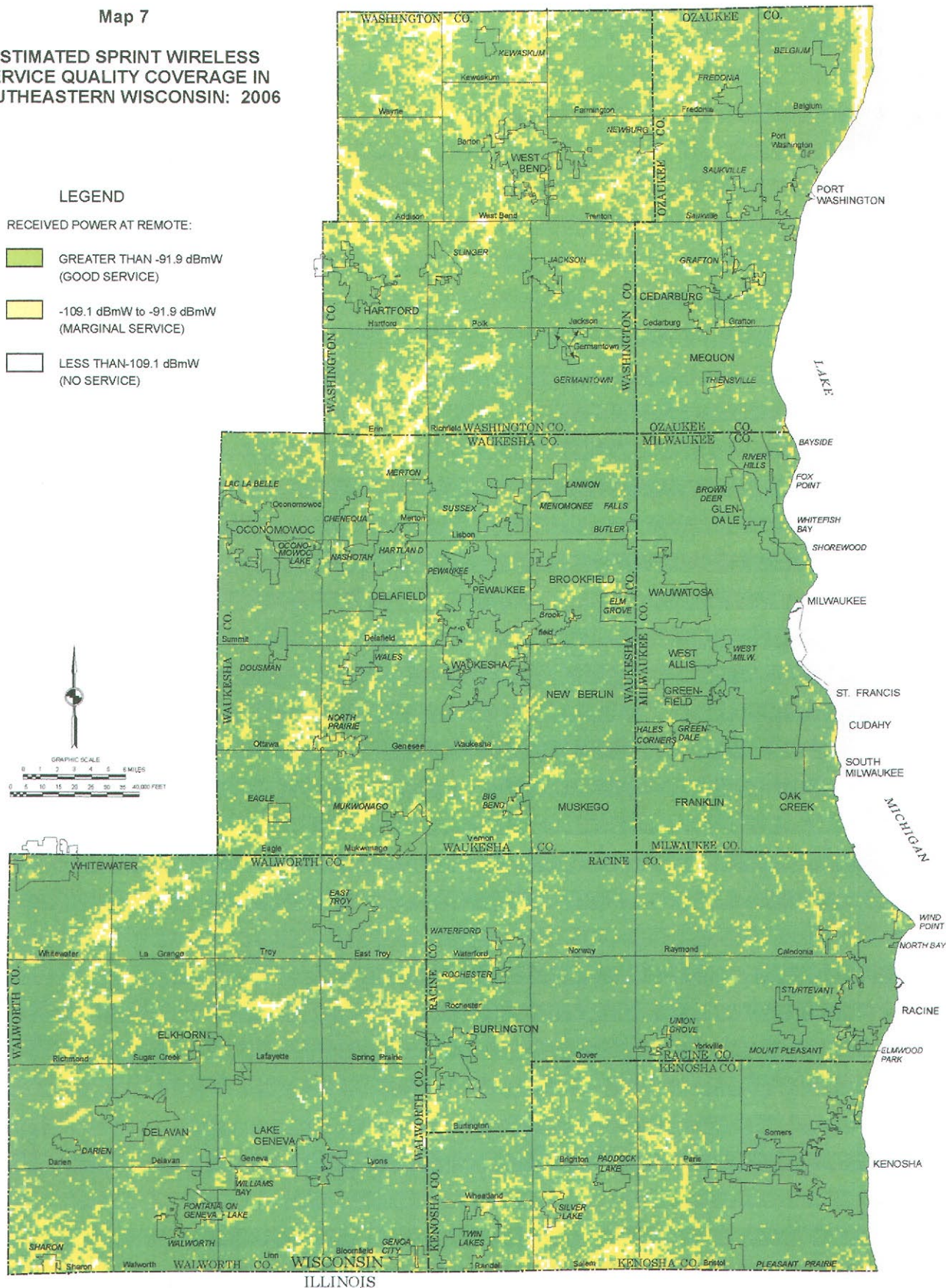
	GREATER THAN -76.9 dBmW
	-81.9 dBmW to -76.9 dBmW
	-91.9 dBmW to -81.9 dBmW
	-100.5 dBmW to -91.9 dBmW
	-109.1 dBmW to 100.5 dBmW
	LESS THAN -109.1 dBmW



ESTIMATED SPRINT WIRELESS
SERVICE QUALITY COVERAGE IN
SOUTHEASTERN WISCONSIN: 2006

RECEIVED POWER AT REMOTE:

-



20

A review of Map 7 indicates the presence within the Region of some areas of marginal performance, and some areas of no coverage. Operating in the 1900 MHz frequency band, results in greater radio path attenuation, than operating in the 800 to 900 MHz band.

Regional Wireless Service Coverage - Nextel

Although Nextel was acquired by Sprint in 2005, it still operates as a separate network with a different technology, iDEN, which features push-to-talk communications and is especially popular with public safety agencies and with industries having mobile employees. iDEN, which is an acronym for Integrated Dispatch Enhanced Network, was developed by Motorola for dispatch-oriented communications, but has become a popular wireless network for a variety of users. It employs a TDMA modulation method which is becoming obsolete for third generation wireless communications. Nextel service coverage within the Region is robust with few areas of marginal performance. Maps 8 and 9, display signal level and service quality performance respectively for the provider.

Regional Wireless Service Coverage – Verizon Wireless

Map 10 displays the radio propagation signal levels of Verizon's network, and Map 11 the three levels of service indicated by these signal levels. Like Sprint, Verizon employs CDMA technology so similar antenna output parameters to those used for the Sprint system were used in the radio propagation modeling for the Verizon system. Map 11, indicates that Verizon provides a good level of service to a higher proportion of its service area than does Sprint with the same technology. Verizon, however, lacks a good level of service coverage of major areas in western Walworth and Waukesha County, and of some of the northern areas of Ozaukee and Washington Counties. Some lack of good rural coverage also exists in parts of Kenosha County.

Regional Wireless Service Coverage – Cingular Wireless

Maps 12 and 13 constitute the radio coverage maps for Cingular Wireless. The uniformly high quality signal levels -- above -76.9 dBmW -- are evident throughout the Region. Consistent with GSM base station practice, the power levels were set at 45 watts in each 120 degree sector. Marginal service quality areas were found to be limited to the extreme southwest corner of Waukesha County, and to small areas of Washington and Ozaukee Counties. The GSM technology used by Cingular is the standard technology throughout most of the world.

LEGEND

RECEIVED POWER AT REMOTE

	GREATER THAN -76.9 dBmW
	-81.9 dBmW to -76.9 dBmW
	-91.9 dBmW to -81.9 dBmW
	-100.5 dBmW to -91.9 dBmW
	-109.1 dBmW to 100.5 dBmW
	LESS THAN -109.1 dBmW



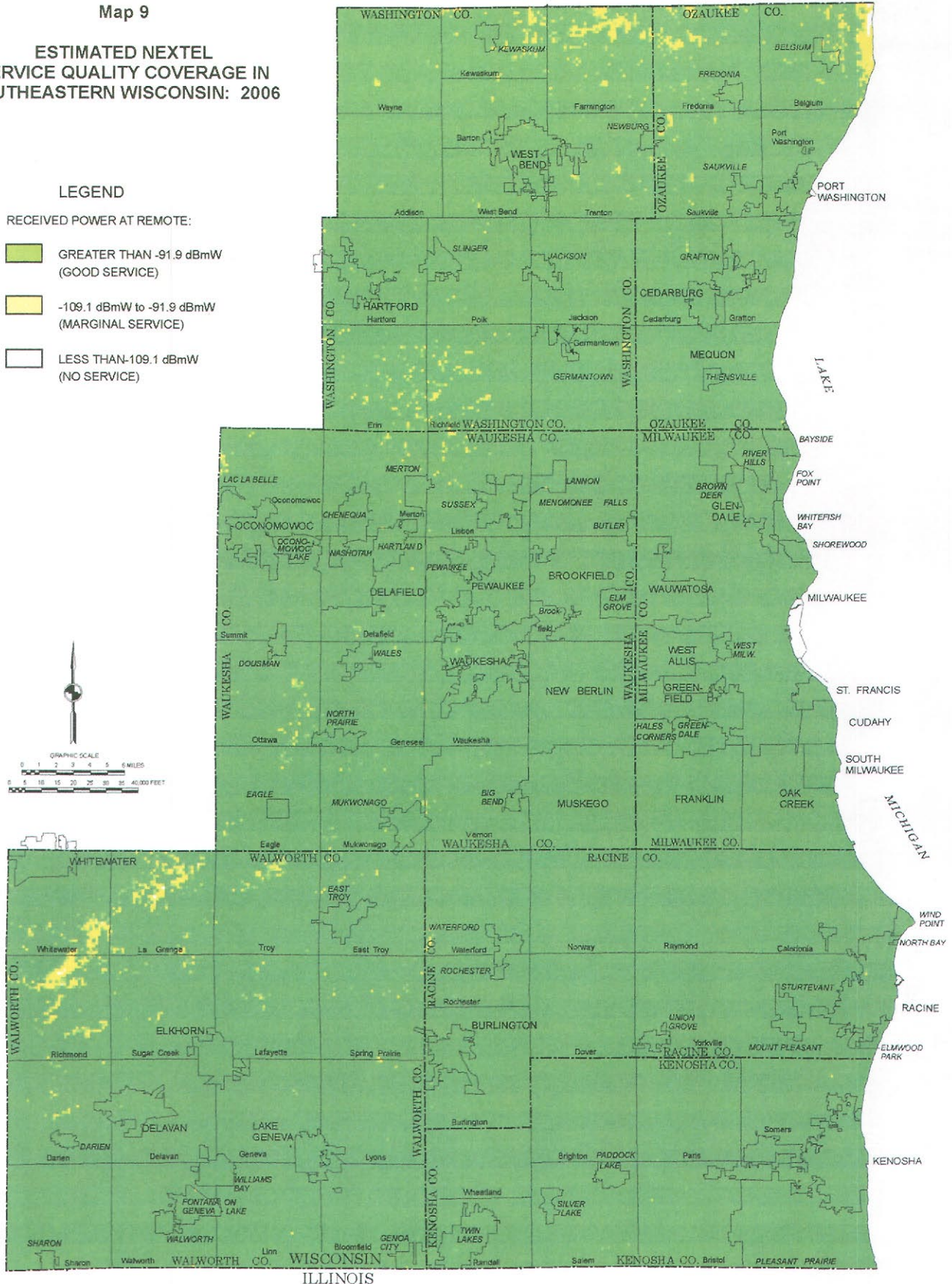
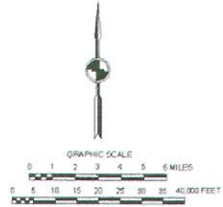
Map 9

**ESTIMATED NEXTEL
SERVICE QUALITY COVERAGE IN
SOUTHEASTERN WISCONSIN: 2006**

LEGEND

RECEIVED POWER AT REMOTE:

- GREATER THAN -91.9 dBmW
(GOOD SERVICE)
- 109.1 dBmW to -91.9 dBmW
(MARGINAL SERVICE)
- LESS THAN -109.1 dBmW
(NO SERVICE)

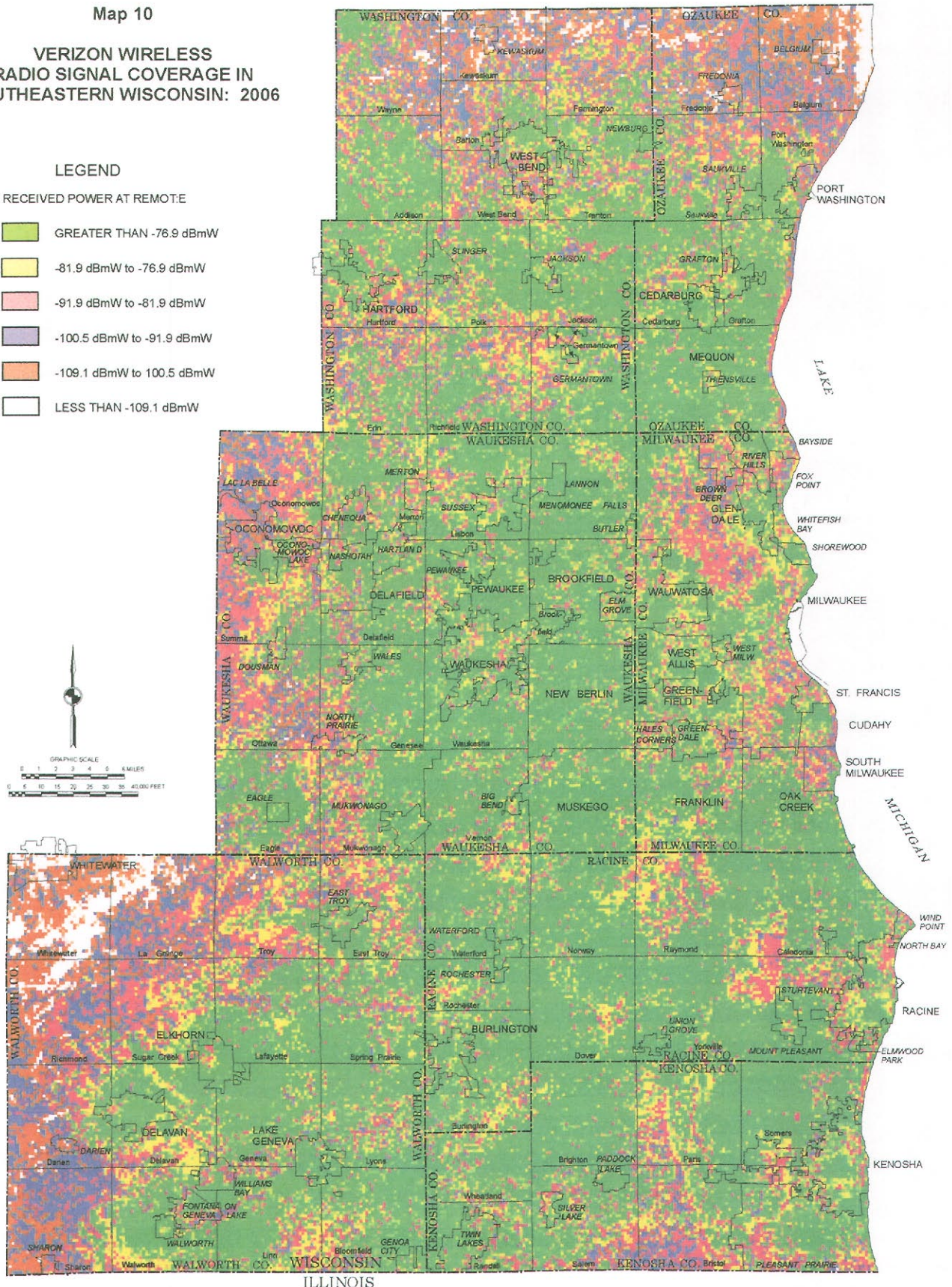
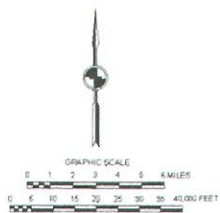


Source: SEWRPC.

PRELIMINARY DRAFT

VERIZON WIRELESS
RADIO SIGNAL COVERAGE IN
SOUTHEASTERN WISCONSIN: 2006

RECEIVED POWER AT REMOTE:



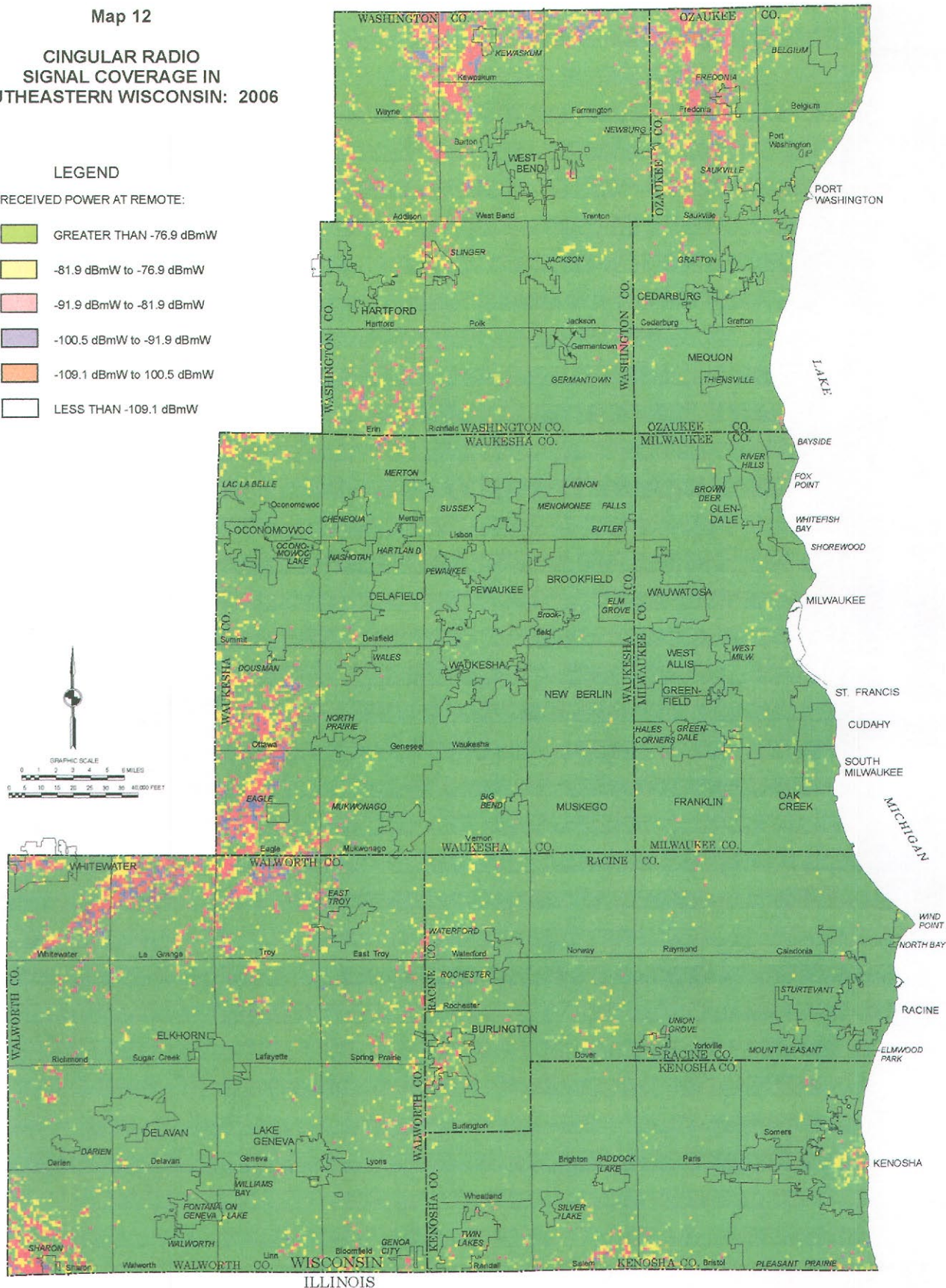
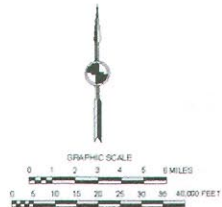
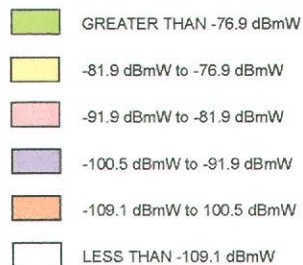
PRELIMINARY DRAFT

Map 12

**CINGULAR RADIO
SIGNAL COVERAGE IN
SOUTHEASTERN WISCONSIN: 2006**

LEGEND

RECEIVED POWER AT REMOTE:



Source: SEWRPC.

PRELIMINARY DRAFT

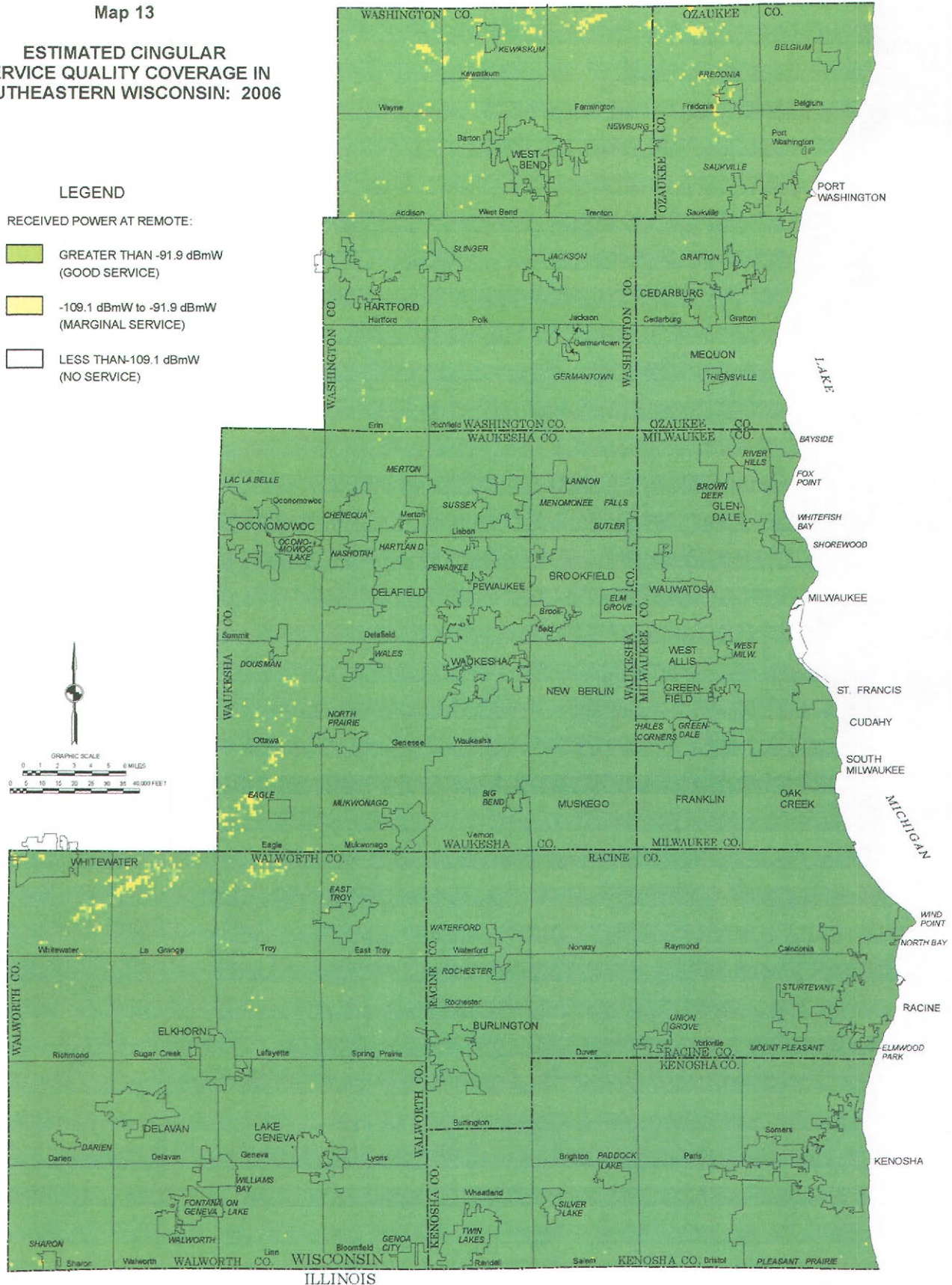
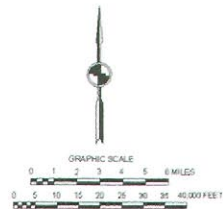
Map 13

**ESTIMATED CINGULAR
SERVICE QUALITY COVERAGE IN
SOUTHEASTERN WISCONSIN: 2006**

LEGEND

RECEIVED POWER AT REMOTE:

- GREATER THAN -91.9 dBmW
(GOOD SERVICE)
- 109.1 dBmW to -91.9 dBmW
(MARGINAL SERVICE)
- LESS THAN -109.1 dBmW
(NO SERVICE)



Source: SEWRPC.

PRELIMINARY DRAFT

Regional Wireless Service Coverage – U.S. Cellular

U.S. Cellular is the third CDMA network provider within the Region considered. This provider is unique in having no circuit-switched component in its network. Maps 14 and 15 constitute the radio coverage maps for this provider. The maps indicate that there are numerous areas with marginal coverage located throughout the Region, with particular areas of deficiencies in Ozaukee, Washington, and Walworth Counties. The reasons for such scattered marginal performance apparently relates to network layout since U.S. Cellular has one of the largest number base stations in the Region. U.S. Cellular consistently showed the lowest availability rate of any of the six regional wireless service providers in recent performance monitoring by the Commission.

Regional Wireless Service Coverage – T-Mobile

The coverage provided by T-Mobile, a second GSM wireless carrier operating within the Region, differs significantly from that provided by the first, Cingular, in the marginal nature of its coverage in many areas of the Region. This carrier provides poor or no coverage, in most of Walworth County and southwestern Waukesha Counties. The service also has significant gaps in Washington and Ozaukee Counties despite the fact that the common power levels were used for all providers in radio propagation modeling. The radio signal coverage is shown in Map 16 and the service quality coverage in Map 17.

Summary – Wireless Service Area Inventory

The cellular-PCS wireless service inventory reveals a Region geographically well covered for mobile wireless voice communications. Five of the six regional wireless carriers provide mobile wireless services in all seven counties of the Region. The sixth carrier, T-Mobile, operates in six of the seven counties, with very limited service in Walworth County. Two of the carriers, Cingular and Nextel, have few areas with marginal coverage, and the remaining carriers provide quality service in the majority of the Region.

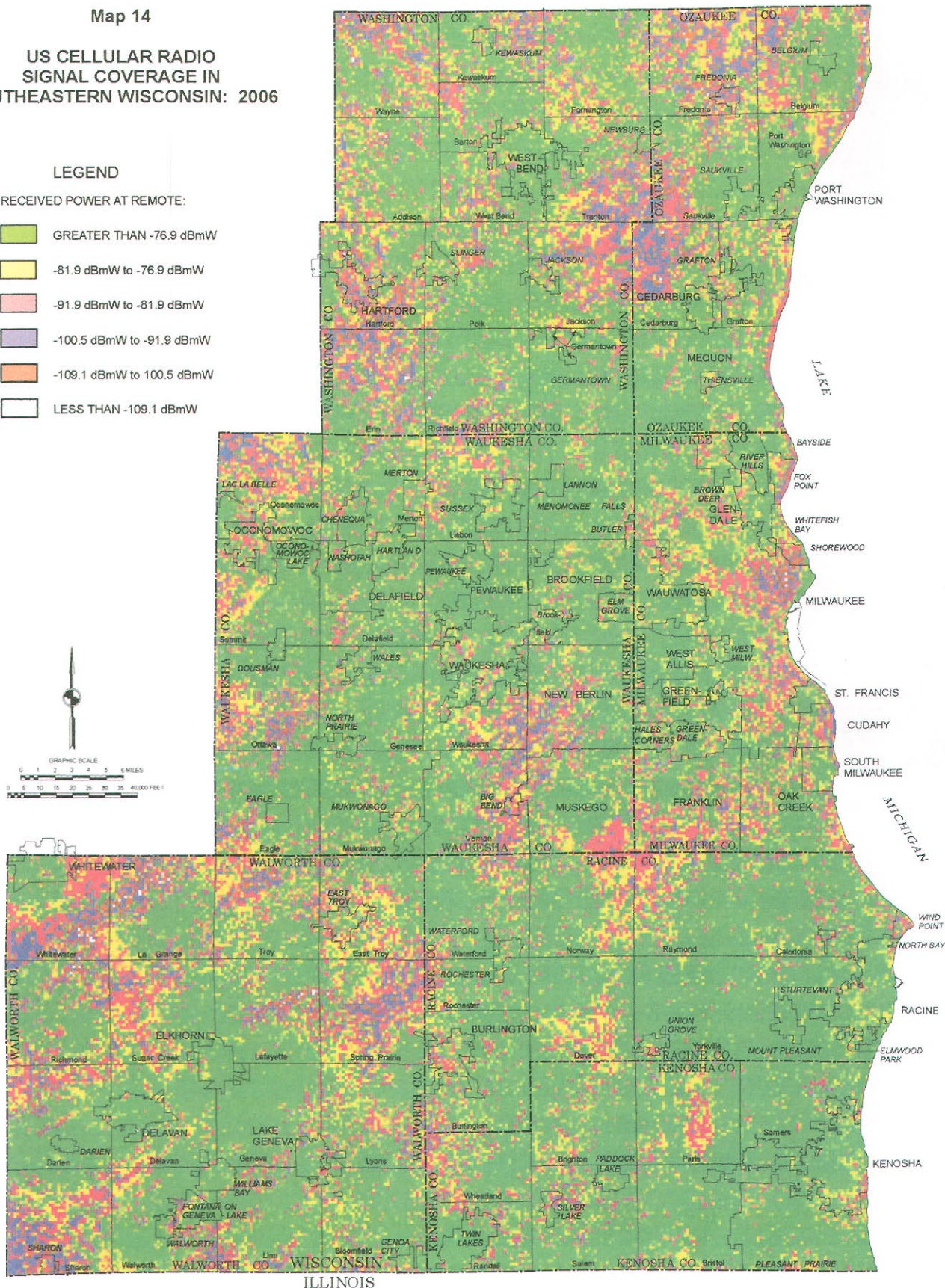
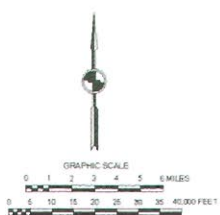
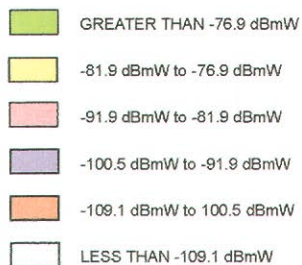
Data communications performance, however, is far below the objectives for fourth generation mobile wireless set forth in Chapter III of this report. The previous seven-county regional wireless network performance inventory recorded download performance of only 178.2 kilobits per second, and upload performance of 63.3 kilobits per second for 2G networks. 3G networks improved to 336.0 kilobits per second for download, and 78.9 kbps for upload. Only the 3G download throughput qualifies for “little broadband” status based on the Federal Communications Commission standard of 200 kilobits per second. Many developed nations of the world have a higher broadband standard of 1.5 megabits per second. All of these performances are far below the throughput objective of 20 megabits per second set forth in Chapter III.

Map 14

US CELLULAR RADIO
SIGNAL COVERAGE IN
SOUTHEASTERN WISCONSIN: 2006

LEGEND

RECEIVED POWER AT REMOTE:



Source: SEWRPC.

PRELIMINARY DRAFT

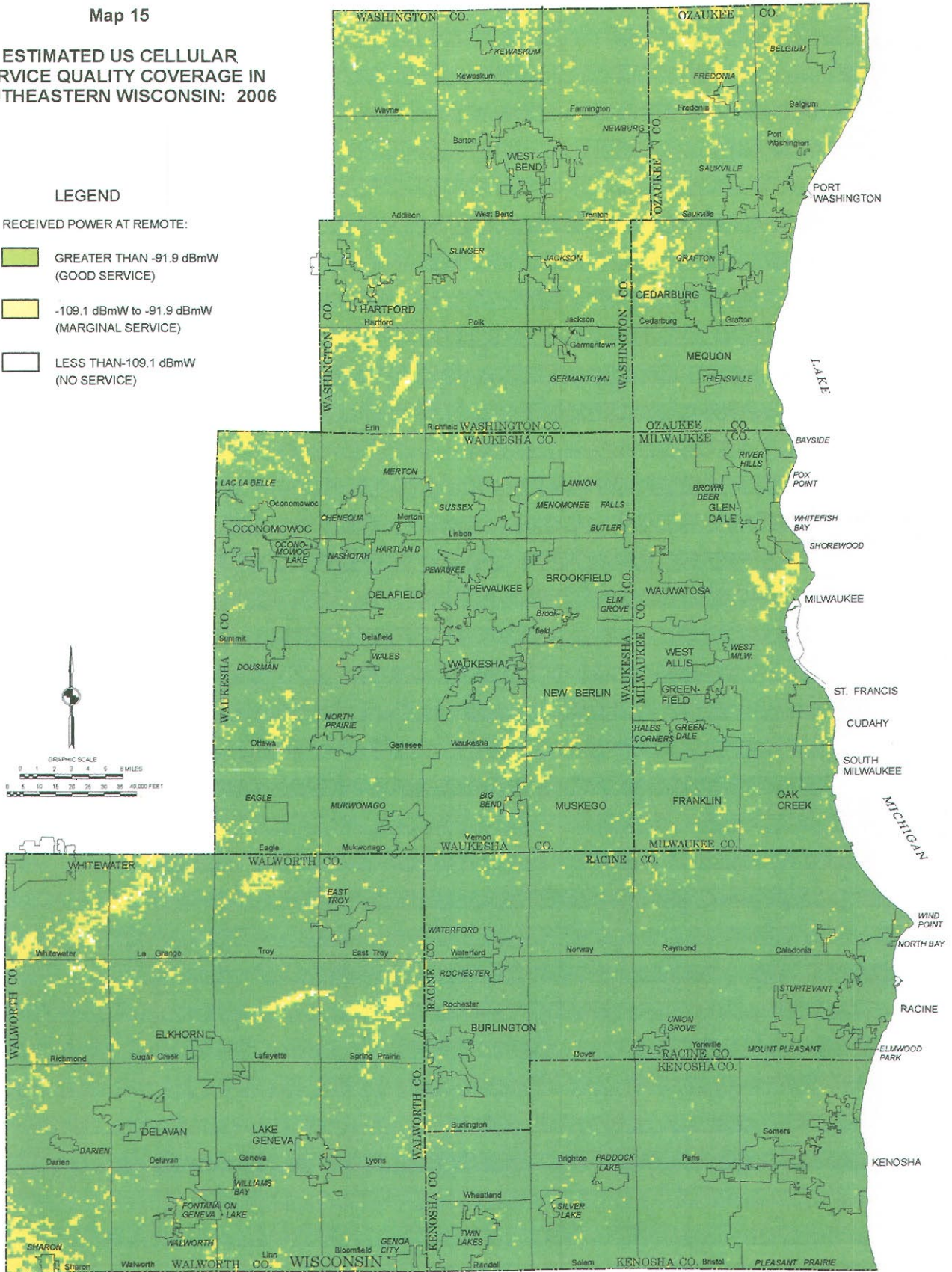
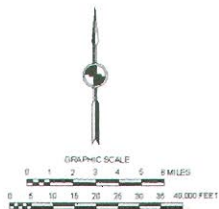
Map 15

**ESTIMATED US CELLULAR
SERVICE QUALITY COVERAGE IN
SOUTHEASTERN WISCONSIN: 2006**

LEGEND

RECEIVED POWER AT REMOTE:

- GREATER THAN -91.9 dBmW
(GOOD SERVICE)
- 109.1 dBmW to -91.9 dBmW
(MARGINAL SERVICE)
- LESS THAN -109.1 dBmW
(NO SERVICE)



Source: SEWRPC.

PRELIMINARY DRAFT

LEGEND

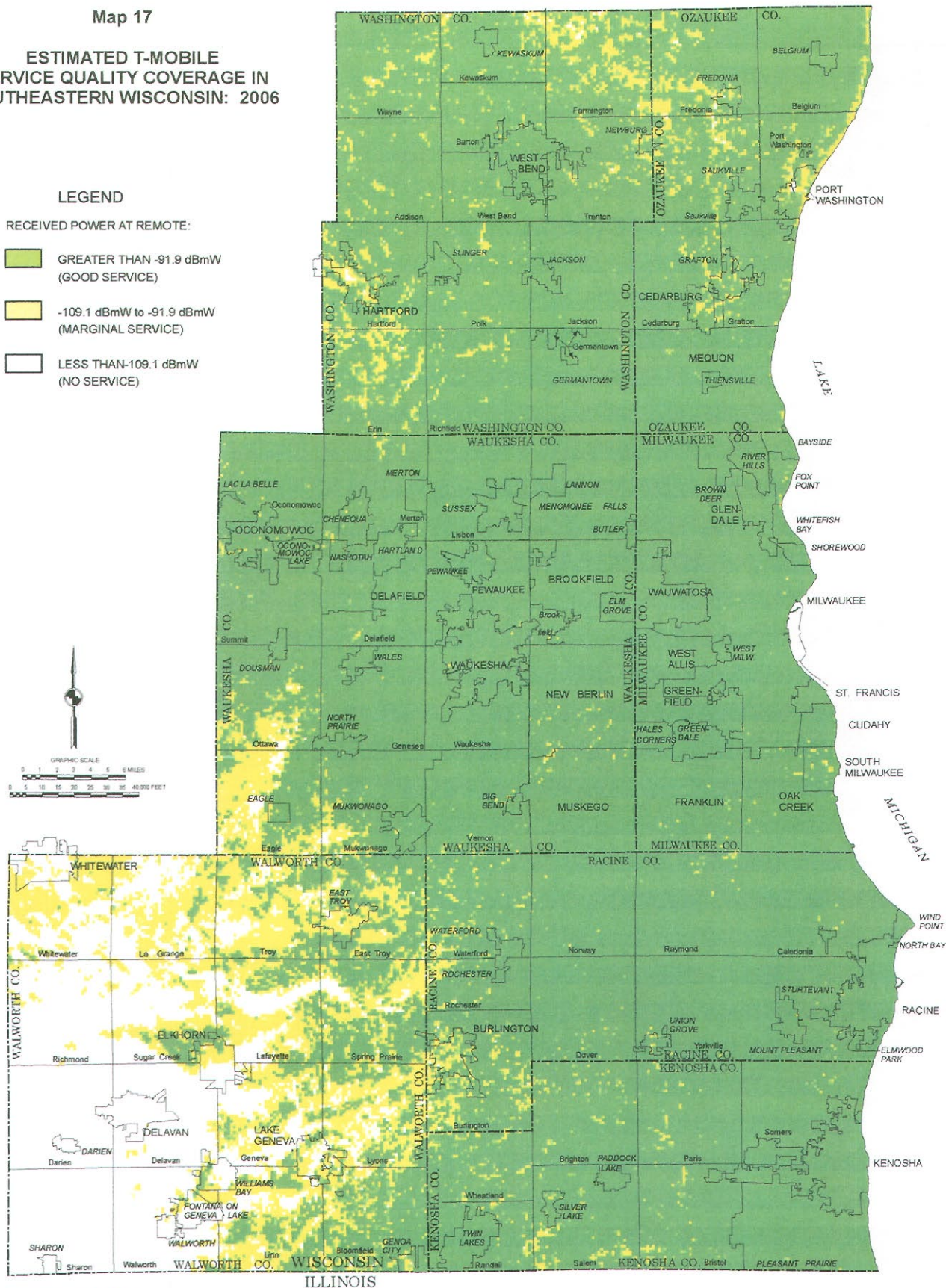
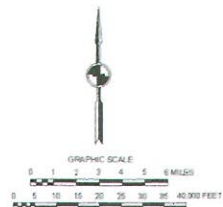
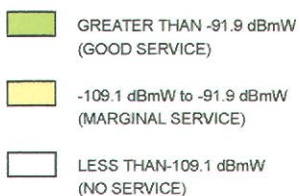
RECEIVED POWER AT REMOTE:

	GREATER THAN -76.9 dBmW
	-81.9 dBmW to -76.9 dBmW
	-91.9 dBmW to -81.9 dBmW
	-100.5 dBmW to -91.9 dBmW
	-109.1 dBmW to 100.5 dBmW
	LESS THAN -109.1 dBmW



ESTIMATED T-MOBILE
SERVICE QUALITY COVERAGE IN
SOUTHEASTERN WISCONSIN: 2006

RECEIVED POWER AT REMOTE:



Source: SEWRPC.

32

None of the three mobile wireless technologies employed in the Region -- GSM, CDMA or iDEN -- is suitable for upgrade to 4G performance levels. The two current competing 4G-class mobile technologies are WiMAX (802.16e), an emerging industry standard, and P2P, a proprietary Qualcomm technology now under development. Sprint is the only Regional mobile wireless carrier to announce field trials with WiMAX. It is fair to assume that deployment of any fourth generation mobile wireless network in Southeastern Wisconsin is at least 3 to 4 years in the future.

CORE NETWORK INVENTORY

Historically, points of presence (POPs) were the interexchange carriers' (IXC) equivalent of the local telephone company central offices. All long distance calls were routed through the IXC's POP facilities. In a traditional circuit-switched network, local exchange carrier calls would be provided a line -- or channel -- for the duration of the call. In the packet-switched networks of concern here, the POP provides an Internet connection to a fiber optic cable network capable of transporting the packet set to its destination. For incumbent local exchange carriers, the POP point is often located at a central office. The decentralized nature of packet-switched networks, and the ability of such networks to access outside of the POP locations makes traditional points-of-presence less important to advanced wireless communications systems as described below.

A partial core network inventory of existing points of presence (POP) locations was originally envisioned as a part of the regional telecommunications planning effort. Such POP points constitute important elements of any future broadband wireline or wireless communications system in the Region since they provide fiber optic connection to the Internet. There are numerous broadband fiber optic core networks in the Region with each having its own POP locations for interconnection with other networks. Some of these POP point locations are known and available for Internet gateway connection to existing or new broadband wireline or wireless networks. Others are not publicly available and are useable only by special private arrangements with the carrier. For a new broadband communications system to interconnect at a POP point, it must provide a wireline or wireless link to that POP point. Such links, particularly for fiber optic wireline links, can be quite costly. The initial and continuing costs of such links can significantly change the economics of network deployment. For this reason, a search was carried out for an alternative to established POP point Internet gateway access.

One such an alternative is found in the hybrid fiber coaxial networks of the two regional cable companies - Time Warner Cable and Charter Communications. Internet access through these cable networks can be implemented with an average link distance of about one-half mile. For this reason, the concept of a POP gateway has little meaning in fiber coaxial cable networks. Both Time Warner Cable

and Charter have literally thousands of "POP points" available wherever their networks are deployed in the Region. One possible key to future new broadband access network deployment, therefore, rests with connection to the hybrid fiber optic coaxial cable networks. Other alternatives for Internet connection may exist in the core fiber optic cable facilities deployed by other service providers within the Region, such as AT&T, Norlight and Time-Warner Telecom. For this reason, a detailed inventory of fiber network POP points for non-cable networks as originally envisioned was not pursued.

SATELLITE BROADBAND COMMUNICATION SERVICES

A number of service providers offer broadband satellite based Internet access communications within the Region and throughout the United States. Download speeds vary from 500 kilobits per second, to 3 megabits per second while upload speeds are much slower in the range of 128 kilobits per second to 1.5 megabits per second. Monthly service fees extend from \$50 per month at the low end to \$1,000 per month at the high end. Megabit per second performance generally calls for charges exceeding \$500 per month. For this reason, broadband satellite services can not compete with other broadband service alternatives when and where they are available. Most current satellite broadband service users reside in rural areas lacking other forms of broadband communications services.

Operating in the super high frequency SHF -- 2.5 to 22 GHz -- bands, satellite communications has the advantage of significant bandwidth allocation which generally allow for high throughput rates. This bandwidth must be shared, however, with a large body of other users to support the costs of launching and maintaining communications satellites in orbit. These low earth orbiting satellites to be effective on a 24-hour basis, must be continuously available on a line-of-sight basis throughout the service area. Such availability requires a large fleet of satellites for continuing coverage.

A geosynchronous (GEO) satellite is a satellite whose orbital track on the Earth repeats regularly over points on the Earth over time. If such a satellite's orbit lies over the equator, it is called a geostationary satellite. Such satellites to be geosynchronous must orbit at an altitude of 22,369 miles so as to have an orbital period of 23 hours and 56 minutes, the same as the Earth's rotation period.

A geostationary satellite appears to be fixed in one location above the equator. Other GEO satellites are stationary over other locations on the earth's surface. All GEO satellites have an inherent time delay of about 0.25 seconds for a round trip to and from the satellite. Such delays preclude their use in voice communications. GEO systems also require the use of expensive, bulky directional antennas that must be pointed and calibrated to acquire a satellite. Low earth orbit (LEO) satellites, in contrast, use small omnidirectional antennas that do not require calibration. GEO satellites also do not interface well with the

Internet and its TCP/IP protocol. For all of these reasons, GEO satellites are best used for television broadcasting and high-speed data transmission.

ENTERPRISE NETWORKS

Modern communications networks in the United States and worldwide take two forms by way of organizational structure and clientele served; utility networks and enterprise networks. Utility networks such as those operated by AT&T, Verizon, Time-Warner Cable and Charter Communications are organized to serve the general public. These networks are owned and managed by the private service providers and offer a wide range of voice, video and data communications services to consumers, businesses, government entities and other organizations. Enterprise networks, in contrast, are owned and operated by individual enterprises to serve the needs of the enterprise. Enterprise networks do not typically offer communications services to the general public. Enterprise networks serve medium and large businesses, government, health care and educational institutions and other private and public enterprises. In developing and deploying their enterprise networks, organizations may lease facilities, particularly land line facilities, from service providers in lieu of constructing all elements of their networks. They also typically purchase other network equipment such as switches, routers and multiplexers for their exclusive network use. The key difference, however, is that enterprise networks are owned and operated by the enterprise to serve enterprise functions.

~~The regional telecommunications planning program has, as set forth in the Commission's prospectus used to constitute the program on only two classes of communications networks: utility networks that serve the general public; and public networks such as public safety networks to serve governmental functions. Enterprise networks, as defined above by their very nature are not a primary concern to a public planning agency such as the Regional Planning Commission since they do not serve the general public and do not directly support governmental functions.~~

The regional telecommunications planning program was originally envisioned to address only telecommunications networks that either performed governmental functions, such as public safety, or offered services to the general public. Enterprise networks were not intended to be addressed except peripherally. Maintaining the economic viability and competitiveness of the Southeastern Wisconsin Region, however, was a major objective of the planning program. And, the availability of fiber optic cable core network facilities is an important factor in regional economic development. For this reason, an attempt was made in the planning program to map the location and geographic availability of the existing fiber optic cable core network serving in the Region.

In this respect, it is important to note the somewhat divergent needs of small, medium and large scale businesses and industries within the Region. Small businesses generally rely on residential

telecommunications networks for reasons of cost, scale and geographic availability. For this reason, universal geographic availability of broadband communications is an important factor in regional economic development. Data published by the U.S. Small Business Administration (SBA) indicate that over 50 percent of all small businesses may be expected to be home-based and therefore widely distributed geographically. Other small business enterprises also tend to be similarly widely dispersed geographically throughout an urban region. Small businesses play a vital role in the growth of the regional economies. Data published by the SBA indicate that from 1996 to 2006 60 to 80 percent of net new jobs created annually at the national level were created by small business enterprises. Many of these businesses are based on new technologies. SBA data also indicate that small businesses produce 13 to 14 times more patents per employee than larger businesses that are active in patenting. An increasing number of these small businesses are information-oriented, and have need for high performance broadband communications. Given their home-based, or small facility-based, nature and their wide dispersion throughout an urban region, small businesses may be expected to benefit from broadband communications networks that cover the entire Region. Accordingly, the Commission telecommunications planning effort focused on services provided to the general public.

The importance of small business enterprises to economic development within the Region is confirmed by the following excerpts from the *Jobs in the New Millennium* report of the Wisconsin Policy Research Institute for the period 1999 through 2003.

1. *Small Business*

In the Metropolitan Milwaukee area -- Milwaukee Waukesha, Ozaukee and Washington Counties --small business employs 76.6 percent of all of the 799,690 private sector employees in the area. In Racine and Kenosha counties, the corresponding small business percentages are 78.7 percent, and 83.9 percent respectively. Nationally, small business provides about 50 percent of all private sector jobs.

2. *Employment gains from 1999 through 2003 were confined to establishments with under 100 employees. Large businesses -- over 500 employees -- accounted for 60 percent of the employment losses even though they represented only 21.3 percent of the workforce.*

The relatively higher percentage of small business employees in Southeastern Wisconsin along with their recent position as the only source of job growth make wide coverage regional broadband communications a high economic priority.

Medium and large-scale organizations present a somewhat different set of telecommunication requirements than small businesses. Such medium and large-scale organizations typically design and operate their own

enterprise networks. The trend toward enterprise networks began with the breakup of the Bell System in 1984, and accelerated with the growth of large-scale national and international data networks. Although enterprise networks are typically designed and installed in cooperation with communications equipment vendors such as Cisco or Nortel Networks, all such networks have the need for land-line fiber optic cable links that provide the required bandwidth capacity to serve the communication needs concerned. Such core network service is typically arranged with core network carriers such as AT&T, Time Warner Telecom, Norlight Communications, or others within the Region. The capacity of the optical fiber cable network generally is not an issue. Most fiber core networks within the United States and the Region are underutilized. The real issue is geographic availability. Fiber optic cable core facilities do not exist in many parts of the Region. For this reason, a definitive, comprehensive map of the Regional fiber optic core network within the Region would provide a valuable resource.

The acquisition of such network layout information requires the cooperation of the core network providers themselves. At the small business level, broadband communications is synonymous with the residential networks. The telephone system Incumbent Local Exchange Carriers (ILECs), and the two regional cable companies, Time Warner Cable and Charter Communications, own the majority of the fiber optic cable facilities required for broadband connection. Although earlier attempts under the regional planning program to obtain detailed information on the core fiber optic cable networks were unsuccessful, the Commission in February 2007 determined to again seek the cooperation of the core optic cable facility providers in mapping those facilities.

In 2007, the major carriers serving the enterprise network fiber optic core network market within the Region included the following: 1.) AT&T; 2.) Time Warner Telecom; 3.) Norlight Telecommunications; 4.) TDS Metrocom; and 5.) Midwest Fiber Networks. The latter form provides "dark" rather than electronically activated fiber optic cable facilities that must be equipped and activated by the user.

The remaining core networks service providers are smaller ILEC carriers that offer core network services only in their own ILEC service areas. These in 2007 included: 1.) Verizon North; 2.) Century Tel; 3.) State Long Distance (Elkhorn); and 4.) Sharon Telephone Company.

An unsuccessful search was made of the Federal Communication Commission, and Wisconsin Public Service Commission data bases to obtain definitive information on the location of the core optic fiber facilities within the Region. The Commission on February 21, 2007, sent letters to all known fiber optic core network carriers operating within the Region requesting definitive information on the cable networks locations. As of March 21, 2007, replies were received only from Verizon, politely declining cooperation. Apparently -- barring State legislation -- the necessary information will become publicly available only

when the carriers see it to be in their own interest to cooperate with public bodies such as the Commission in developing a core network infrastructure inventory.

Lacking comprehensive fiber optic core network location information for the Region, the Commission selected to work with core network providers in plan design and implementation on a project-by-project basis. Such an approach allows for the implementation of specific advanced broadband communications system plans based on core network connections specified for a given geographic area. In such a working relationship, the core network carrier would typically offer a number of possible Internet locations, so that a selection could be made that would maximize the performance versus cost of the new network infrastructure design. To date, two core network carriers, Charter Communications and Time Warner Telecom, have demonstrated a willingness to cooperate in this critical aspect of plan implementation. Attempts will be made to expand this group of carriers so that all parts of the Region will achieve broadband communications coverage.

SUMMARY AND CONCLUSIONS

Broadband wireline communications services in the Region are currently offered primarily by the major incumbent telephone company, AT&T, and the leading cable services provider, Time-Warner Cable. Other incumbent telephone companies, such as Century Tel and Verizon North also offer broadband communications services in some parts of the Region. Charter Communications, the other regional cable services provider, has deployed broadband cable networks in areas of Washington and Walworth counties and in the City of Oconomowoc.

Telephone-based service providers utilize a technology known as DSL - digital subscriber line - which transmits high speed data over twisted pair copper wires originally used for voice communications. Cable companies employ a hybrid communications technology that combines fiber optic cable links with traditional coaxial cable connections to deliver high speed data services.

None of the existing wireline broadband services networks in the Region offer throughput data rates that meet the Commission recommended performance standard of 20 megabits per second. All of the current wireline services are extremely asymmetrical, with upload speeds of 20 percent or less of download speeds. AT&T, the leading DSL service provider, is in the process of deploying a Fiber-to-the-Node technology (FTTN) that is designed to achieve the Commission recommended broadband service standard of 20 megabits per second. Advanced broadband service plans of the two cable service providers, Time-Warner Cable and Charter Communications, have not been revealed at this time. Similarly, the other DSL service

providers have not announced plans for technologies designed to meet the 20 megabits per second throughput standard.

None of the major current wireline broadband service providers offer the universal geographic coverage objective recommended by the Commission. Cable services in many communities serve the large majority of the population, but there are still areas of the Region that do not meet the Commission recommended standards for extension of broadband cable services. DSL broadband services from telephone service providers are also not universally available from the wireline carriers in the Region. Furthermore, AT&T's plans for expanded broadband services target only 25 of the 116 local municipalities in Southeastern Wisconsin that AT&T serves. Although AT&T's post-2008 plans may expand this number, currently there is no information available on these plans.

PCE/KWB/KJS/lgh

03/08/07

#122026 V3 - T/C - PR No. 53 - Chapter V

PRELIMINARY DRAFT

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

Chapter VI

**TELECOMMUNICATIONS BROADBAND
PERFORMANCE INVENTORY FINDINGS**

INTRODUCTION

Chapter V presented the findings of an inventory of the current broadband telecommunications infrastructure within the Region expressed in terms of geographic coverage and types and levels of service. This chapter deals with the performance of the existing broadband communications networks, particularly with regard to throughput speed--the primary parameter for evaluating system performance under the regional telecommunications planning program. Performance data were collated from a variety of Internet websites that routinely collect throughput performance data from within the United States and worldwide. Performance data are analyzed and published by country, state or province, local community, down to the postal service zip code area level in the United States. Data are also summarized by technology -- DSL, cable, wireless -- carrier, and type of connection. Performance data, of course, are more readily available for larger geographic areas such as nations or states than for smaller areas. At the zip code area level, many areas have no recorded data available. For purposes of performance analyses, however, the type of technology and the individual service provider or carrier are of primary interest for planning purposes.

PERFORMANCE MONITORING CATEGORIES

The performance herein reported emphasizes wireline, rather than wireless, networks. This emphasis is based on two major considerations:

1. Wireless performance within the planning area was monitored by the Commission, and the findings were reported in SEWRPC Planning Report No. 51; and
2. The higher levels of performance typically provided by the wireline networks as compared to mobile wireless networks. Fixed wireless networks provide better throughput performance than mobile, but these networks do not serve all areas within the Region.

Broadband wireless performance is, however, herein reported to the extent that data are available for Region through the Commission's monitoring effort. Also of interest are satellite wireless communications in rural areas. Throughput data rate is the only measure of broadband performance herein considered. Data on the other major performance measure considered in the previous Commission wireless monitoring -- availability -- are not readily available for wireline networks. Moreover, availability performance in wireline networks is generally high -- approximating 99 percent or more -- so that availability is not a useful differentiator in wireline broadband service evaluations.

The performance data as herein reported are limited to data on data transmission rather than voice communications, since broadband capabilities are not generally relevant to circuit-switched voice traffic. Voice over internet protocol (VoIP) communications does share bandwidth with data traffic on packet switched networks, but performance quality is more dependent on network response time -- latency -- than on bandwidth or throughput. Also, regional use of VoIP is still at a relatively low level within this Region.

Based on website-based performance data, broadband throughput data are herein tabulated and analyzed by the following categories:

1. Technology -- with emphasis on hybrid fiber coaxial cable and DSL technologies;
2. Service Provider -- with emphasis on the major carriers operating within the Region;
3. Geographic Area -- broadband performance data availability becomes limited as the geographic areas concerned are reduced in size, but to the extent feasible, performance information is provided for counties and municipalities as geographic areas.

The end objective of the performance monitoring as herein reported is to determine the status of broadband communications within the Region as the foundation for developing future regional broadband communications systems.

Wireline Performance Data Sources and Parameters

A number of broadband communications websites were searched and evaluated prior to selecting two websites that provided higher quality and quantities of broadband wireline performance data. These two sites and the rationale for their selection are described below.

1. TCP/IQ Line Speed Meter

This website provides data on download speed, upload speed, and latency -- response time -- by county, state, community and postal service zip code area; and by service provider, technology and class of service.

2. Bandwidth Place

This website provides data only by state and technology type, but reports based upon a relatively large number of performance tests, e.g., over 30,000 for Time Warner Cable and over 48,000 for Charter Communications in Wisconsin alone.

The TCP/IQ website provides the most extensive categorization of the data, but sample quantities are low and non-existent for some categories. The Bandwidth Place website has high sample volume, but categorizations are coarse with no areal categories below the state level.

The TCP/IQ website was developed and is managed by Sigma Solutions, Inc. based in San Antonio, Texas. The company was formed in 1998 and has grown to 85 employees. The company develops database, server and internetworking software for businesses, government and institutional users, typically on a custom basis. The TCP/IQ website for network performance measurement was developed as a promotional tool to attract potential customers to the Company. The primary question relating to the use of the data concerns its accuracy. TCP/IQ line speed data are collected from Internet user volunteers who wish to measure their broadband performance in terms of download and upload throughput and latency time. In return for their cooperation, the volunteers receive free access to the performance data base. TCP/IQ maintains the high accuracy of its Internet performance reporting using the following measures.

1. Multiple Time Series Measurement

When a to be registered user contracts for the free service offered, the user agrees to allow collection of additional performance data which permit the averaging of link performance over time, thereby reducing the standard errors of the applicable means and allowing for measurement of performance variability.

2. Detection of Erroneous Data

A registered user must specify the service levels received in terms of maximum download and upload speeds. Performance data outside of these service ranges are ignored.

3. Three Month Moving Average

Each registered user's performance data are maintained as three month moving averages. Such a moving average provides a more accurate estimate of link performance than single readings.

Bandwidth Place is a small website company operating out of Calgary, Alberta. It differs from TCP/IQ and its sponsor, Sigma Solutions, in that it charges fees for its broadband communications measurement services. Users pay fees from \$10 to \$220 per year to receive network performance data on a continuing basis. The Version 1 of the program was placed on line in early 2000. The data acquisition software system is now in its fourth version, and over 100 million test runs have been compiled.

Bandwidth Place data were used herein only to summarize performance at the State level. All other performance data referenced in this Chapter are from TCP/IQ.

Using a combination of data from these two websites, it is possible to approximate the performance characteristics of the major broadband communications technologies currently operating within the Region. Performance data were collated, tabulated, and analyzed by technology and service providers starting at the national level, and moving down to state, region and community levels as data availability permitted.

Service Specifications

Most broadband communications services are based on a service package offering that states the maximum download and upload speeds permissible on that link connection. For example, a Time Warner Cable service offering of 3000/768 specifies a maximum download speed of 3000 kilobits per second and a maximum upload speed of 768 kilobits per second. These figures represent the results of bandwidth allocations made by the service provider. They do not represent a quality of service guarantee, and they are not typically incorporated in any service agreement. These specifications do, however, represent the maximum throughput possible for a given network service.

National Level Broadband Communications Performance

Since the same broadband wireline and wireless communications technologies are deployed throughout the United States, it was deemed advisable to first review broadband performance at the national level, and then compare it with State and local level performances. The larger sample counts available at the national level also improve the accuracy and reliability of the data.

The current overall performance of broadband communications in the United States is portrayed in Figure 1 which displays the means and standard deviations of the download and upload speeds of all Internet service providers over the time period from January 2003 to November 2006. The disparity between the faster download speeds and the slower upload speeds is quite apparent. Download speeds cover the one to two megabits per second range, while upload speeds are generally no more than 300 kilobits per second.

A display of the performance provided by the two primary wireline technologies used in the United States is provided in Figure 2. Broadband cable and DSL throughput performance for two different service levels are shown.

Although Comcast does not operate in Southeastern Wisconsin, its technology is similar to that of Time Warner and Charter, the primary cable service providers in the Region. Again, the slower upload speeds are graphically shown. A higher download throughput level of cable is indicated, but this performance also comes with a higher level of service and an associated higher cost.

The performance of Time Warner Cable is shown in Figure 3, 4 and 5 over the same 2003 through 2006 time period. Variations by the day of the week and hour of the day are also shown. The relatively slow upload speeds are again evident.

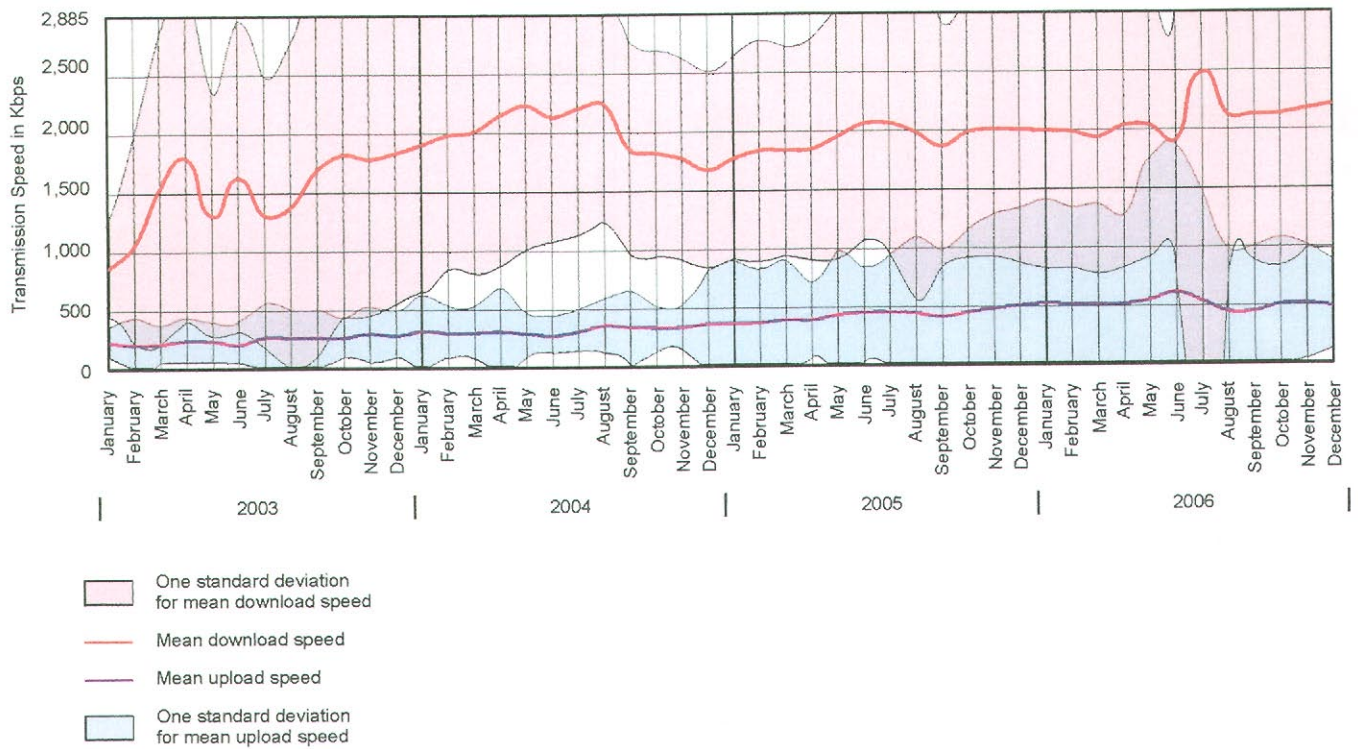
Time Warner Cable performance for a higher level of service offering is shown in Figures 6, 7, and 8. The 5000/512 service package promises a higher download speed than the previous 3000/768 service package but with a slower upload speed. The graphs actually indicate a slower download throughput but a slightly higher upload speed performance. Residential service agreements provide no quality of service guarantees. The higher throughput value represents only a maximum throughput speed allowed and not a guaranteed level of service.

An equivalent performance record for Charter Communications, the other regional cable service provider, is shown in Figures 9, 10 and 11. Throughput speeds are significantly slower than the equivalent service offering of Time Warner.

AT&T DSL performance at a higher service level -- 6,000/608 -- in the United States is plotted in Figures 12, 13 and 14. The significantly higher level of both download --over four megabits per second -- and upload speeds -- approximately 500 kilobits per second -- is noteworthy. The DSL category, however, is xDSL meaning higher level versions of DSL such as VDSL could be included in the data summary. Because deployment of VDSL by AT&T in the United States has not been extensive, most of the data in this summary is believed to represent ADSL technology.

Figure 1

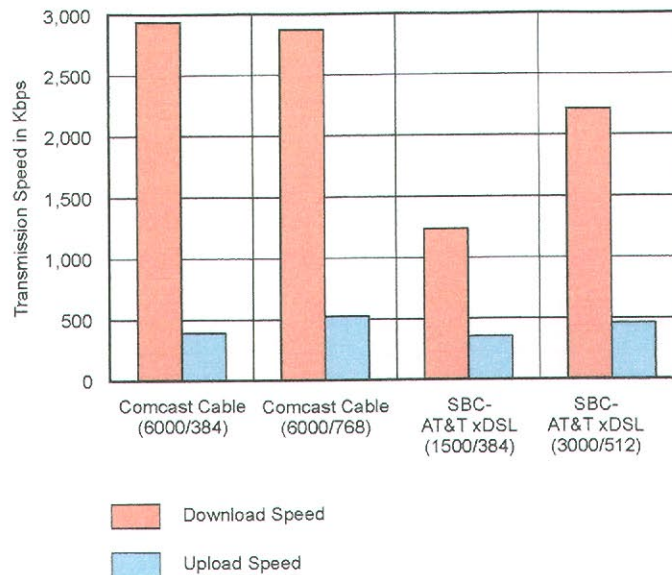
COMPARISON OF DOWNLOAD AND UPLOAD TRANSMISSION RATES FOR ALL INTERNET SERVICE PROVIDERS IN THE UNITED STATES: 2003 - 2006



Source: Sigma Solutions Group, LLC, and SEWRPC.

Figure 2

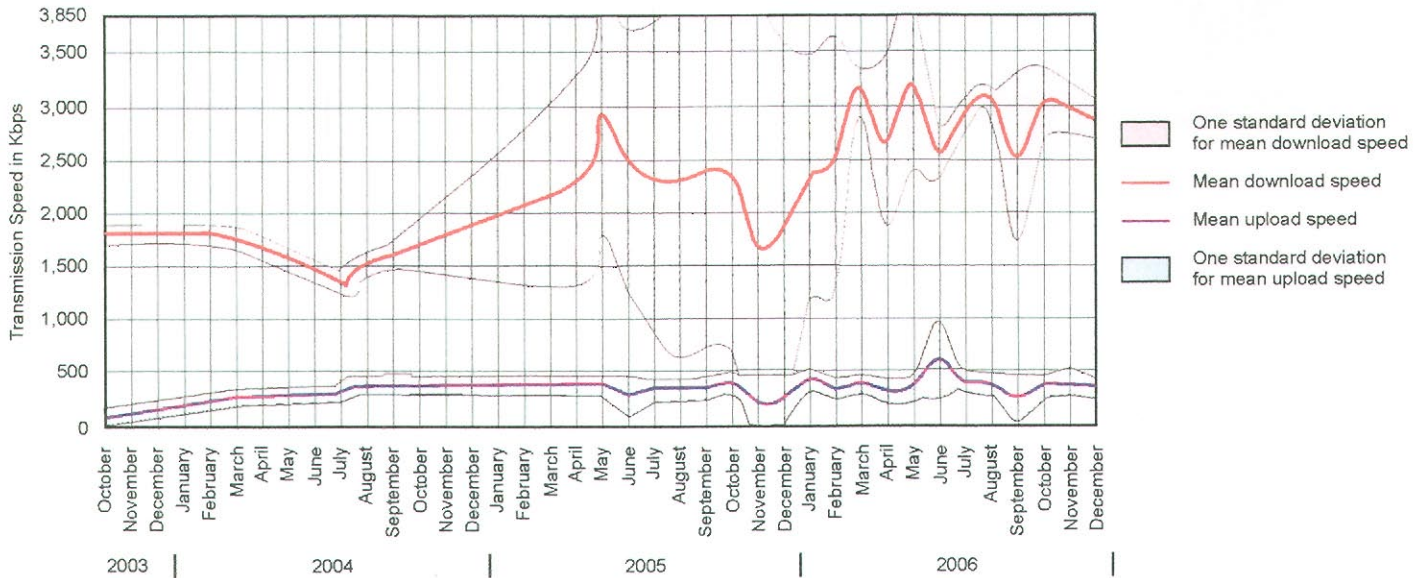
COMPARISON OF BROADBAND AND DSL PERFORMANCE FOR THE TWO PRIMARY SERVICE PROVIDERS IN THE UNITED STATES



Source: Sigma Solutions Group, LLC, and SEWRPC.

Figure 3

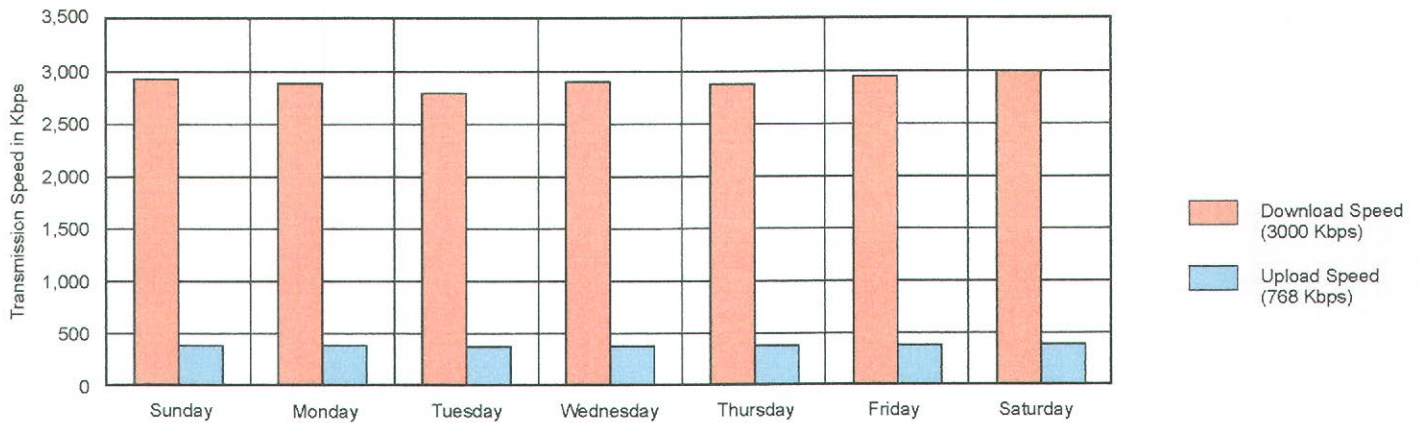
**ROAD RUNNER (TIME WARNER CABLE) SERVICE (3000 Kbps/768 Kbps)
IN THE UNITED STATES: OCTOBER 2003 THROUGH DECEMBER 2006**



Source: Sigma Solutions Group, LLC, and SEWRPC.

Figure 4

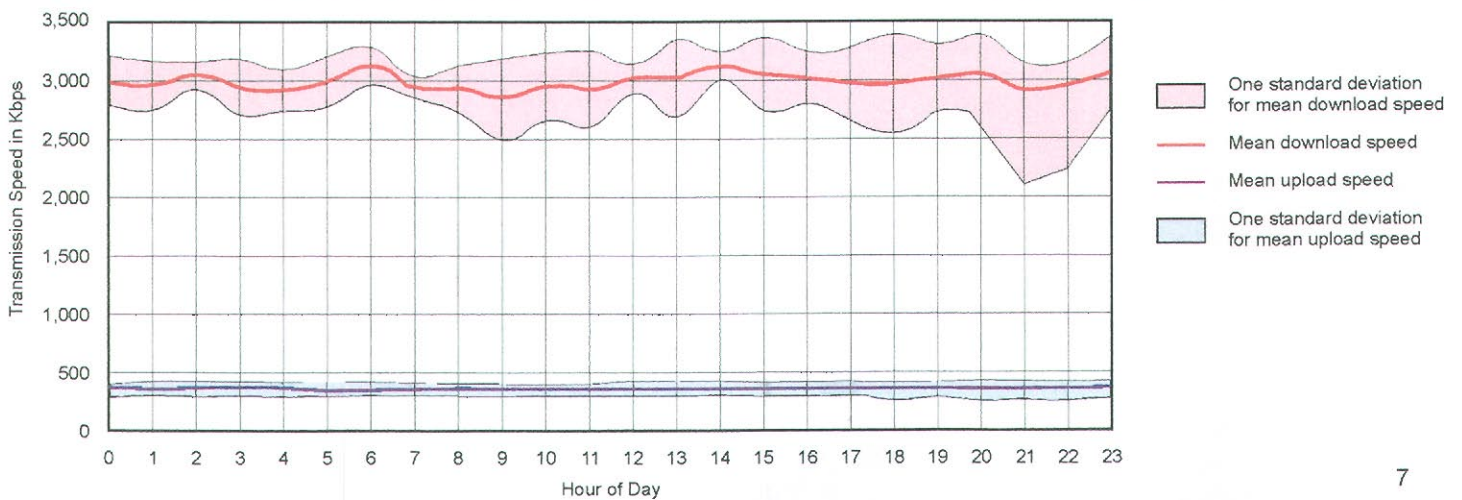
UNITED STATES- ROAD RUNNER (TIME WARNER CABLE) CABLE (3000 Kbps/768 Kbps) SPEED VS DAY OF WEEK



Source: Sigma Solutions Group, LLC, and SEWRPC.

Figure 5

ROAD RUNNER SERVICE (3000 Kbps/768 Kbps) IN THE UNITED STATES SPEED VS HOUR OF DAY (+1000)



Source: Sigma Solutions Group, LLC, and SEWRPC.

Figure 6

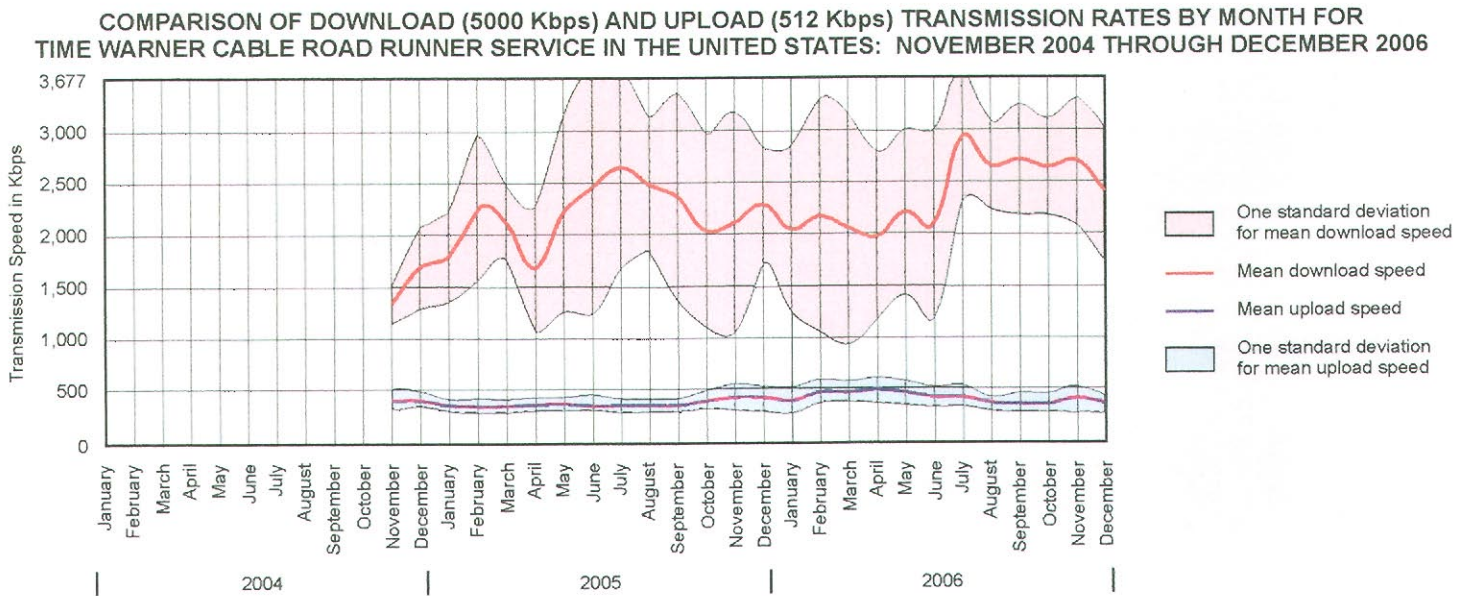


Figure 7

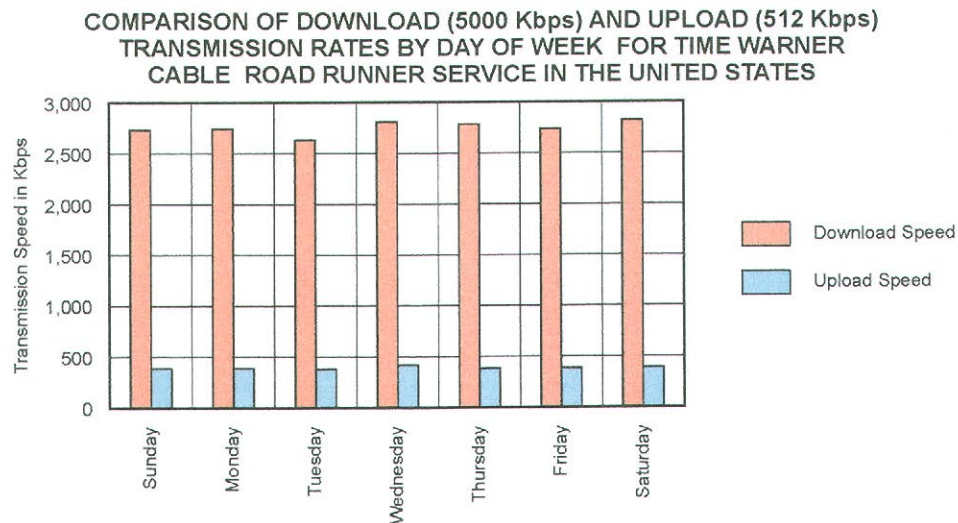


Figure 8

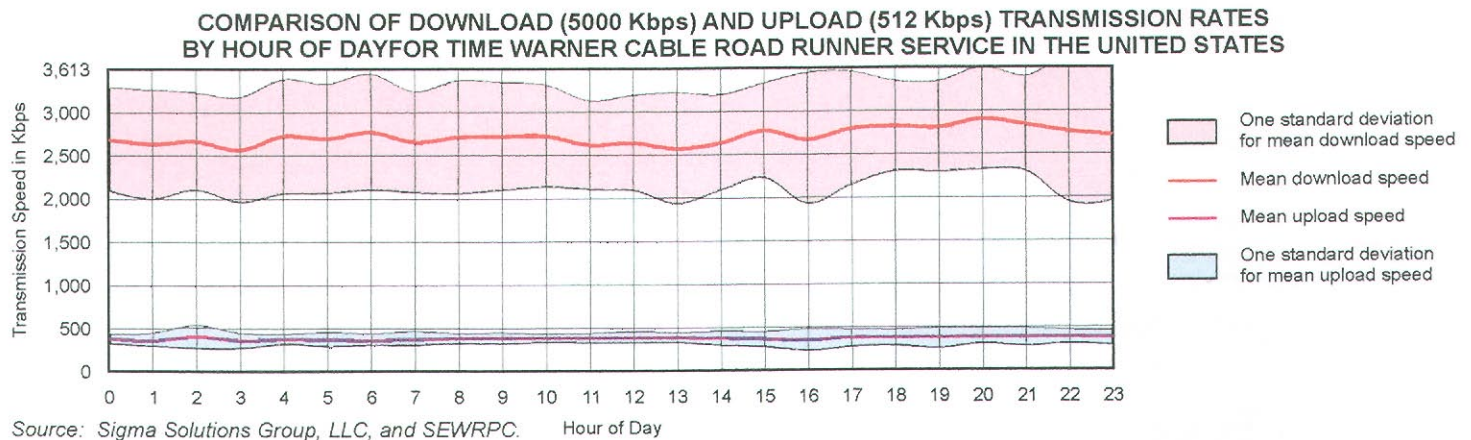
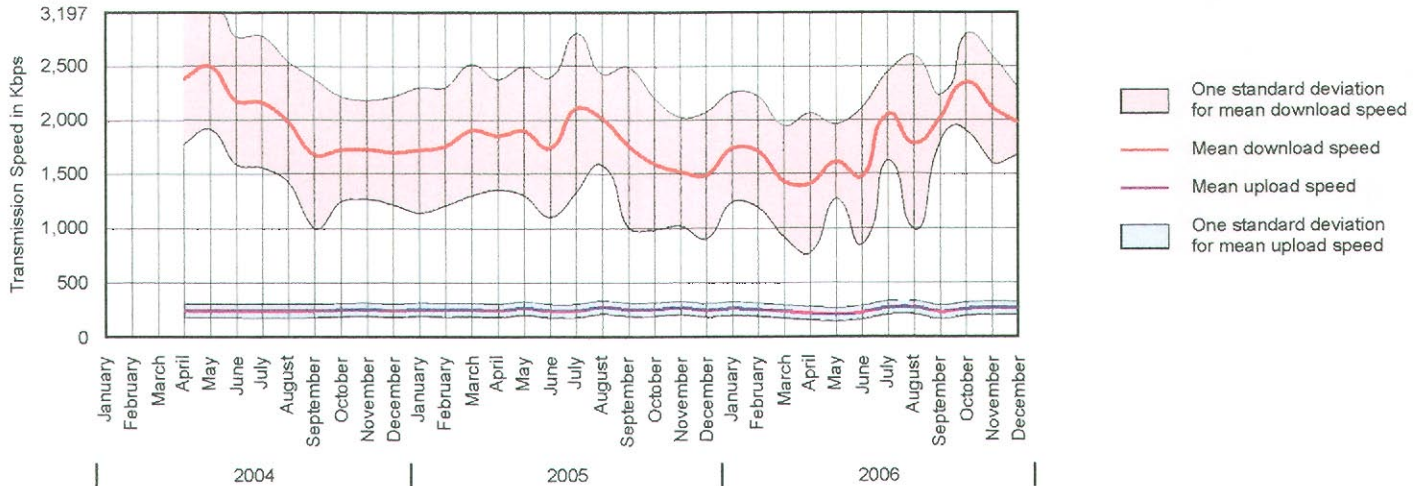


Figure 9

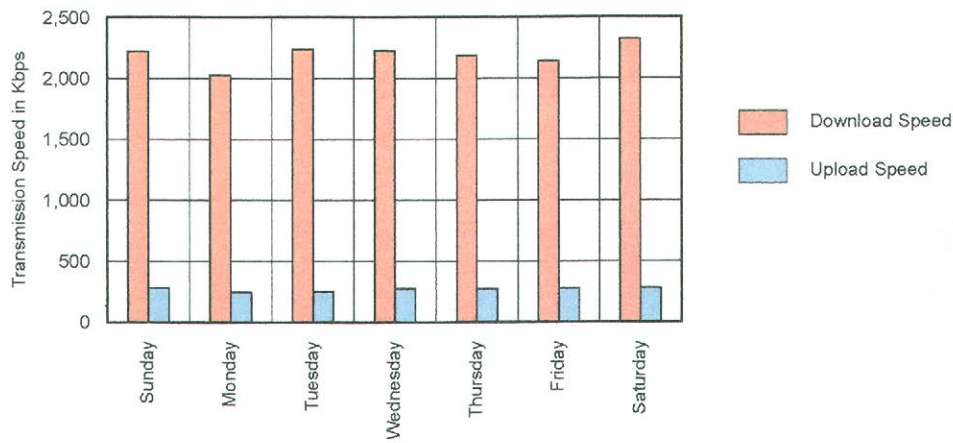
COMPARISON OF DOWNLOAD (3000 Kbps) AND UPLOAD (256 Kbps) TRANSMISSION RATES BY MONTH FOR CHARTER CABLE IN THE UNITED STATES: APRIL 2004 THROUGH DECEMBER 2006



Source: Sigma Solutions Group, LLC, and SEWRPC.

Figure 10

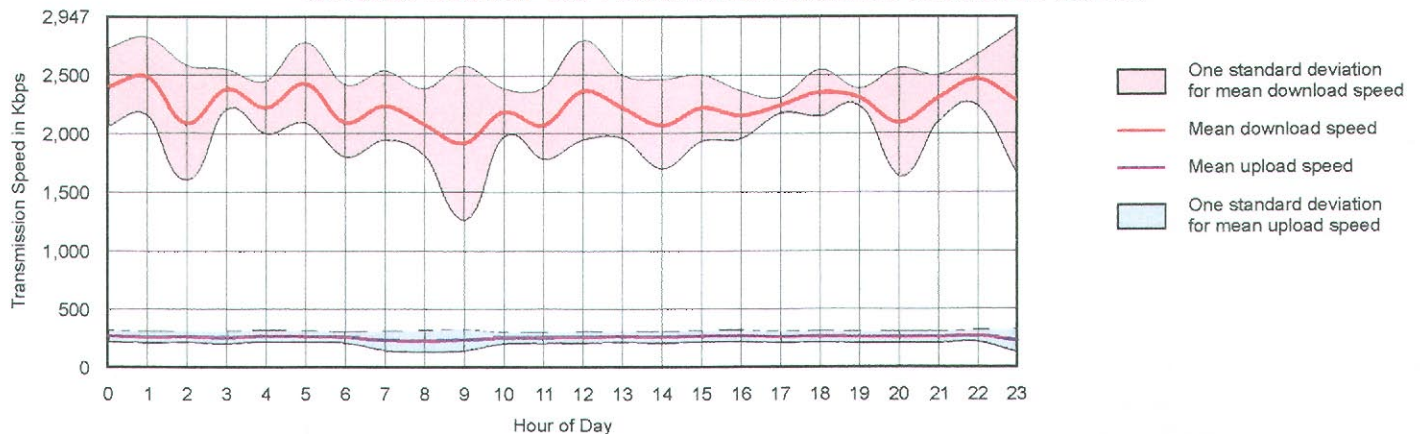
COMPARISON OF DOWNLOAD (3000 Kbps) AND UPLOAD (256 Kbps) TRANSMISSION RATES BY DAY OF WEEK FOR CHARTER CABLE IN THE UNITED STATES



Source: Sigma Solutions Group, LLC, and SEWRPC.

Figure 11

COMPARISON OF DOWNLOAD (3000 Kbps) AND UPLOAD (256 Kbps) TRANSMISSION RATES BY HOUR OF DAY FOR CHARTER CABLE IN THE UNITED STATES

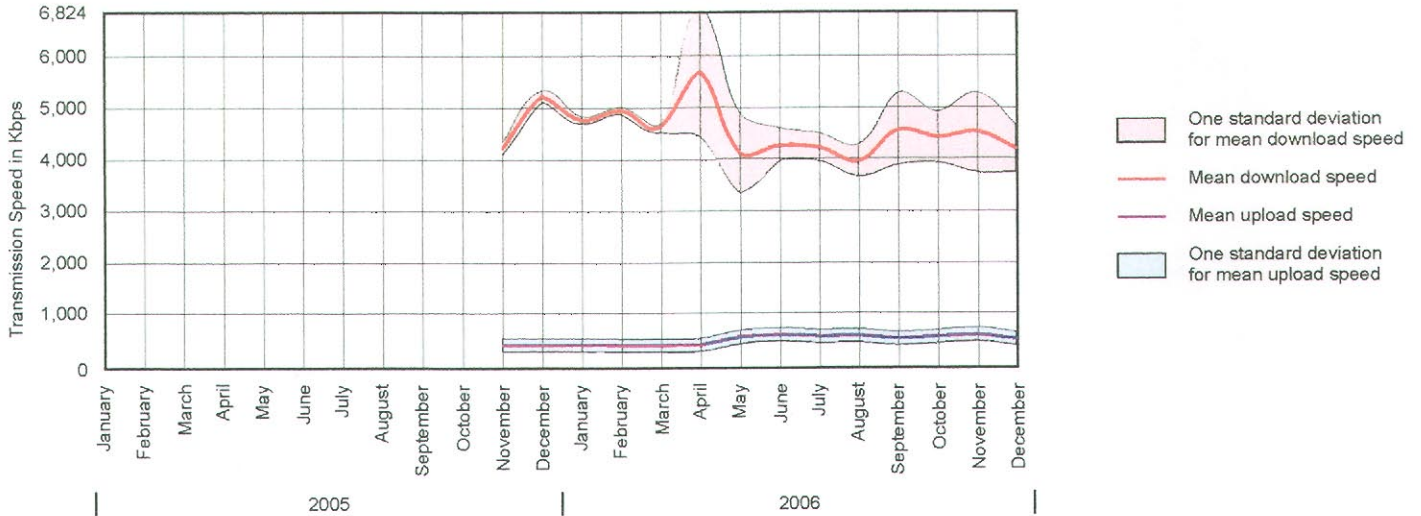


Source: Sigma Solutions Group, LLC, and SEWRPC.

PRELIMINARY DRAFT

Figure 12

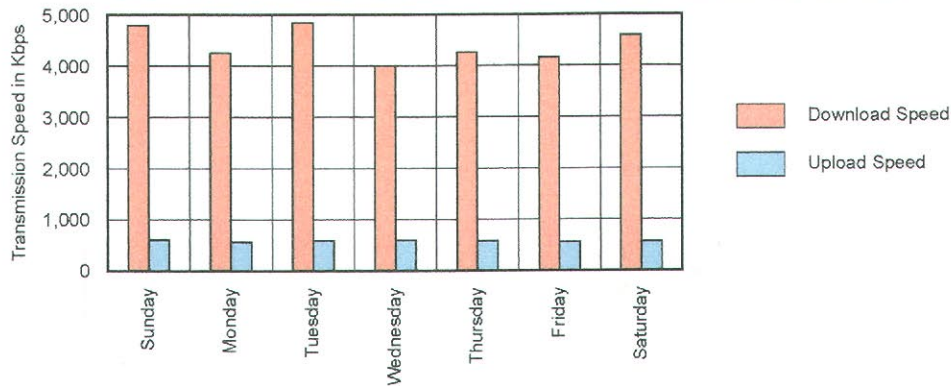
COMPARISON OF DOWNLOAD (6000 Kbps) AND UPLOAD (608 Kbps) TRANSMISSION RATES BY MONTH FOR SBC - AT&T xDSL SERVICE IN THE UNITED STATES



Source: Sigma Solutions Group, LLC, and SEWRPC.

Figure 13

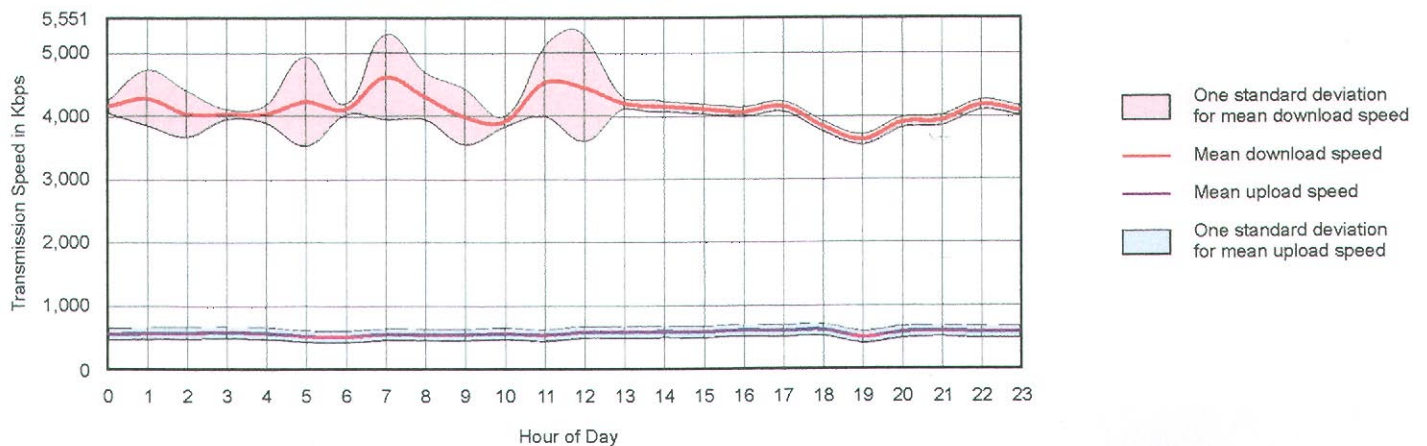
COMPARISON OF DOWNLOAD (6000 Kbps) AND UPLOAD (608 Kbps) TRANSMISSION RATES BY DAY OF WEEK FOR SBC - AT&T xDSL IN THE UNITED STATES



Source: Sigma Solutions Group, LLC, and SEWRPC.

Figure 14

COMPARISON OF DOWNLOAD (6000 Kbps) AND UPLOAD (608 Kbps) TRANSMISSION RATES BY HOUR OF DAY FOR SBC - AT&T xDSL IN THE UNITED STATES



Source: Sigma Solutions Group, LLC, and SEWRPC.

PRELIMINARY DRAFT

A similar data summary for Century Tel, a regional DSL service provider is displayed in Figures 15, 16 and 17. The level of service portrayed, however, is much lower at 1,500/256. It is significant that actual performance is very close to the service specified.

Wireless Broadband Performance

Performance data on wireless broadband networks even at the national level are not widely available. The cellular/PCS wireless monitoring data reported in SEWRPC Planning Report No. 51 provided a greater volume of data than most other publicly available reports even at the national level. The data collected by the Commission were for mobile rather than fixed wireless service. Some of the wireless performance data relate to standard technologies such as WiFi (IEEE 802.11), but most relate to a variety of proprietary technologies.

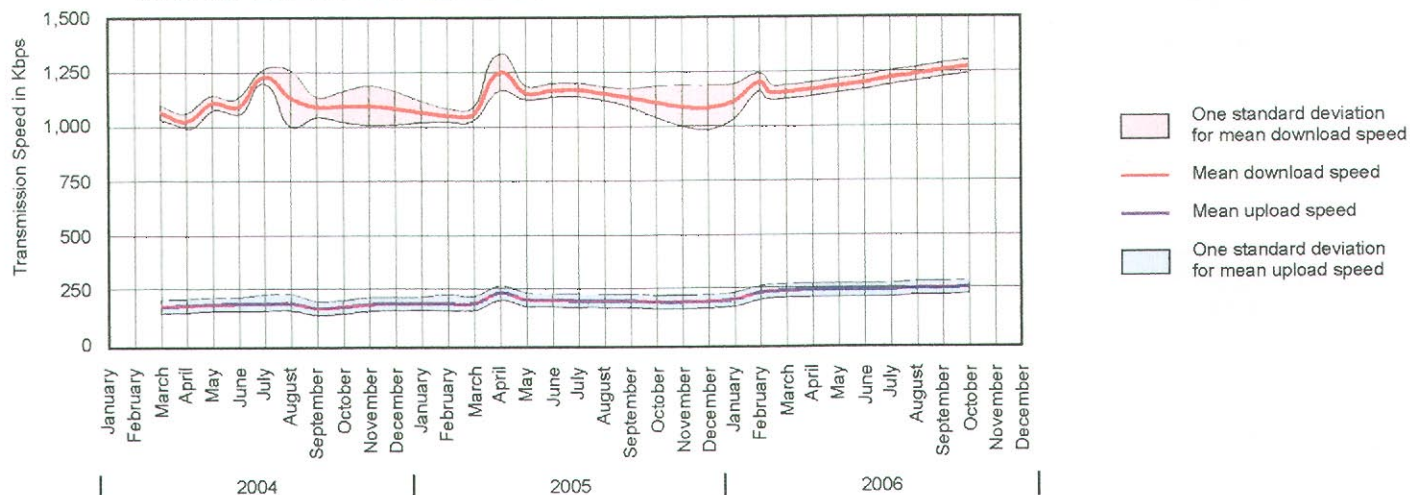
An interesting WiFi performance study is illustrated in Figure 18 for a 3600/3000 service level typical of mesh networks. Initially, upload throughput exceeds download throughput, an unusual situation for any current day broadband network. Although WiFi networks are basically symmetrical, ISPs typically allocate more band width to download traffic than upload traffic because most applications are download oriented.

Some rare data on broadband mobile wireless are shown in Figures 19, 20 and 21. All of the cellular/PCS broadband data collected and presented in SEWRPC Planning Report No. 51 were based on 3G CDMA technology as deployed by Verizon Wireless and Sprint. The new data presented in Figures 19, 20, and 21 relate to the GSM/GPRS technology employed by Cingular Wireless. A 3G version of GSM wireless technologies has not been deployed in Southeastern Wisconsin, but these results indicate that the technology is potentially capable of achieving the 3G throughput objective of two megabits per second. This objective, however, is still below the 4G standard of 20 megabits per second of interest here, but also far above the regional CDMA 3G performance recorded in SEWRPC Planning Report No. 51 which averaged only 336 kilobits per second in download performance, and 79 kilobits per second in upload performance.

Clearwire Wireless is a national broadband wireless service provider that employs a proprietary wireless technology (Alvarion) and WiMAX to provide broadband communications services in certain areas of the United States, including Wisconsin. The Company has deployed networks in the states of Washington, Oregon, California, Texas, North Carolina and Florida as well as a network in the Eau Claire/Chippewa Falls, area of Wisconsin. The performance graphs presented in Figures 22, 23 and 24 indicate performance levels in the 1.0 to 1.5 megabits per second range, which are probably typical of most fixed wireless networks in the United States.

Figure 15

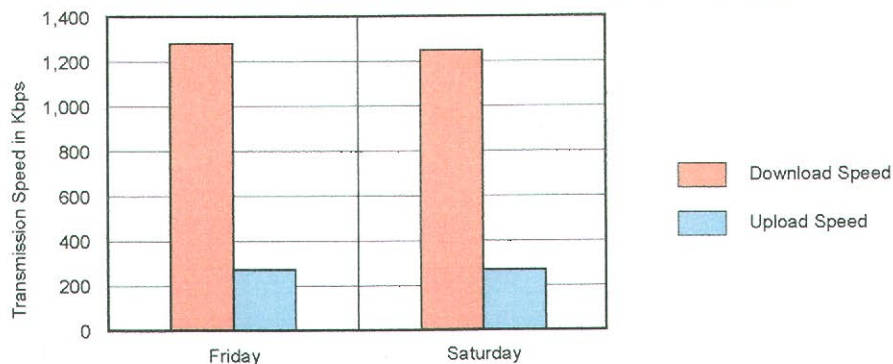
COMPARISON OF DOWNLOAD (1500 Kbps) AND UPLOAD (256 Kbps) TRANSMISSION RATES BY MONTH FOR CENTURYTEL xDSL IN THE UNITED STATES: MARCH 2004 THROUGH OCTOBER 2006



Source: Sigma Solutions Group, LLC, and SEWRPC.

Figure 16

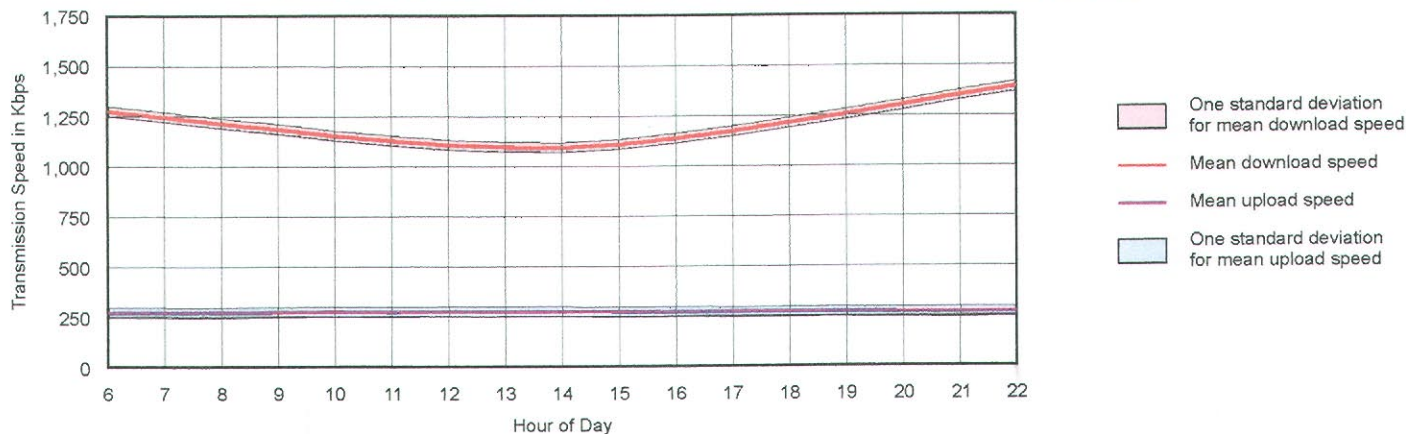
COMPARISON OF DOWNLOAD (1500 Kbps) AND UPLOAD (256 Kbps) TRANSMISSION RATES ON FRIDAYS AND SATURDAYS FOR CENTURYTEL xDSL SERVICE IN THE UNITED STATES



Source: Sigma Solutions Group, LLC, and SEWRPC.

Figure 17

COMPARISON OF DOWNLOAD (1500 Kbps) AND UPLOAD (256 Kbps) TRANSMISSION RATES BY HOUR OF DAY FOR CENTURYTEL xDSL IN THE UNITED STATES

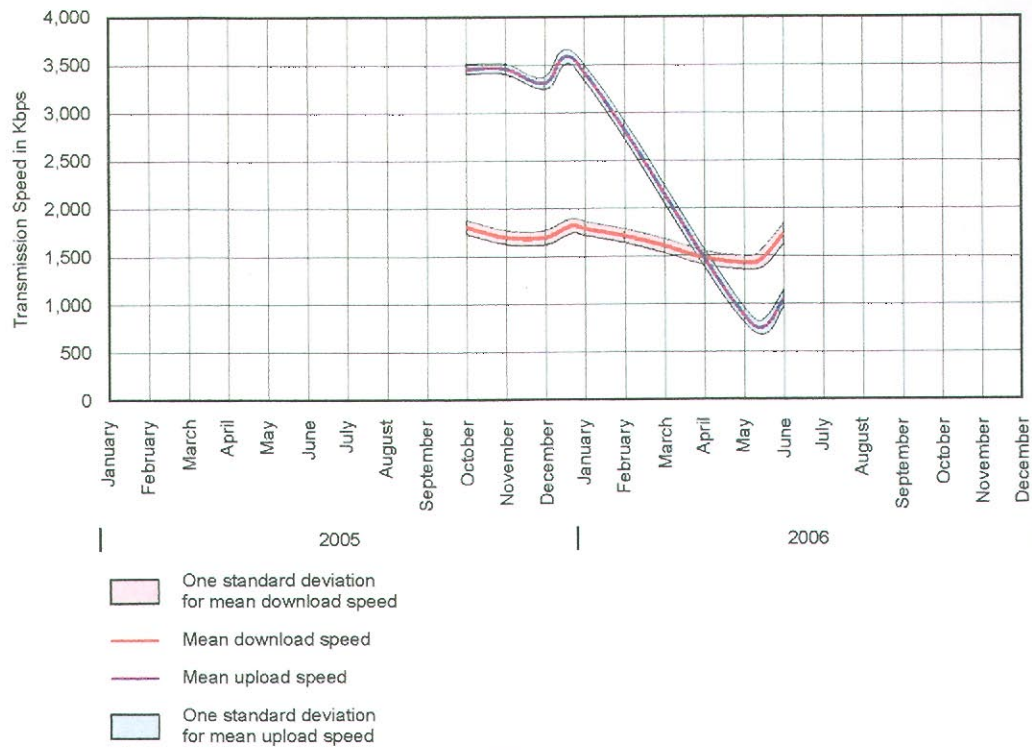


Source: Sigma Solutions Group, LLC, and SEWRPC.

PRELIMINARY DRAFT

Figure 18

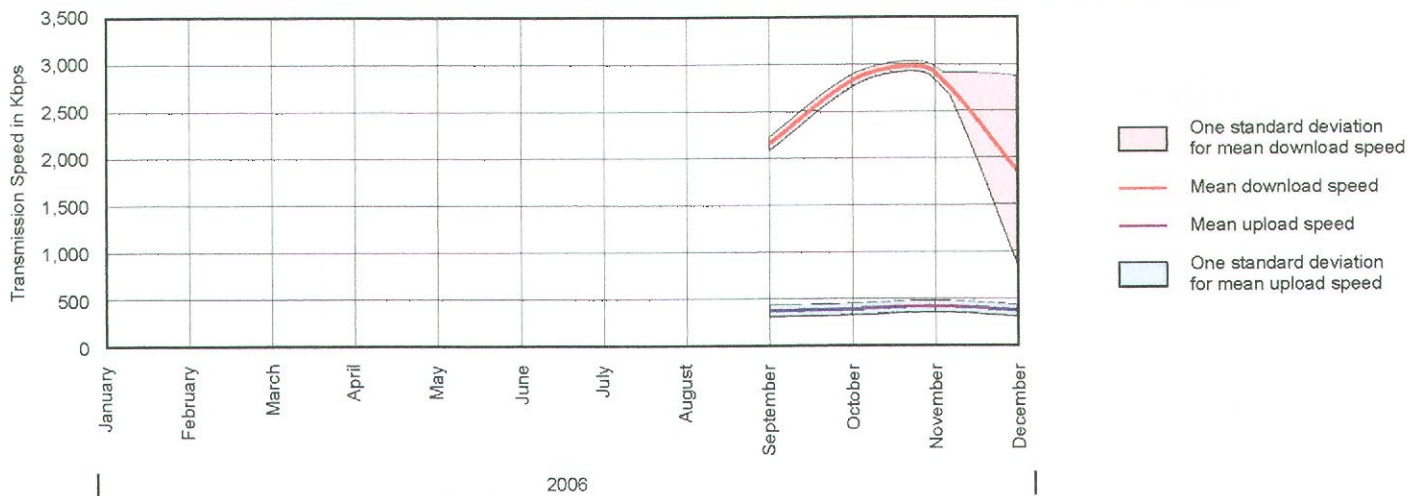
COMPARISON OF DOWNLOAD (3000 Kbps) AND UPLOAD (3000 Kbps) TRANSMISSION RATES BY MONTH FOR WIRELESS BROADBAND INTERNET ACCESS Wi-Fi 802.11a/b/g/n/x IN THE UNITED STATES: OCTOBER 2005 THROUGH JUNE 2006



Source: Sigma Solutions Group, LLC, and SEWRPC.

Figure 19

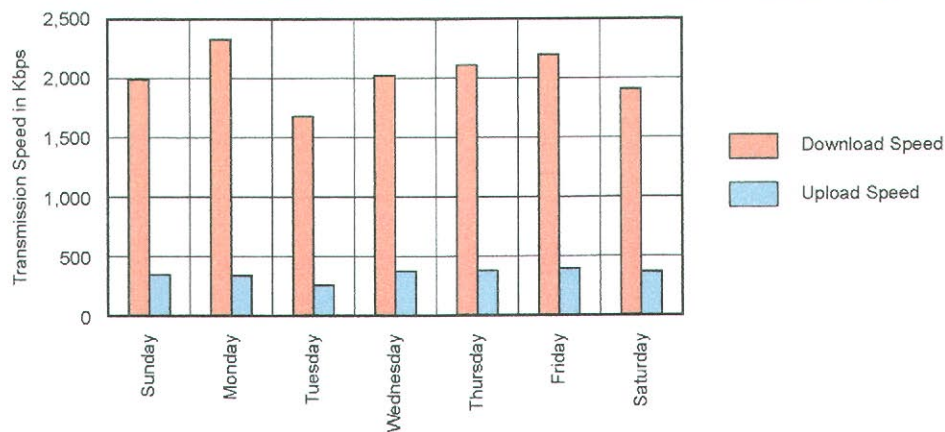
COMPARISON OF DOWNLOAD AND UPLOAD TRANSMISSION RATES BY MONTH FOR CINGULAR WIRELESS GSM GPRS IN THE UNITED STATES: SEPTEMBER 2006 THROUGH DECEMBER 2006



Source: Sigma Solutions Group, LLC, and SEWRPC.

Figure 20

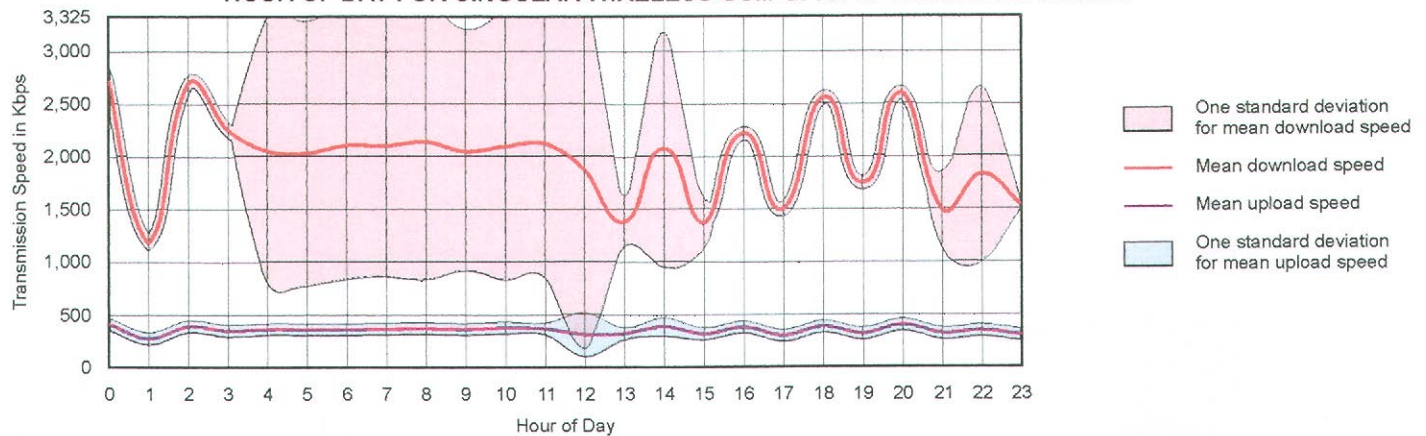
COMPARISON OF DOWNLOAD AND UPLOAD TRANSMISSION RATES BY DAY OF WEEK FOR CINGULAR WIRELESS GSM GPRS IN THE UNITED STATES



Source: Sigma Solutions Group, LLC, and SEWRPC.

Figure 21

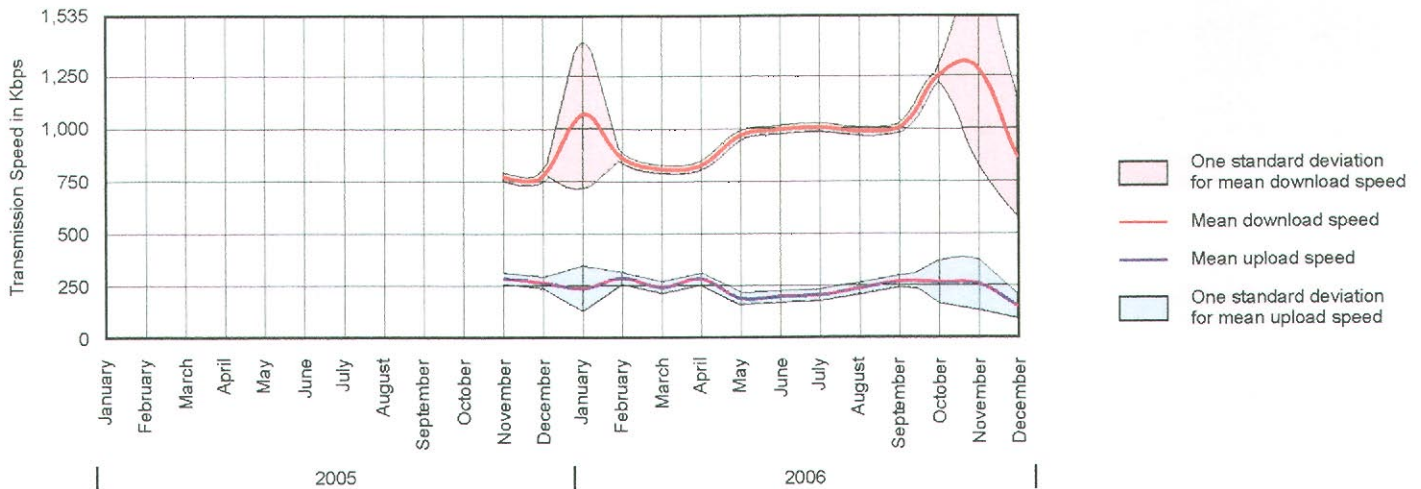
COMPARISON OF DOWNLOAD AND UPLOAD TRANSMISSION RATES BY HOUR OF DAY FOR CINGULAR WIRELESS GSM GPRS IN THE UNITED STATES



Source: Sigma Solutions Group, LLC, and SEWRPC.

Figure 22

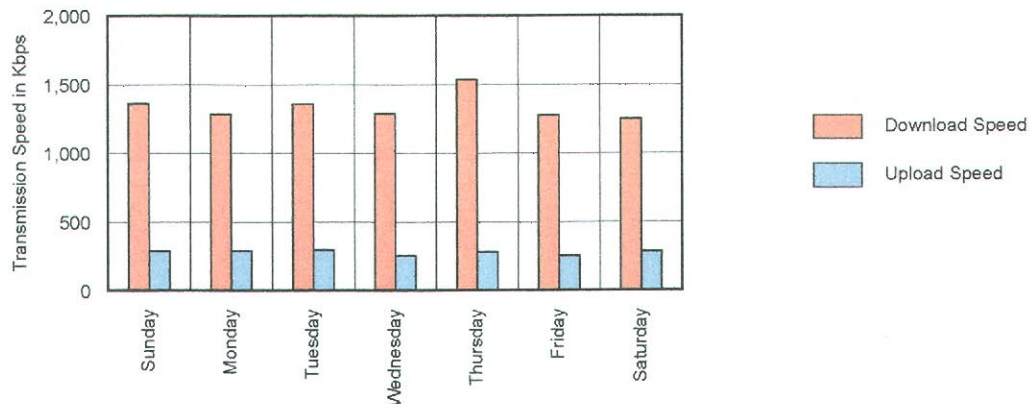
COMPARISON OF DOWNLOAD (1500 Kbps) AND UPLOAD (256 Kbps) TRANSMISSION RATES BY MONTH FOR CLEARWIRE WIRELESS - PROPRIETARY IN THE UNITED STATES: NOVEMBER 2005 THROUGH DECEMBER 2006



Source: Sigma Solutions Group, LLC, and SEWRPC.

Figure 23

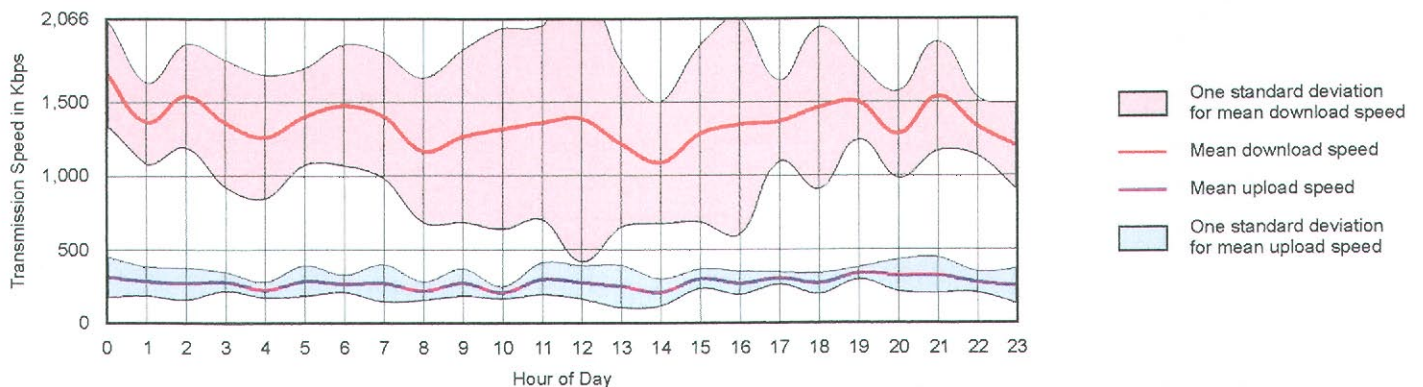
COMPARISON OF DOWNLOAD (1500 Kbps) AND UPLOAD (256 Kbps) TRANSMISSION RATES BY DAY OF WEEK FOR CLEARWIRE WIRELESS - PROPRIETARY IN THE UNITED STATES



Source: Sigma Solutions Group, LLC, and SEWRPC.

Figure 24

COMPARISON OF DOWNLOAD (1500 Kbps) AND UPLOAD (256 Kbps) TRANSMISSION RATES BY HOUR OF DAY FOR CLEARWIRE WIRELESS - PROPRIETARY IN THE UNITED STATES



Source: Sigma Solutions Group, LLC, and SEWRPC.

The performance of fixed wireless service providers can vary widely, however, as indicated by the performance graphs for Communicomm Wireless (Texas) and Keyon Wireless (Nevada) shown in Figures 25 and 26. As shown in Figure 25, a 1500/200 service offering Communicomm provides a throughput level below 500 kilobits per second in the download direction. Keyon Wireless for a 2048/512 service offering averages half of that level as shown in Figure 26.

Finally, wireless satellite performance data on a comparable graphical basis are recorded in Figures 27, 28 and 29 for SATNOW Satellite with a service offering of 1000/56. The upload service is essentially dial-up level throughput performance. Download performance, consistent with the service offering, is around 800-900 kilobits per second.

State of Wisconsin Broadband Communications Performances

A comparison of throughput performance of all ISPs for the United States as presented in Figure 1, and for Wisconsin, as presented in Figure 30, indicates general parity between these geographic areas. Wisconsin performance is more volatile, but that may be due to by the smaller sample sizes involved at the State level. For both the United States and for Wisconsin, overall broadband communications performance is currently in the 1 to 2 megabits per second range.

~~Time Warner Cable (Road Runner) broadband cable service within Wisconsin appears to be somewhat inferior to that provided nationally, as indicated by a comparison of Figures 3 and 31. With the same level of service, the average throughput, within Wisconsin is lower than that provided nationally and in decline. A major limitation of the cable broadband network architecture is the decline in throughput performance as more subscribers join the network. The download speeds shown in Figure 31 would support this observation.~~

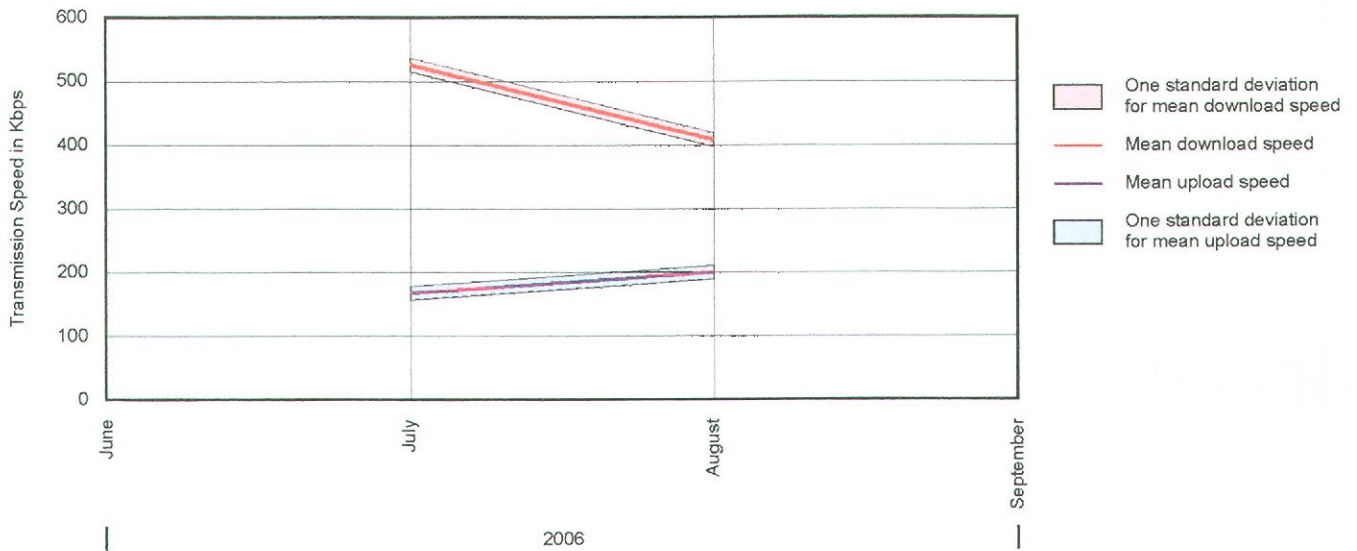
Available performance data for Time Warner Cable Road Runner broadband cable service within Wisconsin appeared to contain serious errors and therefore constituted an unusable data set. Accordingly, no comparison could be made between national and Wisconsin performance levels.

Charter Cable also appears to offer a lower throughput performance in Wisconsin than nationally as indicated by a comparison of Figure 32 31 with Figures 9, 10 and 11. The national level performance is significantly above 2 megabits per second, while the performance within Wisconsin generally ranges under 2 megabits per second and at times below 1 megabits per second.

The DSL performance provided within Wisconsin by the three ILEC carriers -- AT&T, TDS and Verizon -- shows quite similar performance in Figures 33, 34 32, 33, and Figure 35 34.

Figure 25

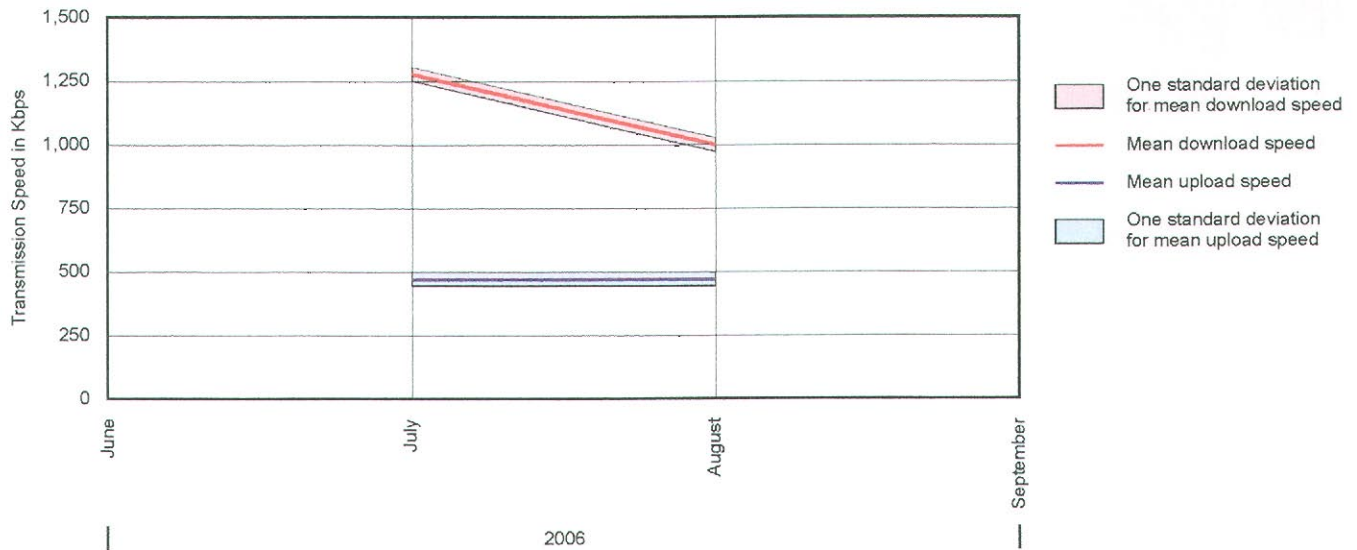
COMPARISON OF DOWNLOAD (1500 Kbps) AND UPLOAD (200 Kbps) TRANSMISSION RATES BY MONTH
COMMUNICOMM WIRELESS - PROPRIETARY IN THE UNITED STATES: JULY 2006



Source: Sigma Solutions Group, LLC, and SEWRPC.

Figure 26

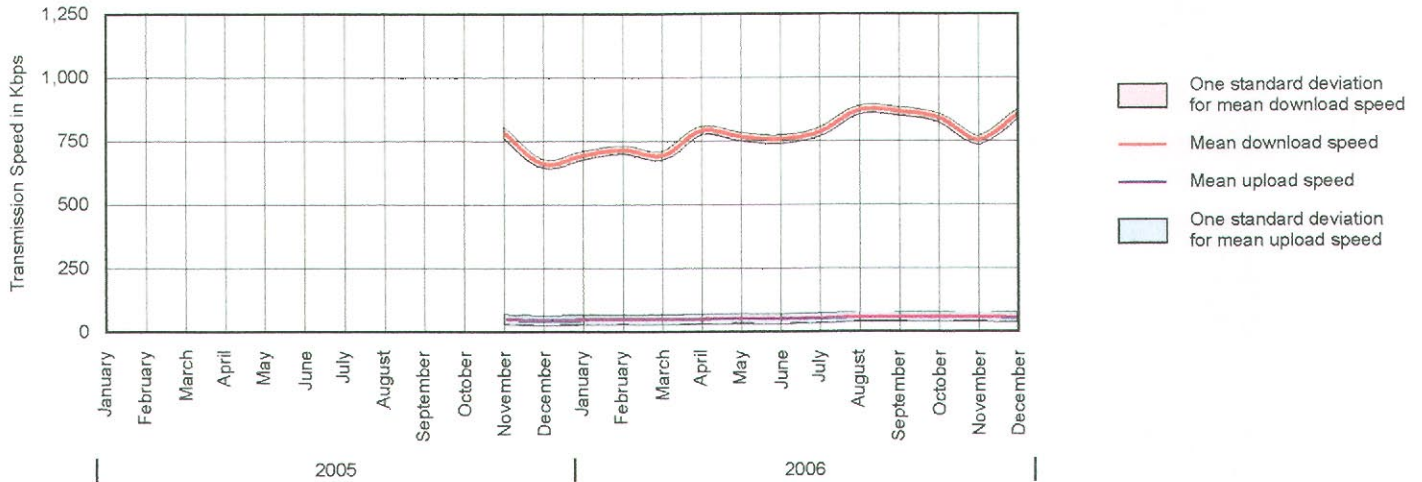
COMPARISON OF DOWNLOAD (2048 Kbps) AND UPLOAD (512 Kbps) TRANSMISSION
RATES BY MONTH KEYON WIRELESS - PROPRIETARY IN THE UNITED STATES: JULY 2006



Source: Sigma Solutions Group, LLC, and SEWRPC.

Figure 27

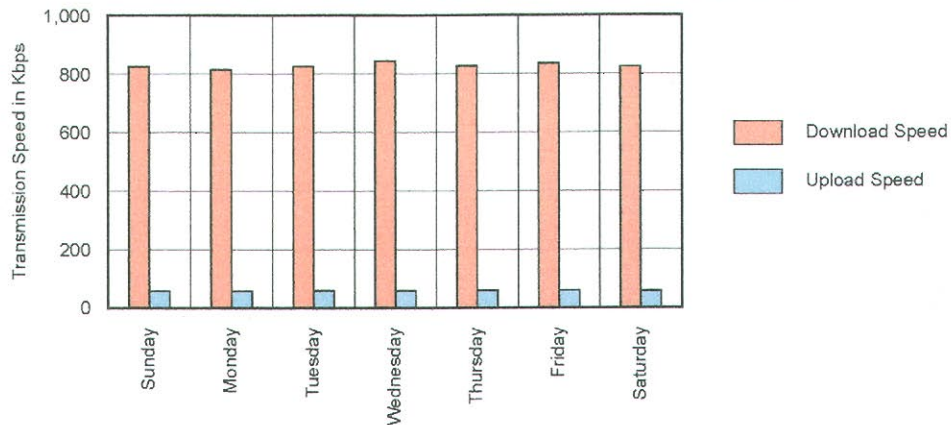
COMPARISON OF DOWNLOAD (1000 Kbps) AND UPLOAD (56 Kbps) TRANSMISSION RATES BY MONTH FOR SATNOW SATELLITE INTERNET SATELLITE + PHONE IN THE UNITED STATES: NOVEMBER 2005 THROUGH DECEMBER 2006



Source: Sigma Solutions Group, LLC, and SEWRPC.

Figure 28

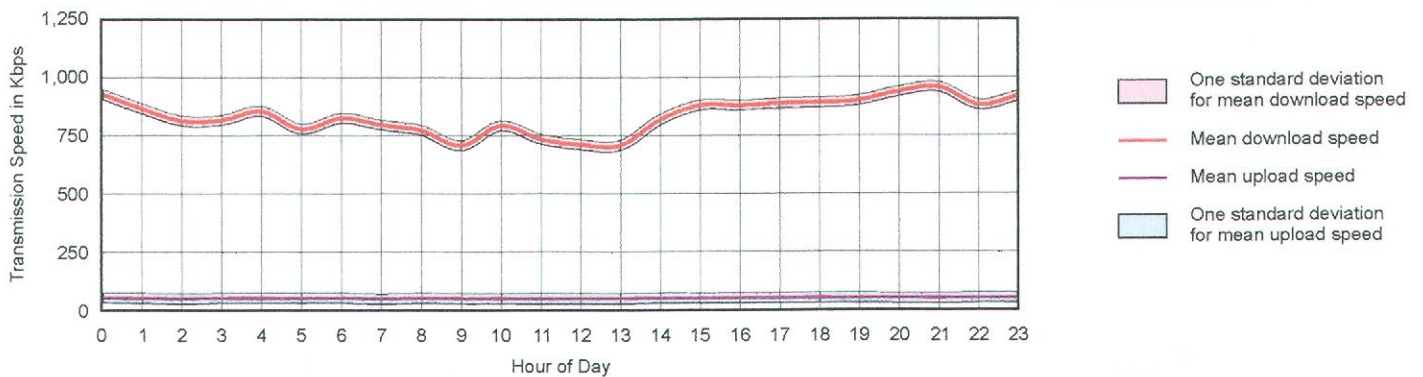
COMPARISON OF DOWNLOAD (1000 Kbps) AND UPLOAD (56 Kbps) TRANSMISSION RATES BY DAY OF WEEK FOR SATNOW SATELLITE INTERNET SATELLITE + PHONE IN THE UNITED STATES



Source: Sigma Solutions Group, LLC, and SEWRPC.

Figure 29

COMPARISON OF DOWNLOAD (1000 Kbps) AND UPLOAD (56 Kbps) TRANSMISSION RATES BY HOUR OF DAY FOR SATNOW SATELLITE INTERNET SATELLITE + PHONE IN THE UNITED STATES

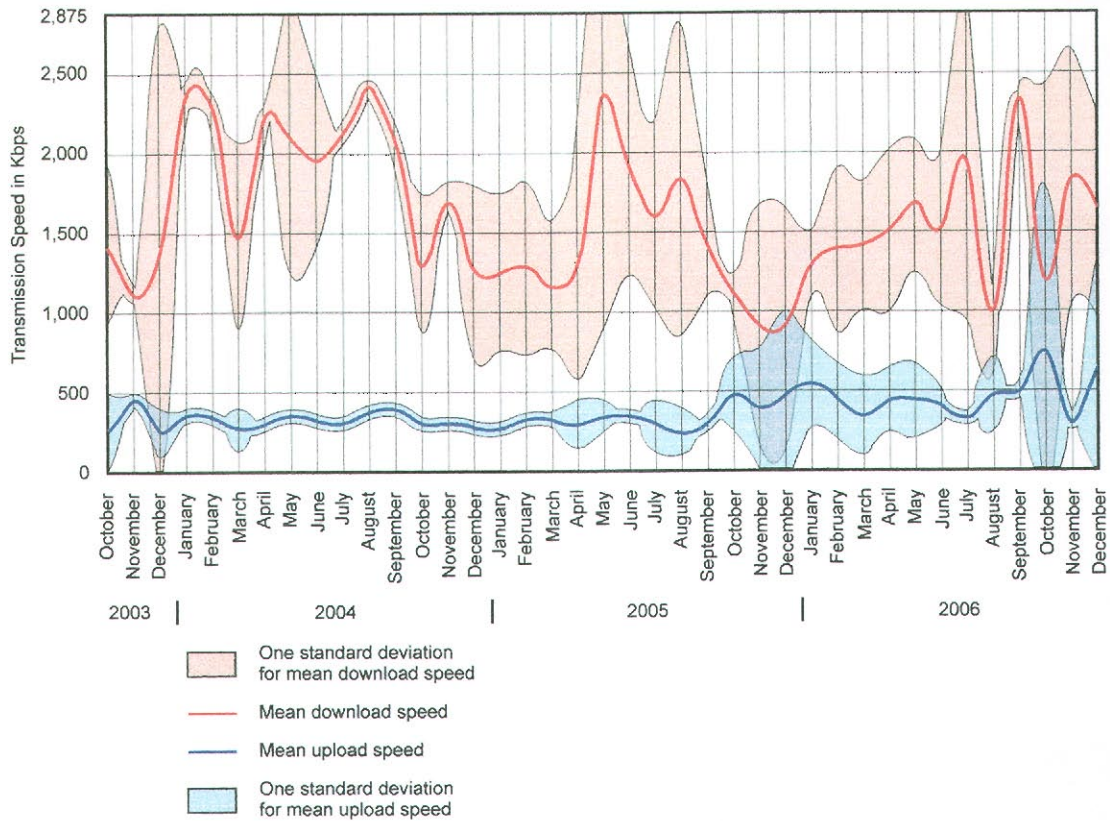


Source: Sigma Solutions Group, LLC, and SEWRPC.

PRELIMINARY DRAFT

Figure 30

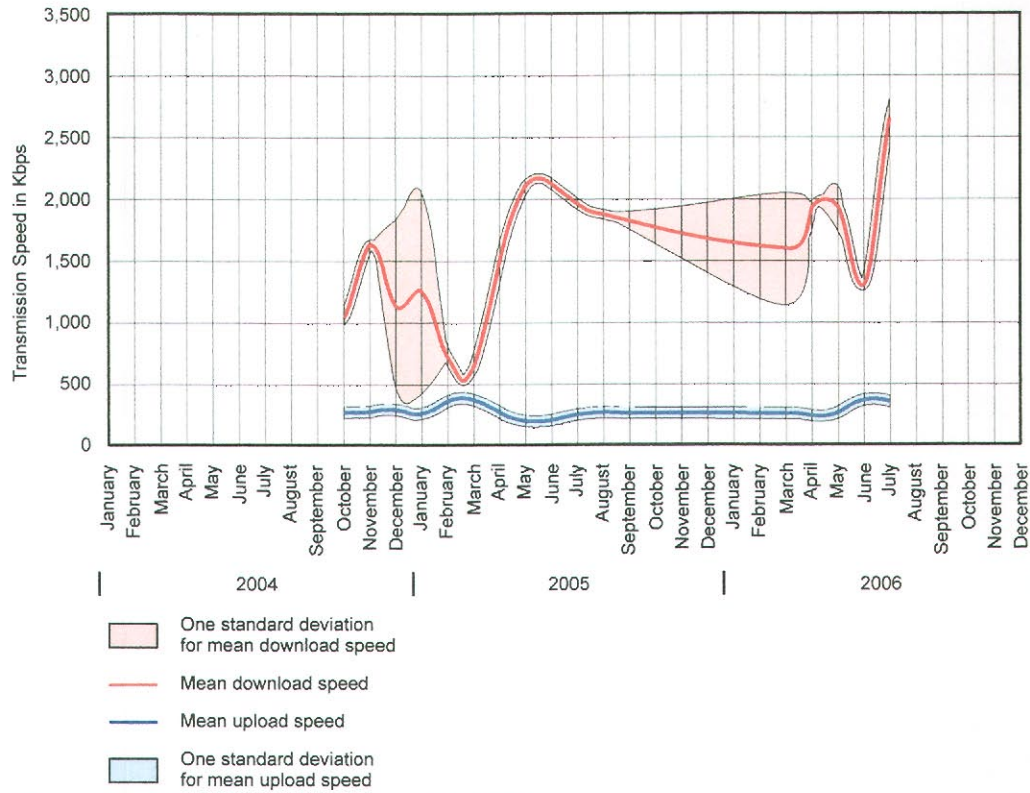
COMPARISON OF DOWNLOAD AND UPLOAD TRANSMISSION RATES FOR
ALL INTERNET SERVICE PROVIDERS IN WISCONSIN: OCTOBER 2003 - DECEMBER 2006



Source: Sigma Solutions Group, LLC, and SEWRPC.

Figure 31

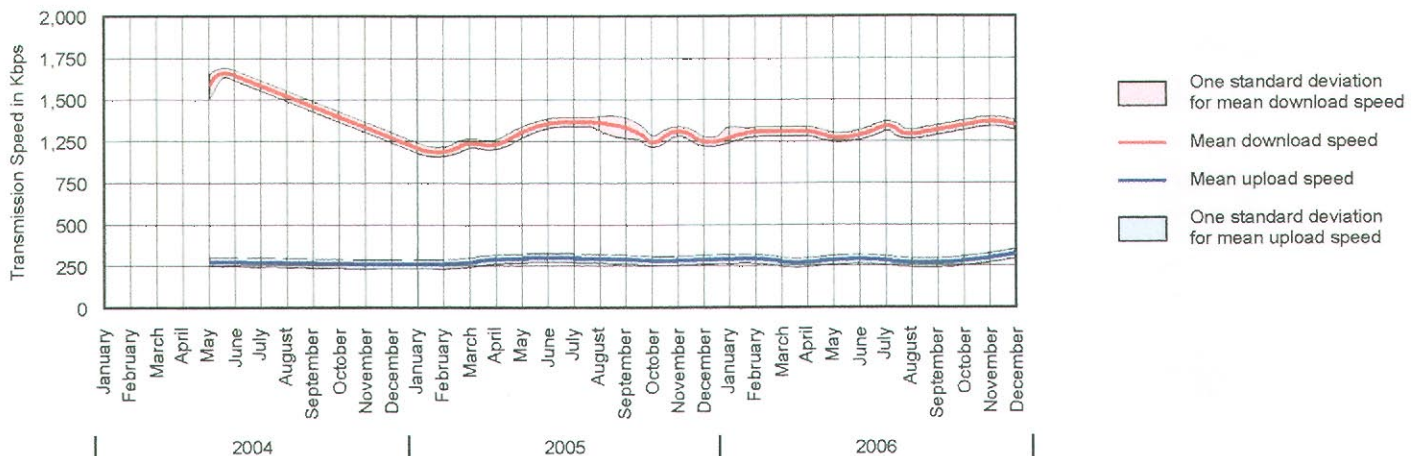
COMPARISON OF DOWNLOAD (3000 Kbps) AND UPLOAD (256 Kbps)
TRANSMISSION RATES BY MONTH FOR CHARTER CABLE IN
WISCONSIN: OCTOBER 2004 THROUGH JULY 2006



Source: Sigma Solutions Group, LLC, and SEWRPC.

Figure 32

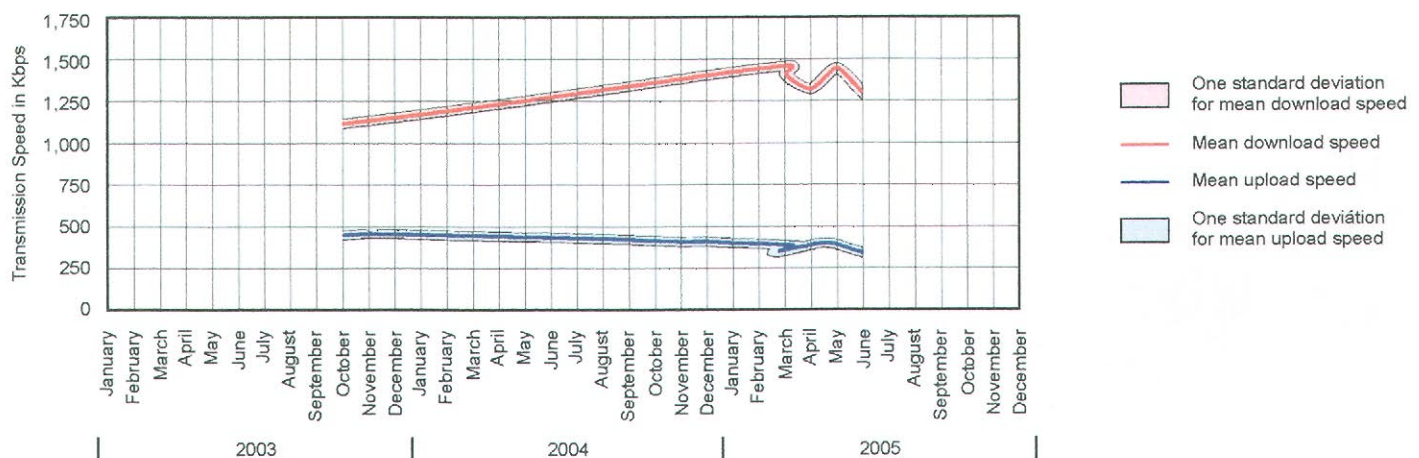
COMPARISON OF DOWNLOAD (1500 Kbps) AND UPLOAD (384 Kbps) TRANSMISSION RATES BY MONTH FOR SBC - AT&T xDSL SERVICE IN WISCONSIN: MAY 2004 THROUGH DECEMBER 2006



Source: Sigma Solutions Group, LLC, and SEWRPC.

Figure 33

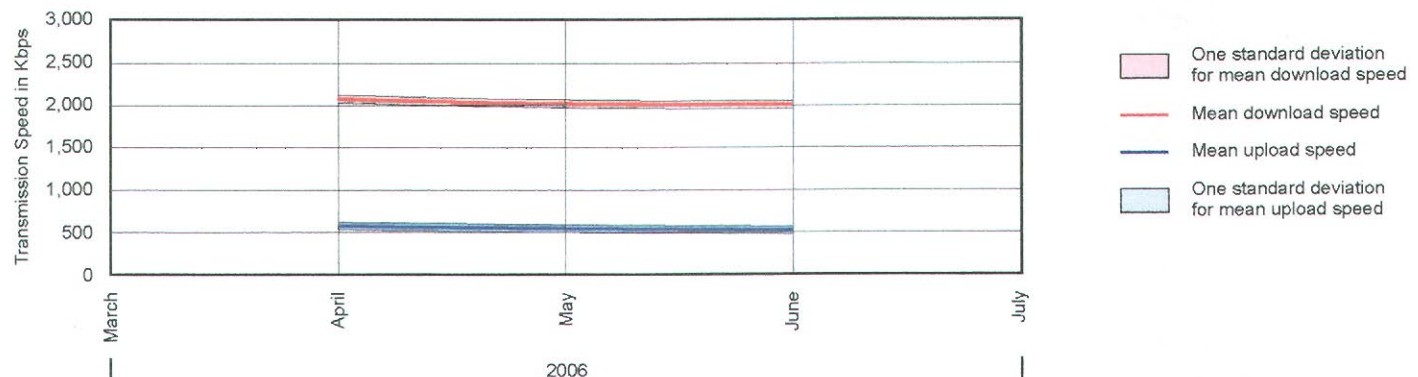
COMPARISON OF DOWNLOAD (1500 Kbps) AND UPLOAD (512 Kbps) TRANSMISSION RATES BY MONTH FOR TDS.net xDSL SERVICE IN WISCONSIN: OCTOBER 2003 THROUGH JUNE 2005



Source: Sigma Solutions Group, LLC, and SEWRPC.

Figure 34

COMPARISON OF DOWNLOAD (3000 Kbps) AND UPLOAD (768 Kbps) TRANSMISSION RATES BY MONTH VERIZON xDSL IN WISCONSIN: APRIL 2006 THROUGH JUNE 2006



Source: Sigma Solutions Group, LLC, and SEWRPC.

A composite tabulation of wireline broadband communication performance within Wisconsin is presented in Table 6-1.

Table 6-1
COMPARATIVE WIRELINE BROADBAND COMMUNICATIONS PERFORMANCE WITHIN WISCONSIN: 2006

	Provider	Technology	Samples	Average Download Throughput (Mbps)
1.	Time Warner Cable	Cable	30,111	2.59
2.	Charter Communications	Cable	48,773	1.91
3.	AT&T	ADSL	12,100	1.01
4.	Century Tel	ADSL	2,491	0.72
5.	TDS	ADSL	2,725	0.47
6.	Netwurx	Fixed / Wireless	130	1.19

Local-Level Broadband Performance Within Southeastern Wisconsin

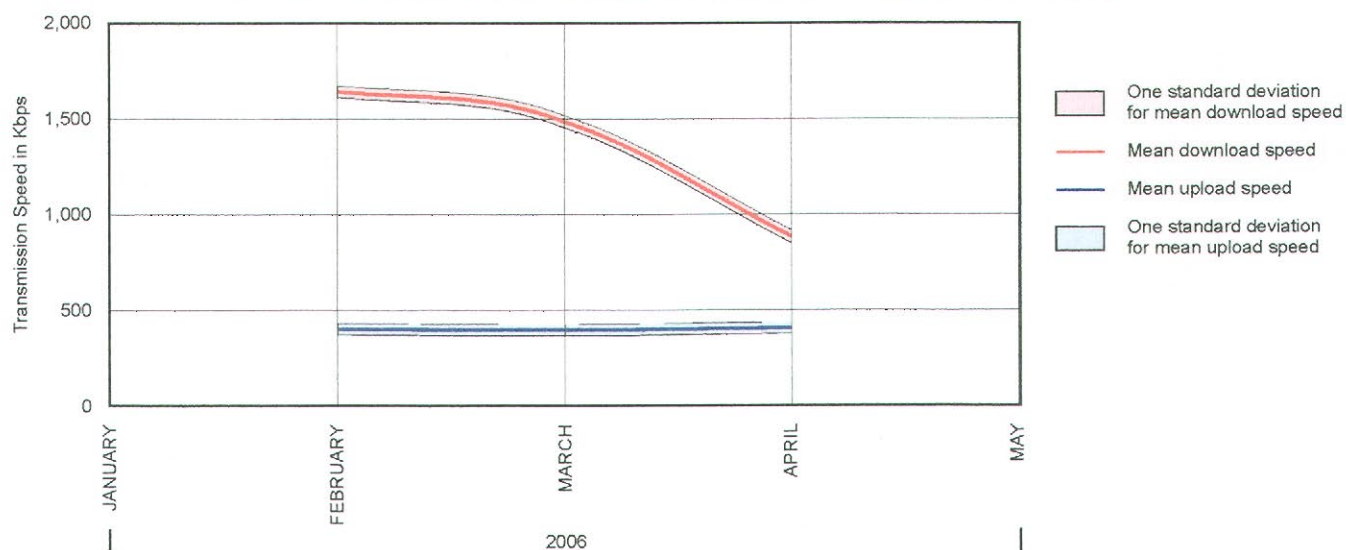
While national and State level broadband performance data provide a comparative evaluation of the wireline broadband communications technologies in use within the Southeastern Wisconsin Region, it is instructive to investigate equivalent network performance at local levels to verify the consistency of broadband performance on a Regional basis. If local level broadband performance data are consistent with national and State evaluation data, then regional performance is likely to match the throughput performance of the same technologies in other states and regions of the United States. In the future, when performance data at the zip code level become more readily available, it will become possible to map regional broadband performance in some detail. Currently, it is possible only to verify performance equivalency with national and State performance levels.

The next level of source data below the state category for the TCP/IQ website is the postal zip code. Source data at the zip code level is sparse with many zip code areas having no data reported. For this reason, the performance data herein presented for smaller geographic areas, was severely constrained.

Broadband cable performance in the City of Lake Geneva -- zip code 53147 shown on Map 6-1 -- in Figure 36 35, evaluates the same downward trend as exhibited at the State level shown in Figure 31. Initial average download transmission rates in 2006 exceeded 1.5 megabits per second but declined over the first half year to average rates under 0.8 megabits per second. This decline in performance as a function of subscriber load is inherent in the hybrid fiber coaxial architecture cable. Upload throughput, though much lower in value, is remarkably stable. It is of interest to note that the offered service level of 5000/768 is significantly above actual performance.

Figure 35

COMPARISON OF DOWNLOAD (5000 Kbps) AND UPLOAD (768 Kbps)
TRANSMISSION RATES BY MONTH FOR TIME WARNER CABLE ROAD
RUNNER SERVICE IN THE U.S. POSTAL ZIP CODE 53147 AREA OF THE CITY
OF LAKE GENEVA AND ENVIRONS: FEBRUARY 2006 THROUGH APRIL 2006



Source: Sigma Solutions Group, LLC, and SEWRPC.

Map 6-1

**U.S. POSTAL SERVICE ZIP CODE
AREAS IN THE SOUTHEASTERN
WISCONSIN REGION: 2005**

NOTE: THE FOLLOWING ZIP CODES
ARE USED FOR CENTRALIZED
POST OFFICE BOX DELIVERY
ONLY, AS SUCH THEY POSSESS
NO MAPABLE SERVICE AREA

ZIP CODE POST OFFICE

53056	MERTON
53060	NEWBURG
53064	NORTH LAKE
53077	ROCKFIELD
53101	BASSETT
53102	BENET LAKE
53109	CAMP LAKE
53127	GENESEE DEPOT
53139	HONEY CREEK
53141	KENOSHA
53152	NEW MUNSTER
53157	PELL LAKE
53159	POWERS LAKE
52171	SOMERS
53176	SPRINGFIELD
53194	WOODWORTH
53195	ZENDA
53187	WAUKESHA
53201	MILWAUKEE

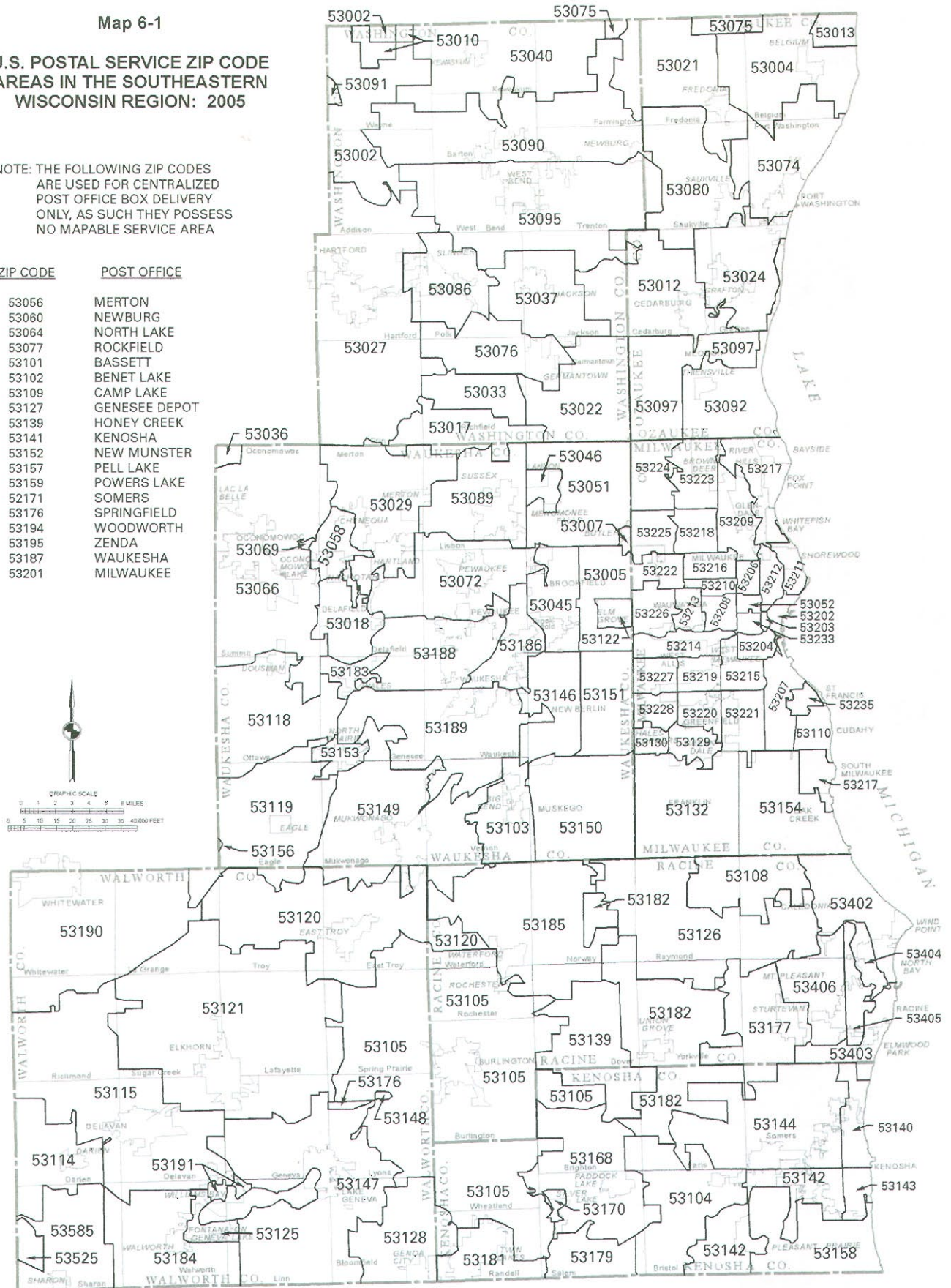
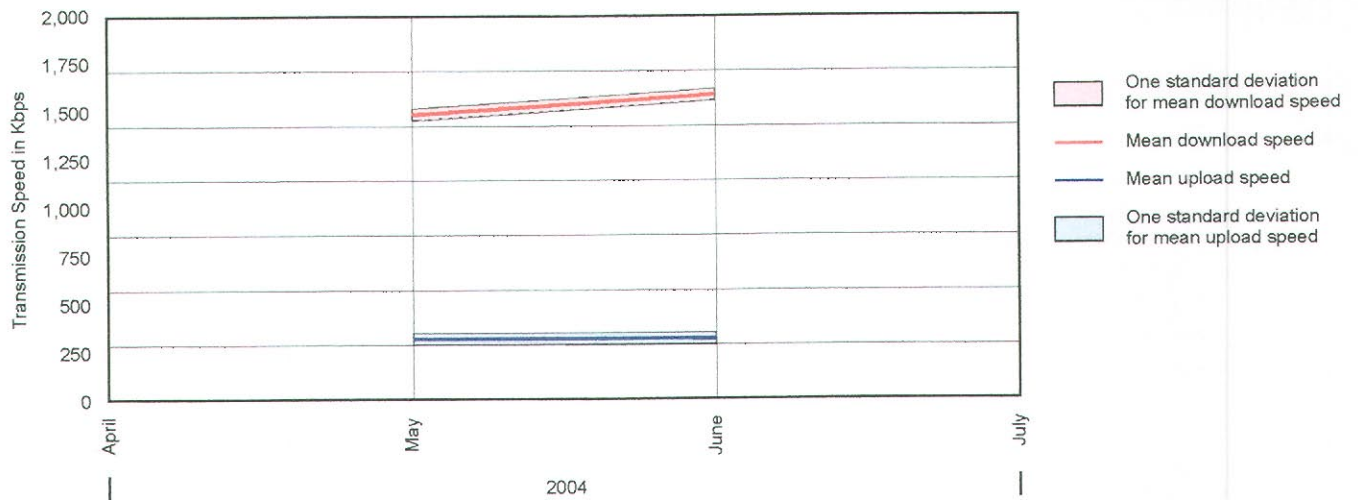


Figure 36

COMPARISON OF DOWNLOAD (1500 Kbps) AND UPLOAD (384 Kbps) TRANSMISSION
RATES BY MONTH FOR SBC - AT&T xDSL IN THE U.S. POSTAL ZIP CODE 53095
AREA OF THE CITY OF WEST BEND AND ENVIRONS: MAY 2004



Source: Sigma Solutions Group, LLC, and SEWRPC.

A remarkably different performance trend for broadband DSL is indicated for AT&T DSL as shown in Figure 37 36 for West Bend -- zip code area 53095 as shown on Map 6-1. Transmission rates are stable near the offered service level of 1500/384 with no apparent downtrend in either download or upload throughput over time.

~~Data for zip code area 53207 as shown on Map 6-1 representing an area located in the south side of the City of Milwaukee as given in Figure 38 indicate that broadband DSL performance can vary with the age and quality of the copper wire connections used in the access network. Comparing the performance provided in the south side of Milwaukee with that provided for West Bend as given in Figure 37, performance in the Milwaukee area with its older copper lines is only about 70 percent of the speed of the same broadband technology provided in West Bend. The lower quality of older copper access network may be expected to also affect future upgrades such as AT&T's Project Lightspeed.~~

Data for zip code area 53207 as shown on Map 6-1 representing an area in the South Side of the City of Milwaukee as given in Figure 37 indicates a lower level of performance than another AT&T site in West Bend. Comparing the performance provided in the south side of Milwaukee with that provided for West Bend as given in Figure 36, performance in the West Bend area is about 30 percent faster than in the selected area of Milwaukee using the same broadband DSL technology. This performance difference is probably best explained by the presence of multiple remote terminals in the West Bend area because of its size and newly developed subdivisions. Remote terminals enhance performance by bringing greater fiber optic bandwidth closer to the user DSL performance degrades with distance from either the Central Office or fiber-linked terminals.

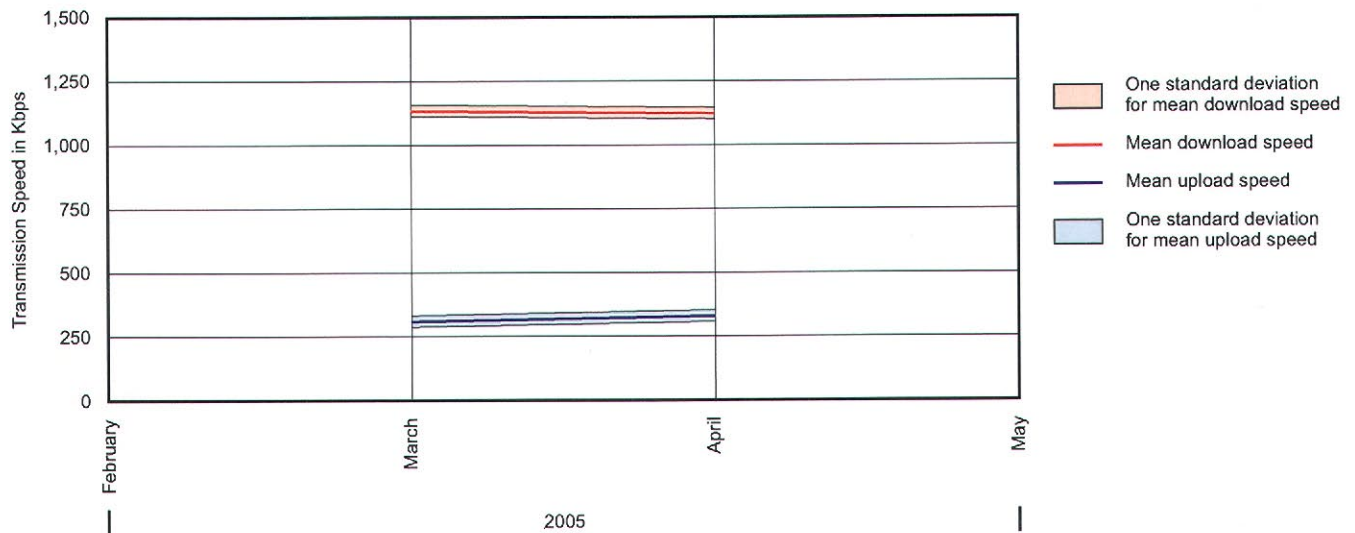
An unusual level of broadband cable network performance is illustrated for the City of Greenfield -- zip code area 53228 as shown on Map 6-1 in Figure 39 38 where the service offering is reversed with greater bandwidth allocated to upload than download transmission (750/3000). Throughput performance appears to be stable over time.

Broadband Communications, Performance Summary

National broadband download wireline throughput performance as measured in megabits per second averages in the 1.0 to 2.5 range in the United States. Upload performance is much slower with recordings around 0.25 to 0.50 megabits per second. This disparity in download versus upload speeds occurs primarily because more bandwidth is generally allocated by the carriers to download traffic. Most user application such as web search heavily favor download volume. If more bandwidth were allocated to upload traffic, download transmission speeds would be reduced.

Figure 37

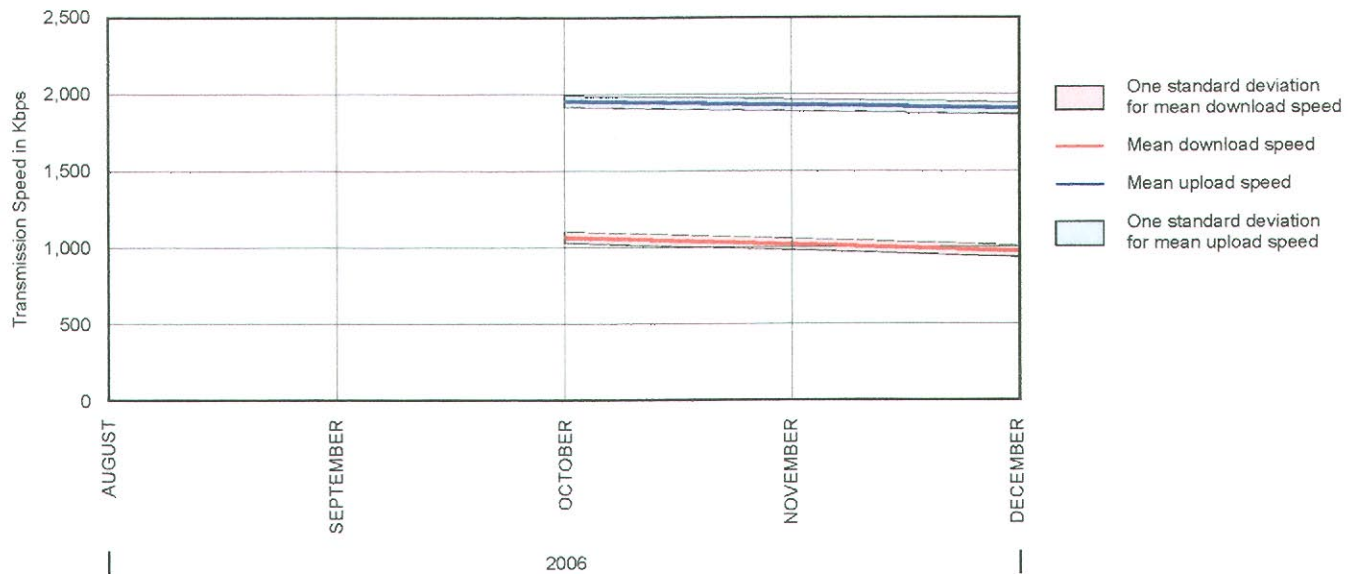
**COMPARISON OF DOWNLOAD (1500 Kbps) AND UPLOAD (384 Kbps) TRANSMISSION
RATES BY MONTH FOR SBC - AT&T xDSL IN THE U.S. POSTAL ZIP CODE 53207 AREA
OF THE NEAR SOUTHSIDE OF THE CITY OF MILWAUKEE: MARCH 2005**



Source: Sigma Solutions Group, LLC, and SEWRPC.

Figure 38

COMPARISON OF DOWNLOAD (750 Kbps) AND UPLOAD (3000 Kbps) TRANSMISSION RATES BY MONTH FOR EARTHLINK CABLE IN THE U.S. POSTAL ZIP CODE 53228 AREA OF THE CITY OF GREENFIELD AND ENVIRONS: OCTOBER 2006 THROUGH DECEMBER 2006



Source: Sigma Solutions Group, LLC, and SEWRPC.

Depending on service agreements in terms of maximum download and upload speeds, DSL and cable broadband services are generally equivalent in the 1.0 to 5.0 megabits per second range at the national level. DSL performance can vary significantly with individual carriers and with the distance of the subscriber from the telephone central office or extended remote terminal. Cable performance also varies between carriers and tends to decline as more subscriber share a common channel in the hybrid fiber coaxial cable network architecture.

Fixed wireless generally offers more symmetrical service offerings in terms of download and upload speeds. Standards based WiFi networks also perform in the 1 to 3 megabits per second range. Mobile wireless networks resemble wireline networks in their bias toward much faster download speeds

Although the field measurement studies conducted by the Commission recorded 3G mobile network throughputs well below the 2 megabits per second targets at 336 kilobits per second, some national data for GSM networks supports throughput above 2 megabits per second.

Overall, measures of broadband throughput at the State level indicate performance levels in the same range as nationally. Time series recordings of Time Warner Cable, however, display a statewide downward trend in throughput for download traffic. This trend appears to be consistent with the network architecture limitations of hybrid fiber coaxial cable networks. However, Charter Cable performance, while more volatile, does not confirm this downward trend. DSL networks though sensitive to central office distances, do not show this performance reduction from network loading.

Overall measurements of broadband communications networks as provided in Table 6-1, thousands of samples, indicate significantly higher performance for cable networks. Average download throughputs for Time Warner and Charter Cable networks are more than double those of telephone DSL networks. It may be concluded from the data summary that broadband cable has an inherently greater bandwidth capability than the current ADSL version of DSL. A smaller sample data summary for a Regional fixed wireless service provider, Netwurx using the Motorola Canopy technology, appears to confirm the broadband capability of fixed wireless in the over one megabits per second range.

Local broadband performance data at the postal zip code area level, where available, are generally consistent with national and State wide broadband throughput performance data.

Overall, currently available wireline and wireless broadband communications technologies do not provide the throughput performance levels specified in the regional telecommunications service objectives and standards set forth in Chapter III of SEWRPC Planning Report No. 51, and in Chapter III of this report. In addition, only one of the technologies, DSL, has a current infrastructure development plan aimed at achieving these objectives. AT&T with its Project Lightspeed has targeted line speeds exceeding 20 megabits per second based on a fiber to the node (FTTN/VDSL) technology. Deployment plans, however, currently involve only 25 of the 147 ~~communities~~ *municipalities* in the Region, and there is no commitment to serve all of the geographic areas of these communities. There are no ~~known~~ *publicly available* higher throughput broadband plans for the Time Warner or Charter Cable networks.

Fixed wireless in its WiFi version is currently focused on mesh networks which have demonstrated throughput only in the 1 to 3 megabits per second range with little upward prospects. Proprietary fixed wireless systems as manufactured by Motorola and Alvarion are operating in the same performance range with no known plans for upward scaling.

WiMAX has been advanced as the standards-based answer to higher performance wireless broadband but current focus in WiMAX is on the mobile version of the technology for licensed spectrum with little activity for the unlicensed bands which provide the basis for most fixed wireless networks. Sprint Nextel has announced plans for the introduction of WiMAX in the United States as a major upgrade of its mobile network with 2008 as a target year. Service level determinations of throughput for the carrier's WiMAX technology are still in the experimental stage.

PRELIMINARY DRAFT

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

Chapter VII

**A REGIONAL COMPREHENSIVE BROADBAND
TELECOMMUNICATIONS PLAN
FOR SOUTHEASTERN WISCONSIN**

INTRODUCTION

Previous chapters of this report have presented information pertinent to the development of alternative fourth generation (4G) broadband telecommunications plans for Southeastern Wisconsin. The objectives and standards set forth in Chapter III of this report provide the criteria for judging the relative merits of the alternative plans considered, and the rationale for the selection of a recommended plan.

The findings of the existing wireless antennae base station sites within the Region set forth in Chapter V of SEWRPC Planning Report No. 51 provide the bases for selecting antennae station sites for the alternative regional wireless plan. The findings of the service area coverage inventories documented in Chapter V of this report provide the geographic basis for plan design and implementation. The findings of the performance inventory Chapter VI of this report reveal both the capabilities and shortcomings of current wireline and wireless networks in the Region. These findings also describe the state of current plans for broadband service within the Region, indicating that no single service provider or group of providers have plans for networks that would satisfy the objectives and standards set forth in Chapter III.

Six alternative broadband communications plans were developed and are described and evaluated in this chapter as a bases for the selection of a recommended plan. The recommended plan is a composite of the best features of the alternative plans considered, since no single wireline or wireless communications technology can cost effectively satisfy the needs of all areas of the Region. It is important to understand in this respect, that private sector service providers or governmental organizations could develop different

regional broadband communications plans that would satisfy the objectives and standards of Chapter III. The plan presented herein is not intended to impede the development or 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 telecommunication service within the Region toward the achievement of the agreed upon objectives and standards set forth in Chapter III of this report. It is hoped, however, that the plans herein presented would serve as a point of departure for further telecommunication planning by private providers and public agencies.

The telecommunications plans presented in this chapter represents a mixture of wireline and wireless communications technologies in order that the technology most cost-effective for application within each community, or parts of communities, may be ascertained. The alternative plans presented emphasize the access element of communications networks, since this element represents the primary bottleneck in delivering broadband capability to users. Beyond the direct access networks are the backhaul networks which link primary access networks to core networks which carry the bulk traffic throughout the United States and world. All access communications networks require a core network in order to link with subscribers beyond their immediate areas. The placement of access network node locations is often heavily influenced by the availability of fiber optic gateway locations.

Preparation of a comprehensive broadband regional communications plan involves a sequence of steps that include:

1. Selecting a set of basic communications technologies for consideration in the preparation of alternative plans;
2. Identifying and defining the equipment requirements for both network infrastructure and users to implement the selected technologies;
3. Developing performance data for the various technologies as necessary to determine the estimated performance of alternative plans;
4. Developing capital and operating cost data for the same technologies sufficient to estimate the costs of alternative plans;
5. Preparing geographic network layouts of alternative broadband communications systems with base stations, access points, points of presence, distribution networks and Internet-connecting Gateway stations indicated;
6. Specifying the expected performance, benefits and costs associated with each alternative broadband communications system plan; and

7. Evaluating the ability of each alternative plan to meet the objectives and standards set forth in Chapter III of this report as a basis for selecting a recommended broadband communications system plan for the Region.

The end result of this sequence of design activities is a proposed regional broadband communications network infrastructure that will support a wide variety of broadband users with a fourth generation (4G) communications deployment.

Analyses and Forecasts

In the classic approach to systems planning, forecasts are made of those factors that affect the structure of the system plan concerned, but which lie outside of the scope of the system being planned. Thus, public infrastructure systems planning typically involves the preparation of forecasts of probable future system demand -- expressed in terms of such parameters as person trips, per capita sewage contribution, or per capita water demand -- derived from population, household, employment, and land use forecasts for the plan design year. The forecast period is determined by the physical and economic life of the facilities concerned -- for most types of public works facilities this period approximates 20 years. Procedures for developing such forecasts are well established and widely used for transportation, sanitary sewerage, storm water drainage and flood control, and water supply system planning. In transportation system planning, for example, population, household, employment, and land use forecasts are used to estimate future travel demand by mode. This demand is then used in the simulation of the performance of the arterial street and highway and transit systems through mathematical modeling. This permits quantitative analyses of the performance of alternative system plans considered, and facilitates the selection and more detailed design of a recommended system plan.

This classic approach to systems planning was originally intended to be applied in the regional telecommunications planning effort. The formulation and calibration of the necessary mathematical simulation models, however, required detailed information about the configuration, capacity and utilization of the existing telecommunications facilities within the Region that would permit the correlation of such utilization with socioeconomic and land use data for use in forecasting probable future demand. The necessary information was available only from the existing service providers, which refused to provide the information to the Commission. Therefore, the classic approach to systems planning could not be applied in the regional telecommunications process.

Consequently, a different approach to the plan design process was taken. Telecommunication supply and demand are known to be greatly influenced by the rate of new technology adoption and user acceptance. User acceptance is typically measured by a “take rate” which may vary widely, perhaps from 2 to 50 percent, or by a ratio of 25 to 1. This uncertainty of demand for a new broadband telecommunication service creates a need for system designs that may be expected to be profitable at the lowest expected take rate, but which have the capacity to accommodate much higher take rates at the desired levels of service. Thus, in the absence of being able to base alternative plan designs on long term forecasts and performance simulation, alternative plans were designed so that “break even” operation would be possible at low take rates, but which possessed capacities able to serve much higher take rates at the desired level of service.

In the planning process, the ability to achieve break even operation at low take rates was assessed on the basis of analyses of the capital costs involved. The adequacies of the system capacity were assessed on the basis of analyses of the level at which subscriber arrival rates and message sizes would become unacceptable with respect to the level of throughput desired. The alternative plans were, moreover, designed to permit the ready expansion of the initially available capacity through simple changes in the software and hardware concerned, without changes in the basic structure of the system plan. These analyses were based on modified versions of traffic engineering formulas originated by the Danish mathematician, A. K. Erlang, and used for many years by the Bell System in determining the capacity of circuit-switched telephone systems. The probability distributions involved -- Poisson and Erlang -- and their supporting algorithms were converted from circuit-switched to packet-switched network form for application to the network system plans developed under the regional telecommunications plan program.

TECHNOLOGICAL ALTERNATIVES

Five separate but related technological alternatives were considered in formulating alternative broadband telecommunications plans for the Region:

1. Community-Based Advanced WiFi Wireless Networks

This plan is based on extended range versions of IEEE Standard 802.11g operating in the 2.40 to 2.48 GHz band, and is intended to serve fixed and nomadic users. The plan would be implemented on a community-by-community basis.

2. Regional Advanced WiFi/WiMAX Wireless Network

This plan is based on IEEE Standards 802.11a (WiFi) and 802.16 (WiMAX) operating in the 5.8 GHz band, and is intended to serve fixed and nomadic users. The plan would be implemented to serve the Region as a whole.

3. Regional Mobile WiMAX-based Wireless Network

This plan is based on IEEE Standard 802.16e and is intended to serve mobile users.

4. Regional Fiber-to-the Node Wireline Network

This plan would provide fiber optic cable from telephone system central offices to remote nodes, and twisted pair copper wires from the nodes to each user. The plan would be based on VDSL technology.

5. Localized Fiber-to-the Premises, Wireline Network

This plan would provide fiber optic cable to each premise in areas with sufficient population and/or enterprise densities to justify the investment required.

Advanced WiFi Wireless and WiMAX Technologies

Information on the history and general background of IEEE Standard 802.11 (WiFi for Wireless Fidelity) were provided in SEWRPC Planning Report No. 51, and will not be repeated here. It is important however, to emphasize the advanced high performance version of the WiFi technology proposed to be employed in the plans. Traditional WiFi networks operate around very short range -- 300 feet radius -- access points -- hot spots -- in homes, coffee shops, hotels, schools and other designated locations. The WiFi networks planned here feature a sectoral cellular network topology and high gain active antennas at each fixed user premises. This combination of network structure and augmented user transceiver equipment allows for 4G levels of network throughput performance exceeding 20 megabits per second. Community-level WiFi access networks will operate using the 802.11g standard at 2.4 GHz with 802.11a backhaul at 5.8 GHz, while regional networks will operate with the 802.11a standard and WiMAX (802.16) for backhaul. The WiMAX backhaul links will also operate in the 5.8 GHz band but with more advanced protocols suitable for handling high volume backhaul traffic.

Initial releases of WiMAX equipment are expected to be in the licensed bands such as 2.5 GHz and 3.5 GHz. Such bands are available only to licensed carriers who have purchased radio spectrum from the Federal Government. Such licensed bands are expected to be used primarily for mobile communications. Succeeding WiMAX equipment releases, however, are expected to be at 5.8 GHz an unlicensed band suitable for backhaul communications as defined here. WiMAX equipment for backhaul infrastructure deployment will be more costly of equivalent WiFi (802.11a) equipment operating in the 5.8 GHz band. The improved quality of service features and traffic handling capability of WiMAX is expected to justify the increased cost.

Mobile WiMAX Technologies

The WiMAX technology referenced in the previous section is specified for fixed backhaul networks. Another version of WiMAX 802.16e is being developed for mobile use. This WiMAX version differs in its ability to serve users in moving vehicles rapidly crossing sectoral boundaries and requiring rapid handoffs to adjacent access points. This version of WiMAX is also able to service fixed and nomadic users, but generally at slower data rates than fixed WiFi/WiMAX networks. In mobile application, the potential advantage of WiMAX over current 3G versions of GSM/UMTS and CDMA/EV-DO technologies is the provision of higher data rates with the potential at least of 4G-level performance of 20 megabits per second or better. Early deployments of mobile WiMAX are expected to be data centric to take advantage of the higher throughput performance of this technology. WiMAX also will have more advanced quality of service (QoS) capabilities with a more sophisticated media access protocol than current WiFi networks.

Because mobile WiMAX technology will be available, at least initially, only in licensed bands such as 2.5 GHz and 3.5 GHz, regional deployment of mobile WiMAX will depend on the selection of this technology by licensed American wireless carriers. To date, Sprint/Nextel is the only American wireless carrier committed to WiMAX. WiMAX plans then must be based on a Sprint/Nextel regional deployment. The timing of such a Southeastern Wisconsin mobile WiMAX deployment, will depend upon corporate priorities concerned. Sufficient information on both WiMAX technology and the current Sprint/Nextel base station infrastructure, however, is available to prepare a 802.16e WiMAX plan for the Region. In fact, the antenna site information from Sprint and Nextel is the best in the database documented in SEWRPC Planning Report No. 51 since these were the only two service providers that cooperated in the Commission regional antenna site inventory.

Fiber-to-the-Node Wireline Technologies

The Fiber-to-the-Node (FTTN) technology to be employed in the broadband wireline communications plan of the same name is the Alcatel-based technology currently being used by AT&T to deploy the U-Verse system as part of Project Lightspeed in Southeastern Wisconsin. The reasons for selecting the particular version of FTTN are two:

1. State of the Art Technology

This particular Alcatel-based version of FTTN is obviously a current, well-conceived and carefully reviewed technology.

2. AT&T – Major Incumbent Local Exchange Carriers (ILEC) in the Region

As the dominant ILEC in Southeastern Wisconsin, AT&T owns the copper lines required to implement any FTTN wireline plan. For this reason, any FTTN plan must be based on an ILEC carrier who owns copper lines to homes, businesses and other organizations. FTTN extensions beyond AT&T's regional areas must be carried out in cooperation with the other smaller ILECs such as Century Tel and Verizon North in the Region.

The AT&T, FTTN broadband communications network is based on Alcatel's 7330 Intelligent Services Access Manager, ISAM. The 7330 ISAM is connected by fiber optic cable with the local central office and serves as a remote distribution point for broadband traffic to users over existing twisted pair copper links. Each ISAM can service subscribers located within a 3,000 feet radius of the node. High speed throughput is possible because the signal-to-noise ratio, (SNR), which decreases with distance from the node, is still high enough to support throughputs exceeding 20 megabits per second.

A pictorial diagram of a U-Verse network is shown in Figure 1. Supporting the node and local central offices are a series of special central offices that manage Internet access and Voice over IP as well as video. Regional IP video hub offices store and distribute video content to end users through local central offices. Local central offices also support fiber-to-the premises services as shown in the diagram.

Physically, the U-Verse network takes the form of a set of outdoor cabinets as shown in Figure 2. Three cabinets are typically located at each node location:

1. Fiber Conversion Cabinet

This cabinet houses the Alcatel 5330 ISAM, with 200, 400 or 800 line connections, the corresponding cabinets being designated as 52 BP, 52B or 52E respectively.

2. Power Cabinet

This cabinet houses power line connections, power supply equipment and power metering.

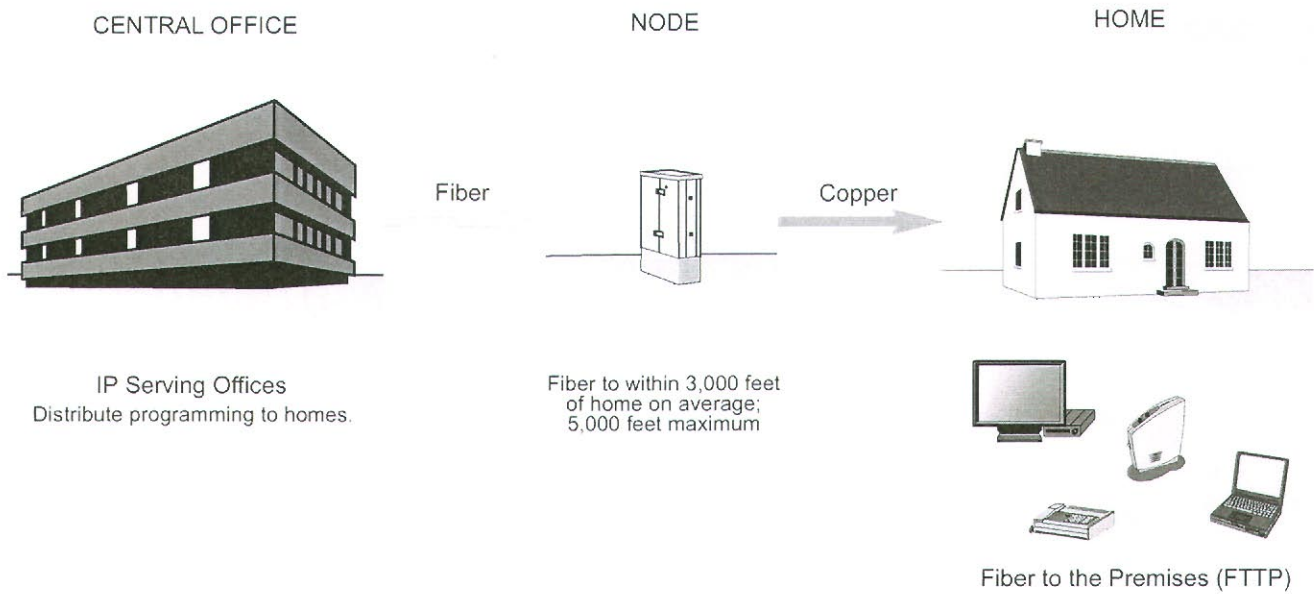
3. Cross Connection Cabinet

This cabinet serves as a cross-connection point for subscriber twisted pair copper lines.

It should be emphasized that U-Verse represents a further stage upgrade to AT&T's original Digital Subscriber Line (DSL) broadband offering as shown in Figure 3. The original ADSL deployment was

Figure 1

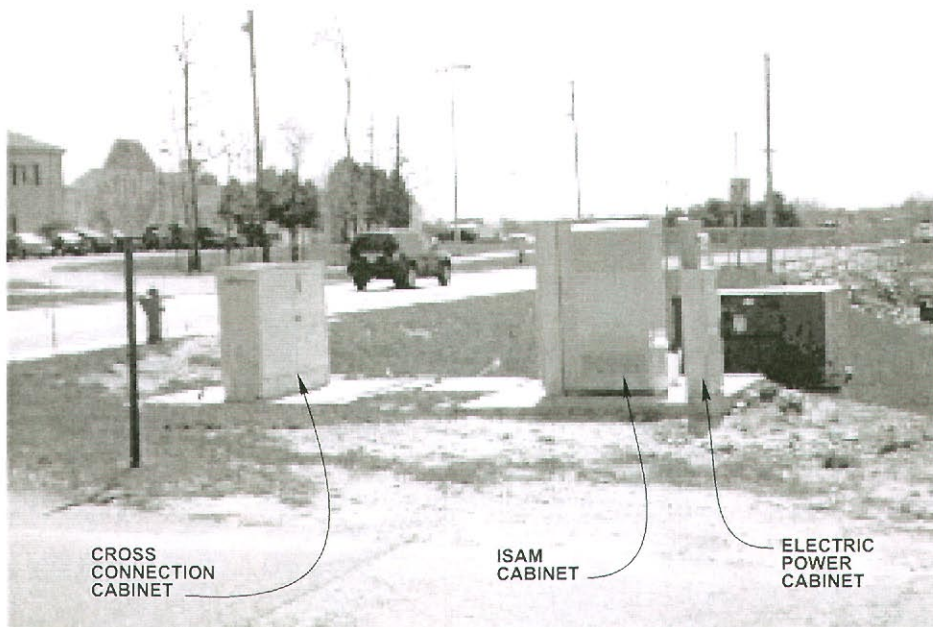
FIBER OPTIC CABLE TO THE NODE WIRELESS TELECOMMUNICATION TECHNOLOGY



Source: AT & T and SEWRPC.

Figure 2

TYPICAL INTELLIGENT SERVICE ACCESS MANAGER (ISAM)



based on copper line connections to a central office. The central office is able to serve DSL subscribers within a radius of about 18,000 feet of a central office. The first upgrade, shown just below the all-copper existing network in Figure 3, deployed fiber-linked remote terminals that extended DSL range to a new radius of 18,000 feet from the remote terminal. This upgrade brought DSL services to areas previously located too distant from central offices. The second upgrade, shown in the lower part of Figure 3, is the U-Verse upgrade now part of the current Project Lightspeed (VDSL). Because the new high speed VDSL technology is limited to a 3,000 foot radius, this upgrade will require a much higher density of remote nodes than the original ADSL remote terminals.

Achieving the data rates of 20 to 25 megabits per second needed for high definition television represents a significant challenge for copper-based networks. An important component in achieving these high data rates is video compression technology. Alcatel and AT&T are relying on significant improvements in the current MPEG-4 video compression technology to satisfy their target markets.

Fiber-to-the User (FTTU) Wireline Technology

Fiber optic cable technology represents the ultimate in bandwidth for broadband communications systems. A single-mode fiber strand using the most sophisticated fiber transceiver technology has currently an ultimate demonstrated capacity of 14 terabits per second, where a terabit per second is equal to 1,000 gigabits per second. A gigabit per second in turn represents a 1,000 megabits per second. Fiber optic transmission systems of such capacity are deployed only on major trunk lines such as transoceanic links. Economic cost and need considerations result in lower capacity networks for user broadband access.

Two major technologies are utilized in fiber optic access networks; Active optical networks (AONs) and, Passive optical networks (PONs).

Active optical networks require a dedicated fiber from a central office to each user with transceiver electronic equipment at both ends of the connection. In an AON network, throughput is limited only by the cost and complexity of the transceiver equipment at both ends of the connection. The fiber strand itself, as already noted, has essentially unlimited bandwidth. Cost considerations, however, do limit the capacity of the transceiver equipment to data rates in the lower gigabit range.

Passive optical networks share both optical fiber and transceiver equipment. With the Alcatel 7340 Fiber-to-the-user (FTTU) System employed regionally by AT&T, a single fiber connects multiple users to

a single transceiver located at a central office. The single fiber is split, using a passive optical splitter, to serve up to 32 users. The PON approach reduces not only the amount of fiber required, but also the electronic transceiver equipment, lowering both capital and operating costs for the service provider. AT&T Wisconsin has selected the PON design alternative to take advantage of these lower capital and operating costs. The disadvantage of this determination is in the lower throughput potential of a PON as compared to an AON system configuration. The Alcatel 7340 PON system selected by AT&T will provide Internet access data rates up to 100 megabits per second. While this data rate is significantly above data rates possible with AT&T's ADSL service, or even Fiber-to-the-node (FTTN) technology, it is also below the ultimate potential of fiber optic broadband service which lies well into the gigabit per second range. Broadband service of 100 megabits per second however, complies with the 4G objective and standards set forth in Chapter IV of this report. In the future, this network capacity may be challenged by the needs of video-on-demand. A network diagram of the Alcatel 7340 FTTU System is shown in Figure 4. The system is comprised of the following functional components:

At the Central Office

1. Packet Optical Line Terminal (P-OLT)
This component serves data and voice traffic.
2. Video Optical Line Terminal (V-OLT)
This component serves video traffic.
3. Web – based Access Manager (WAM)
This component provides local network management.
4. Wavelength – Division Multiplexer
This component provides frequency multiplexing on the fiber optic link.

In the Field

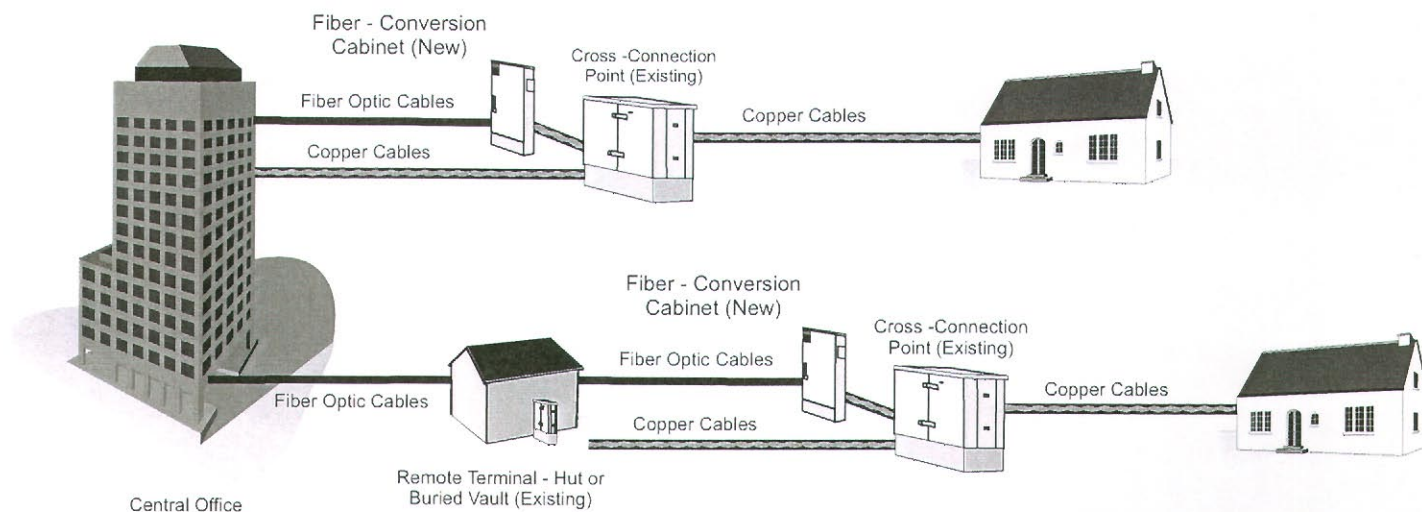
1. Alcatel 6620 Outside Plant
This component consists of fiber optic cable, splicing enclosures for patching, coupling and optical splitters.

User Premises

1. Home Optical Network Terminal (H-ONT)
This component terminates the PON fiber optical cable at the residence and provides voice, data and video interfaces.

Figure 3

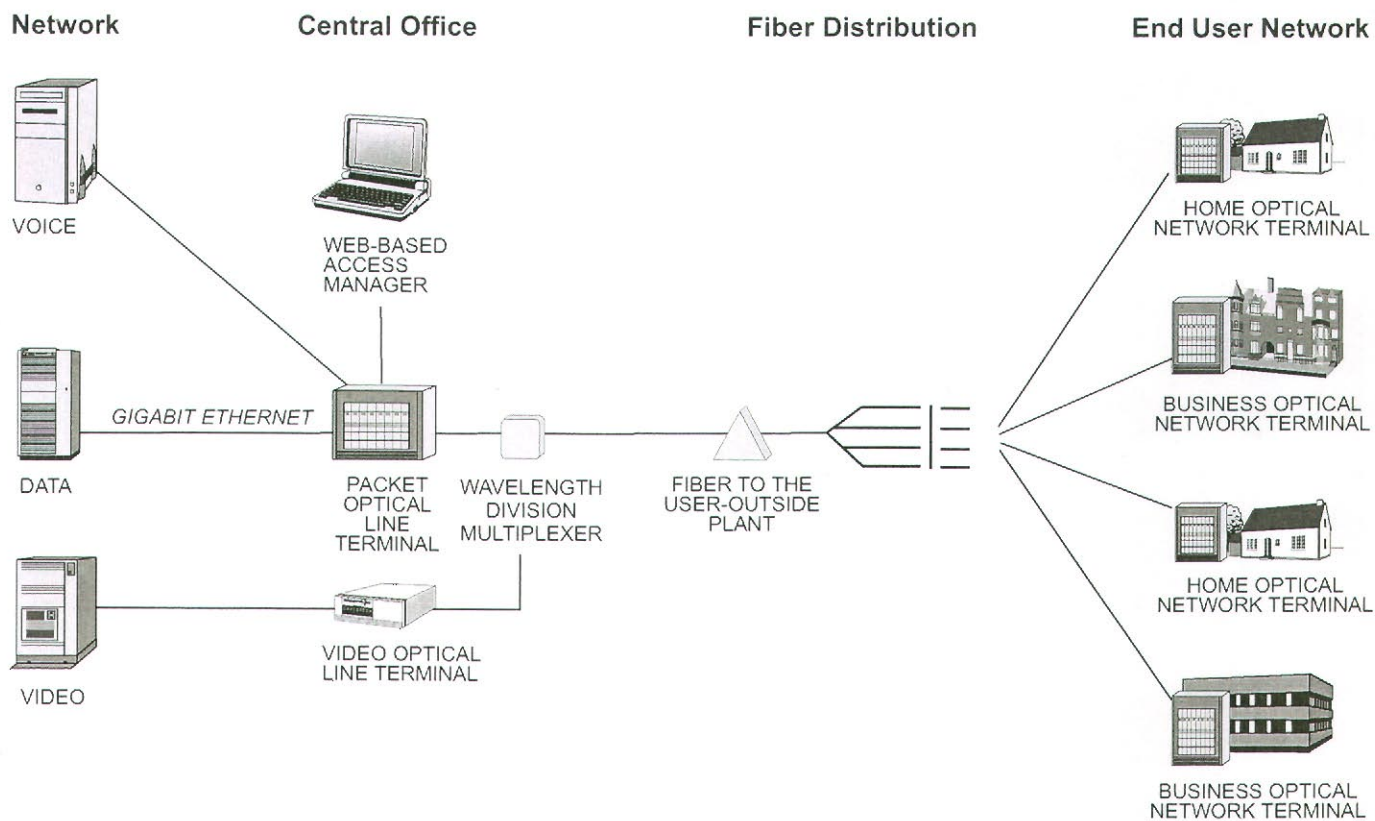
AT & T WISCONSIN NETWORK UPGRADE LAYOUT



Source: AT & T and SEWRPC.

Figure 4

NETWORK DIAGRAM



Source: ALCATEL and SEWRPC.

2. Business Optical Network Terminal (B-ONT)

This components terminates the PON fiber optic cable at the business site and provides voice, data and video interfaces.

The Alcatel 7340 FTTU System supports a long distance reach of up to 12.4 miles from the central office. The P-OLT collects voice traffic and routes it to a voice gateway. Data traffic is accrued and routed to a broadband switch or router also by the P-OLT at the central office. In a similar manner, video traffic is directed through the V-OLT where it is amplified for downstream or upstream transmission.

For reasons similar to those presented for the fiber-to-the-node wireline technologies this particular version of Alcatel FTTU technology was selected for the regional wireline plan. It is the choice of AT&T, the major ILEC in the Region. While legacy home or business copper lines are no longer involved in this technology, the major capital commitments required to implement the technology makes the technology of the major ILEC an important consideration.

PLAN ALTERNATIVES

Employing the wireless and wireline technologies just described, six alternative broadband telecommunications plans were developed as candidates for the recommended regional plan. Four of these plans employ wireless broadband technologies and two employ fiber optic wireline technologies. Since no one technology is likely to fulfill all of the functional needs -- fixed, nomadic and mobile users -- and all of the geographic constraints -- urban, suburban and rural area -- the final regional comprehensive broadband telecommunications plan is a composite of the functional capabilities and geographic components of a number of the alternative wireless or wireline broadband communications plans.

The following six alternative broadband communications plan are presented in this chapter:

1. Community-Based Wireless Plan

Under this plan advanced WiFi/WiMAX wireless networks would be provided on a community-by-community basis with the option of a WiMAX-based backhaul network for fixed and nomadic users. With some minor changes in associated hardware and software, this alternative is the wireless plan presented in SEWRPC Planning Report No. 51.

2. Regional Wireless Plan

Under this alternative plan all areas of the Region would be served by an integrated WiFi wireless network with fiber optic gateways provided at each base station site for fixed and nomadic users.

3. Mobile WiMAX-based Wireless Plan

This plan is based on IEEE Standard 802.16e, and would use licensed frequency bands in the 2.5 or 3.5 GHz spectral regions to provide high data rate cell phone service to the entire Region.

4. Mobile Wi-Fi-based Wireless Plan

This plan is based upon IEEE Standard 802.11a and 802.20, and would use unlicensed frequencies in the 5.8 GHz band to provide high data rate cell phone service as an extension of the Alternative Plan 2, the Regional Wireless Plan.

5. Regional Fiber-to-the-Node (FTTN) Wireline Plan

This plan is based upon Alcatel 7330 FTTN technology, and would extend fiber optic cable from telephone system central office locations to remote sites for copper line transmission to users. The plan would employ very high speed VDSL technologies.

6. Regional Fiber-to-the User (FTTU) Wireline Plan

This plan is based on Alcatel 7340 FTTU technology, and would extend fiber optic cable to each user's premises using Passive Optical Network (PON) technology.

Community-Based Wireless Plan

As already noted, the community-based wireless plan is substantially the plan presented in SEWRPC Planning Report No. 51, *A Wireless Antenna Siting and Related Infrastructure Plan for Southeastern Wisconsin*, September 2006. Differences relate only to additional equipment and related software options for the end user and an alternative approach to servicing nomadic users in community-based wireless networks. These additions and alternatives are described below as a part of a short review of the structure of this plan as presented in SEWRPC Planning Report No. 51.

The regional community-based wireless plan consists of two major mutually supportive networks: a regional wireless backhaul network and a set of community level wireless service plans.

The Regional Wireless Backhaul Network Plan is fully described on pages 195 to 199 of SEWRPC Planning Report No. 51 previously referenced. The description includes Map 60 on page 196 which shows all 47 backhaul base stations and the 7 recommended gateway stations required to service all potential community-based wireless networks in the Region. This Plan map is provided as

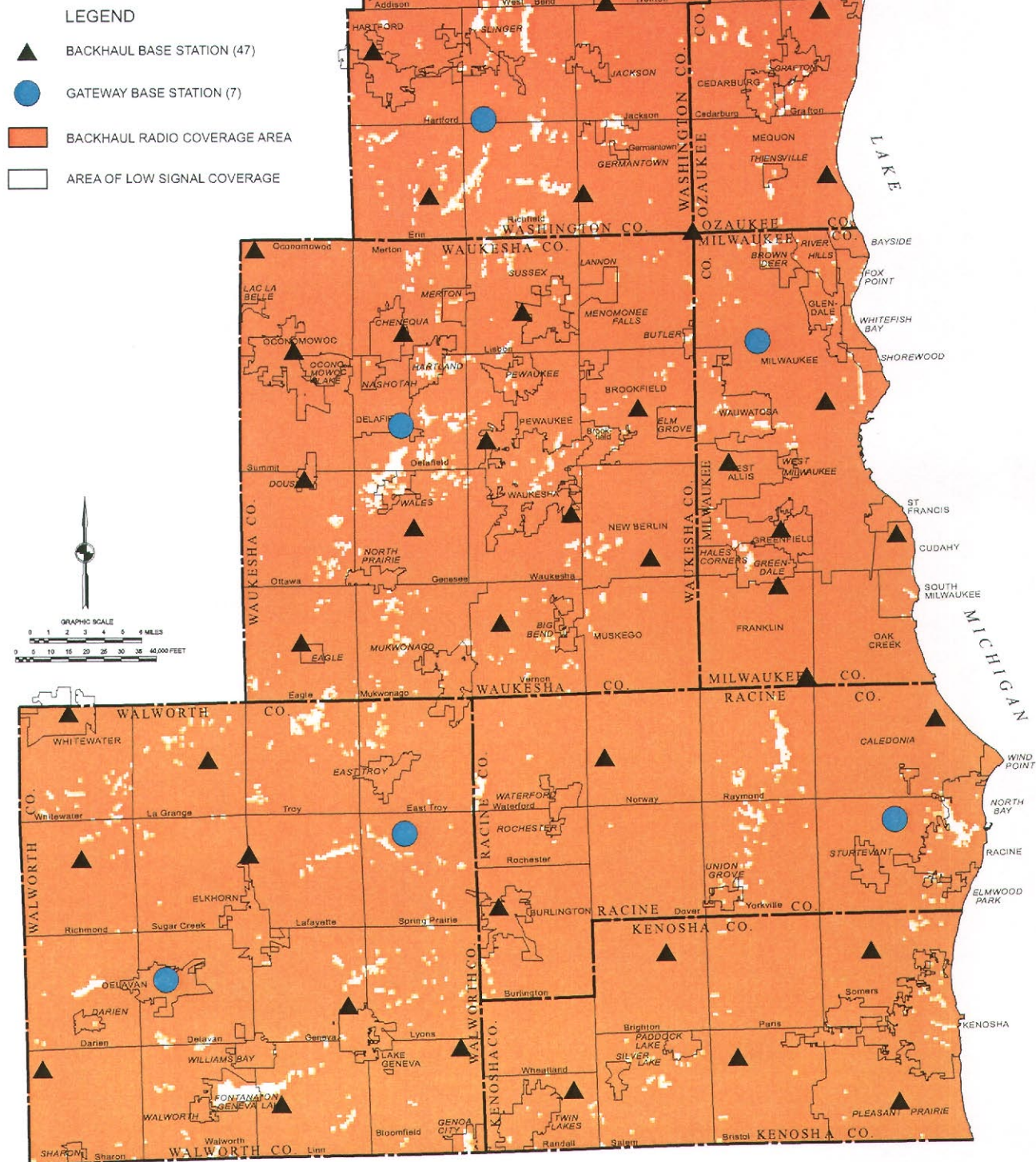
Map 1 in this Chapter. While all communities will have the option of arranging for their own Internet gateway connections, most would benefit financially by interconnecting to a regional wireless backhaul network. The alternative WiFi and WiMAX technologies to be used in building the wireless backhaul infrastructure are also described in SEWRPC Planning Report No. 51.

Summary costs for deploying the backhaul network infrastructure are provided on page 197 of SEWRPC Planning Report No. 51 and all detailed in Appendix F of that report. Costs are provided for both new and existing co-located sites. Estimated operating costs of the regional backhaul network are detailed in Appendix G of that report.

Individual community level wireless plans would be prepared by the Commission, or by consultants or potential providers upon request of the local unit or units of government concerned. An example of a community wireless plan for the City of Cedarburg and Village of Grafton area is presented in SEWRPC Planning Report No. 51. This example plan is based on advanced WiFi 802.11g technology included in the detailed plan description on pages 199 to 204 of the report. Maps 61 and 62 on pages 200 and 201 of that report depict a 41 access point structure with 18 in the City of Cedarburg and 23 in Village of Grafton servicing both fixed and nomadic users. Map 61 on page 200 of that report indicates anticipated performance levels for nomadic users and Map 62 on the page following for fixed users. These plan maps are provided as Maps 2 and 3 in this Chapter. Table 67 on page 202 lists all of the recommended access points for the Cedarburg-Grafton community wireless plan. This table is provided as Table 1 in this Chapter. Infrastructure capital costs and system operating costs are provided in Appendices F and G respectively of SEWRPC Planning Reporting No. 51. These appendices are provided as Tables 2 and 3 in this Chapter.

Since the publication of SEWRPC Planning Report No. 51 the Commission has been asked by several municipalities to prepare second level plans as envisioned in the plan implementation procedure set forth in SEWRPC Planning Report No. 51. The requests have involved both rural and urban communities. The preparation of these second level plans has involved the conduct of extensive field tests of the initially proposed networks, and the findings of these tests have resulted in some changes to and enhancements of the original network plans for the areas concerned. These changes and enhancements include:

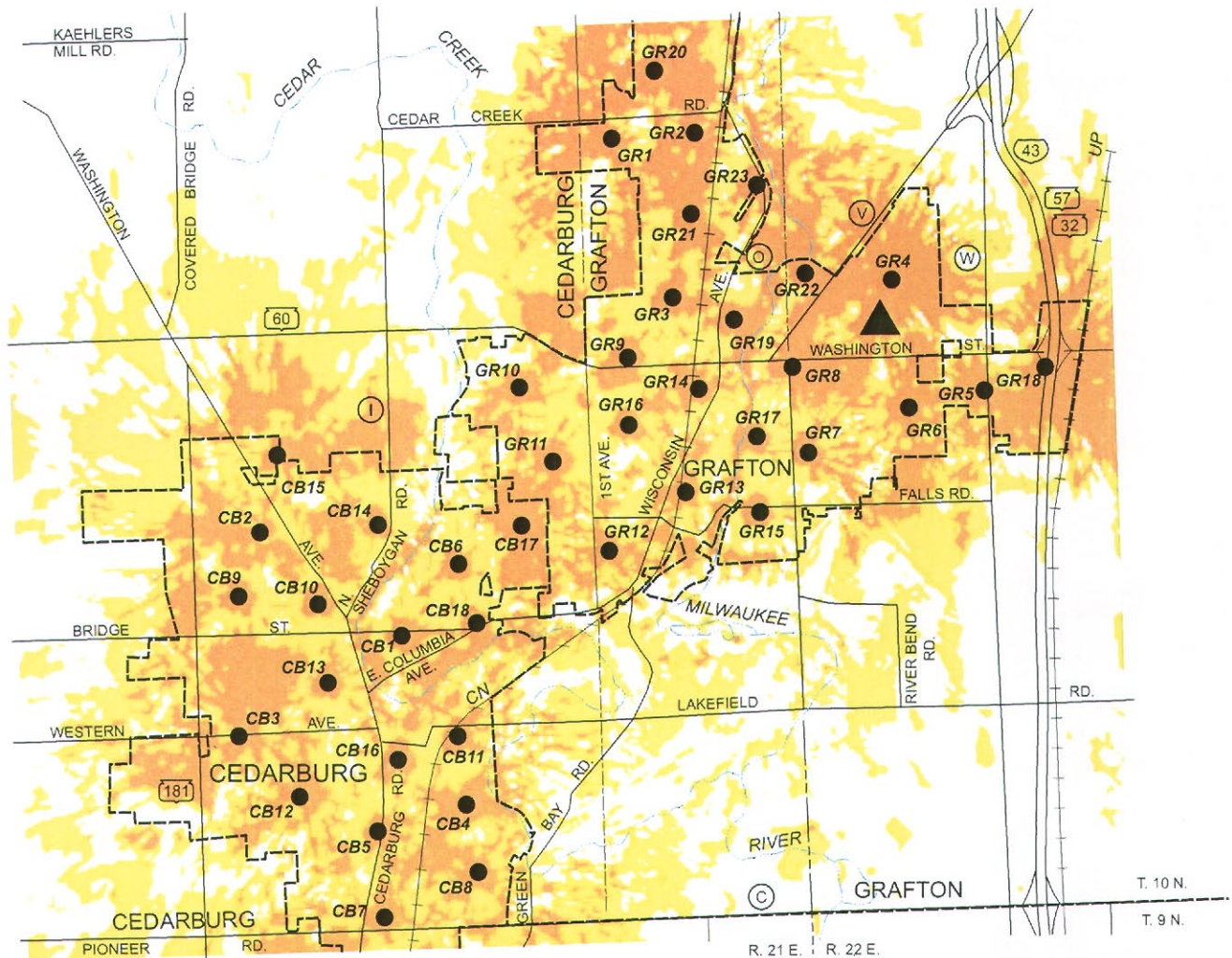
POTENTIAL LOCATIONS OF BASE STATIONS AND GATEWAYS AND ATTENDANT PERFORMANCE OF BACKHAUL WIRELESS COMMUNICATIONS IN THE REGION



15

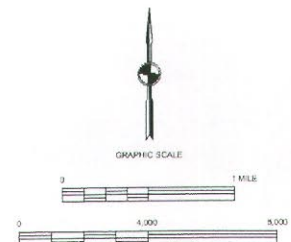
Map 2

POTENTIAL LOCATIONS OF WiFi ACCESS POINTS AND ATTENDANT PERFORMANCE OF ACCESS NETWORK FOR NOMADIC USERS IN THE CEDARBURG-GRAFTON AREA: BASE STATION TO USER



LEGEND

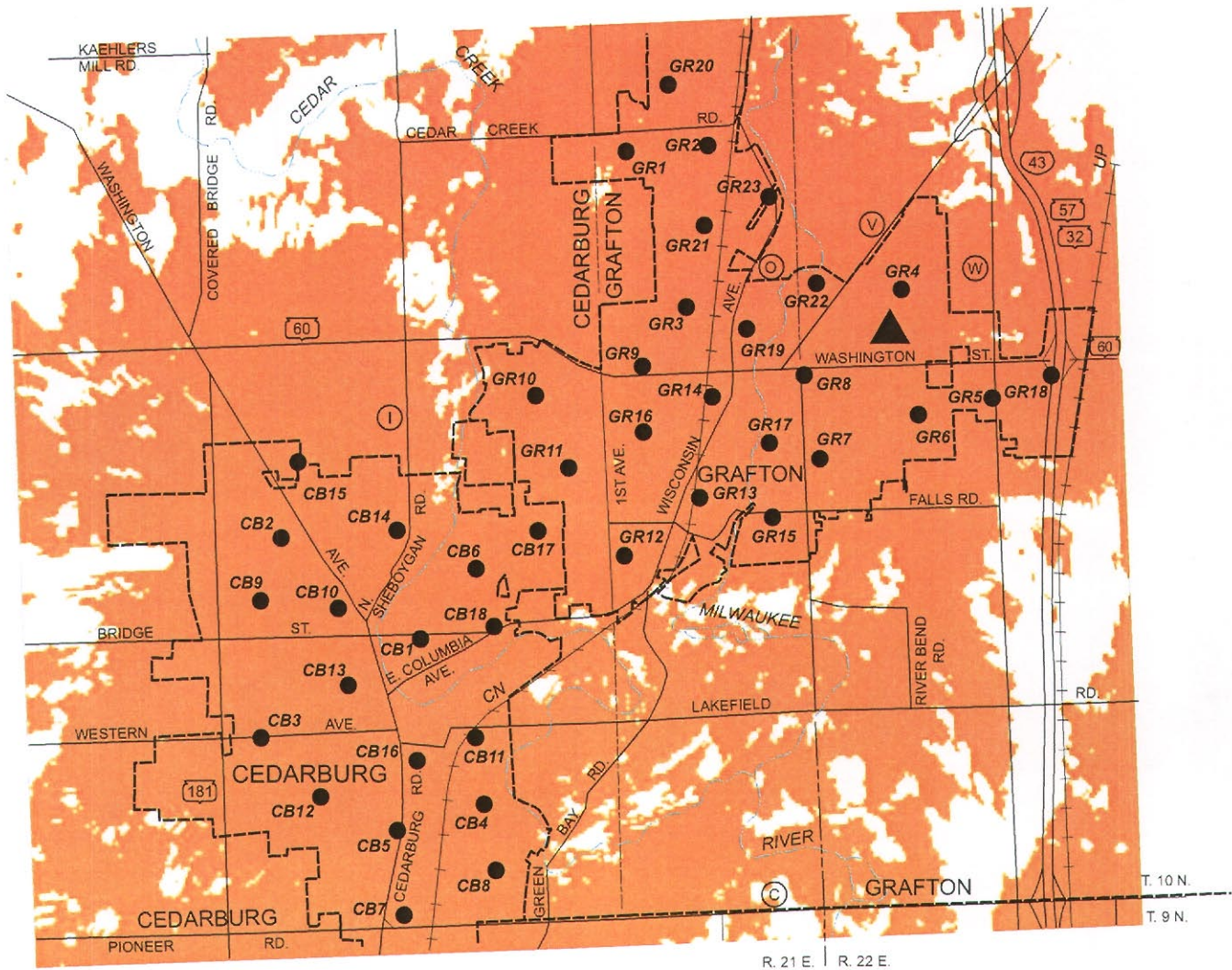
- ▲ EXISTING BASE STATION TO BE USED FOR WiMAX APPLICATION
- RECOMMENDED LOCATION OF WiFi ACCESS POINT
- GR3 IDENTIFICATION NUMBER (SEE TABLE 1)
- RECEIVED POWER AT REMOTE:
-70dBmW TO -79dBmW,
THROUGHPUT: 24 Mbps to 54Mbps
- RECEIVED POWER AT REMOTE:
-79dBmW to -87dBmW,
THROUGHPUT: 6 Mbps to 24 Mbps
- AREA NOT WITHIN ACCEPTABLE COVERAGE



Source: SEWRPC.

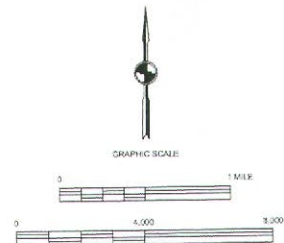
Map 3

POTENTIAL LOCATIONS OF WiFi ACCESS POINTS AND ATTENDANT PERFORMANCE OF ACCESS NETWORK FOR FIXED USERS IN THE CEDARBURG-GRAFTON AREA: BASE STATION TO REMOTE



LEGEND

- ▲ EXISTING BASE STATION TO BE USED FOR WIMAX APPLICATION
- RECOMMENDED LOCATION OF WiFi ACCESS POINT
- GR3 IDENTIFICATION NUMBER (SEE TABLE 1)
- RECEIVED POWER AT REMOTE:
-70dBmW TO -87dBmW,
THROUGHPUT: 24 Mbps to 54Mbps
- AREA NOT WITHIN ACCEPTABLE COVERAGE



Source: SEWRPC.

Table 1

**LOCATIONS OF RECOMMENDED WIRELESS ACCESS POINTS TO BE USED FOR WIFI
PURPOSES IN THE CITY OF CEDARBURG AND VILLAGE OF GRAFTON, OZAUKEE COUNTY, WISCONSIN**

Site Number (See Maps 2 and 3)	Location			
	State Plane Coordinates ^a		U.S. Public Land Survey Township- Range-Section	Civil Division
	North	East		
GR1	493,567	2,542,022	T. 10 N., R. 21 E. Sec. 13	Village of Grafton
GB2	488,807	2,545,318	T. 10 N., R. 21 E. Sec. 13	Village of Grafton
GR3	489,372	2,543,603	T. 10 N., R. 21 E. Sec. 13	Village of Grafton
GR4	489,971	2,549,446	T. 10 N., R. 22 E. Sec. 18	Village of Grafton
GR5	486,743	2,551,950	T. 10 N., R. 22 E. Sec. 19	Village of Grafton
GR6	486,450	2,549,905	T. 10 N., R. 22 E. Sec. 19	Village of Grafton
GR7	485,296	2,547,322	T. 10 N., R. 22 E. Sec. 19	Village of Grafton
GR8	487,628	2,546,826	T. 10 N., R. 22 E. Sec. 19	Village of Grafton
GR9	487,928	2,542,530	T. 10 N., R. 21 E. Sec. 24	Village of Grafton
GR10	487,149	2,539,665	T. 10 N., R. 21 E. Sec. 23	Village of Grafton
GR11	485,188	2,540,599	T. 10 N., R. 21 E. Sec. 23	Village of Grafton
GR12	482,694	2,541,918	T. 10 N., R. 21 E. Sec. 25	Village of Grafton
GR13	484,267	2,544,017	T. 10 N., R. 21 E. Sec. 24	Village of Grafton
GR14	487,002	2,544,322	T. 10 N., R. 21 E. Sec. 24	Village of Grafton
GR15	483,683	2,545,926	T. 10 N., R. 21 E. Sec. 25	Village of Grafton
GR16	485,980	2,542,482	T. 10 N., R. 21 E. Sec. 24	Village of Grafton
GR17	485,633	2,545,878	T. 10 N., R. 21 E. Sec. 26	Village of Grafton
GR18	487,463	2,553,785	T. 10 N., R. 21 E. Sec. 26	Village of Grafton
GR19	488,807	2,545,318	T. 10 N., R. 21 E. Sec. 24	Village of Grafton
GR20	495,301	2,543,229	T. 10 N., R. 21 E. Sec. 12	Village of Grafton
GR21	491,564	2,544,215	T. 10 N., R. 21 E. Sec. 13	Village of Grafton
GR22	490,090	2,547,290	T. 10 N., R. 22 E. Sec. 18	Village of Grafton
GR23	492,355	2,546,028	T. 10 N., R. 21 E. Sec. 13	Village of Grafton

Site Number (See Maps 2 and 3)	Location			
	State Plane Coordinates ^a		U.S. Public Land Survey Township- Range-Section	Civil Division
	North	East		
CB1	480,488	2,536,424	T. 10 N., R. 21 E. Sec. 26	City of Cedarburg
CB2	483,338	2,532,805	T. 10 N., R. 21 E. Sec. 27	City of Cedarburg
CB3	477,856	2,532,271	T. 10 N., R. 21 E. Sec. 34	City of Cedarburg
CB4	475,954	2,538,218	T. 10 N., R. 21 E. Sec. 25	City of Cedarburg
CB5	475,207	2,535,812	T. 10 N., R. 21 E. Sec. 24	City of Cedarburg
CB6	482,317	2,537,883	T. 10 N., R. 21 E. Sec. 26	City of Cedarburg
CB7	473,063	2,535,915	T. 10 N., R. 21 E. Sec. 34	City of Cedarburg
CB8	474,070	2,538,428	T. 10 N., R. 21 E. Sec. 35	City of Cedarburg
CB9	481,530	2,532,094	T. 10 N., R. 21 E. Sec. 27	City of Cedarburg
CB10	481,367	2,534,206	T. 10 N., R. 21 E. Sec. 27	City of Cedarburg
CB11	477,791	2,537,969	T. 10 N., R. 21 E. Sec. 35	City of Cedarburg
CB12	476,276	2,533,937	T. 10 N., R. 21 E. Sec. 34	City of Cedarburg
CB13	479,193	2,534,415	T. 10 N., R. 21 E. Sec. 27	City of Cedarburg
CB14	483,477	2,535,790	T. 10 N., R. 21 E. Sec. 27	City of Cedarburg
CB15	483,417	2,533,281	T. 10 N., R. 21 E. Sec. 22	City of Cedarburg
CB16	477,206	2,536,337	T. 10 N., R. 21 E. Sec. 24	City of Cedarburg
CB17	483,309	2,539,755	T. 10 N., R. 21 E. Sec. 26	City of Cedarburg
CB18	480,689	2,538,419	T. 10 N., R. 21 E. Sec. 26	City of Cedarburg

^aState Plane Coordinates are from the Wisconsin State Plane Coordinate System, South Zone, North American Datum of 1927. Coordinates are rounded to the nearest foot.

Source: SEWRPC.

Table 2

ANTENNA AND RELATED INFRASTRUCTURE COST ESTIMATES FOR THE CEDARBURG-GRAFTON AREA WIRELESS NETWORK PLAN

COMMUNITY WiFi NETWORK (802.11) ACCESS POINT EQUIPMENT

WiFi (802.11 a,g) Access Point

1. Transceiver Modules	
2 at \$1,500 =	\$3,000
2. Sectorized Antenna	995
3. Auxiliary Equipment	841
4. Installation and Testing	
17 hours at \$80	<u>1,360</u>
Total	\$6,196

For rural wireless network, add:

Three sets of preamplifiers, connectors and power injectors - \$645

WiFi Network Cost Summary - Cedarburg-Grafton Area

1. Access Points	
41 at \$6,196 =	\$254,036
2. Gateway Stations	
2 at \$17,300 =	34,600
3. Network Monitoring System	10,000
4. Project Management and Engineering	<u>55,000</u>
Total	\$353,336

BACKHAUL WiMAX/WiFi NETWORK (802.11, 802.16) BASE STATION EQUIPMENT

Co-located Site

1. Site Preparation and Cleanup	\$ 1,000
2. Enclosures	200
3. Utility Connection	2,000
4. Power Conditioning and Backup	7,020
5. 21 dBi Antenna	150
6. 16 dBi Sectorized Antenna	1,404
7. Transceiver Modules	
WiFi (802.11) (2)	2,800
WiMAX (802.16) (1)	3,000
8. Installation and Testing	
40 hours at \$80	3,200
9. Miscellaneous (Freight, cabling and travel)	<u>2,250</u>
Total	\$23,024

New Site

1. Items 1-9 of co-located site above	\$23,024
2. Tower Erection	
100 foot tower	\$7,200
Foundation	4,100
Labor	2,200
Climb Shield	1,000
	<u>14,500</u>
Total	\$37,524

Table 2 (continued)**Gateway Station**

1.	Site Preparation and Cleanup	\$ 1,000
2.	Enclosures	10,850
3.	Utility Connection	2,000
4.	Power Conditioning and Backup	7,020
5.	31.2 dBi Antenna	3,874
6.	16 dBi Sectorized Antenna	1,404
7.	Transceiver Modules	
	WiFi (802.11) (2)	2,800
	WiMAX (802.16) (1)	3,000
8.	Internet Interconnection	
	MPLS Router	30,420
	Fiber Interconnect Equipment	20,000
9.	Installation and Testing	
	80 hours at \$80	6,400
10.	Miscellaneous	
	(Freight, cabling and travel)	<u>2,750</u>
	Total	\$91,518
	If new tower required	<u>14,500</u>
		\$106,018

Backhaul Network Cost Summary – Co-Location

1.	Antenna Base Stations	
	47 at \$23,024 =	\$1,082,128
2.	Gateway Stations	
	7 at \$91,518 =	640,626
3.	Project Management and Engineering	<u>350,000</u>
	Total	\$2,072,754

Backhaul Network Cost Summary – New Tower Sites

1.	Antenna Base Stations	
	47 at \$37,524 =	\$1,763,628
2.	Gateway Stations	
	7 at \$106,018 =	742,126
3.	Project Management and Engineering	<u>350,000</u>
	Total	\$2,855,754

Table 3
OPERATING AND MAINTENANCE COST ESTIMATES FOR THE CEDARBURG-GRAFTON
AREA WIRELESS NETWORK PLAN

Access Point
Community WiFi Network

1. Electric Power	
50 watts at \$0.05/kwh	\$ 1.80 per month
2. Maintenance and Network	
Management	25.00 per month
3. Pole Rental	<u>10.00 per month</u>
Total	\$ 36.80 per month

Backhaul Base Station
WiFi/WiMAX Network – Co-location

1. Electric Power	
200 watts at \$0.05/kwh	\$ 7.20 per month
2. Maintenance and Network	
Management	100.00 per month
3. Base Station Rental	
\$4/foot/month	
100 foot tower	400.00 per month
4. Transport Costs (100 Mbps)	
74 x 100 =	<u>7,400.00 per month</u>
Total	\$ 7,907.20 per month

Backhaul Base Station
WiFi/WiMAX Network – New Towers

1. Electric Power	
200 watts at \$0.05/kwh	\$ 7.20 per month
2. Maintenance and Network	
Management	100.00 per month
3. Land usage fee	1,060.00 per month
4. Transport Costs (100 Mbps)	
74 x 100 =	<u>\$7,400.00 per month</u>
	\$8,507.20 per month

Note:

Base station operators are often required to have liability insurance in the range of \$1 to 3 million for each base station site. Less often they are required to post performance bonds for the contingency of tower abandonment. Neither of these costs are included here.

1. User Premises Equipment

Previously, potential users were offered the option of installing either a directional antenna or a directional antenna with a high gain preamplifier. For reasons of both performance and network simplicity, all users will now require an antenna/amplifier combination.

2. Repeater Sites and Nomadic Users

Previously, the wireless network plans were prepared separately for two classes of users – fixed users and nomadic users. Plans servicing nomadic as well as fixed users typically required a larger number of access points to provide the same level of performance. A new wireless network design approach using lower cost repeater sites will significantly lower the overall cost of a system configured to serve nomadic users. A repeater site is estimated to cost about 30 percent of the cost of a primary access point, and the repeaters can be selectively placed in locations where nomadic user performance upgrades are required. This repeater-based network enhancement can be accomplished without changing the network access point structure originally laid out to serve only fixed users.

With the exception of the afore listed changes and enhancements, Alternative Plan One is identical to the community-based wireless plan described in SEWRPC Planning Report No. 51 and is intended to be used as a model for any community-based wireless plans that may be prepared.

The infrastructure capital costs for the community wireless plan are typified by the Cedarburg-Grafton sample community wireless plan is estimated at about \$353,000 for 47 access points in the network. Operating costs for each access point, as detailed in Table 3, are estimated at about \$37 per month per station, or about \$1700 per month total for all 47 access points. Each backhaul station operating cost will range from \$7,900 to \$8,500 per month per station depending upon the type of installation, for a total cost of \$459,000 per month for all 54 base stations. Thus, the total operating costs of the system are estimated at about \$460,700 per year. This cost assumes operation at full capacity which capacity would be achieved only over time.

Regional Wireless Plan

A major shortcoming of the community-based wireless plan is its cost effectiveness when applied in rural communities with lower resident population densities. In some communities it will be difficult to justify the infrastructure investment even for a comparatively low cost advanced WiFi-based system. The question of cost effectiveness and return on investment also arises with respect to service to lower income

areas within the Region. Since a major objective of the broadband regional wireless plan is universal coverage, an alternative regional wireless plan that is potentially cost effective in all regional communities has been developed as a Regional Wireless Plan. This broadband WiFi-based system is designed to serve fixed and nomadic users in all geographic areas of the Region from the inner city of Milwaukee to the most rural areas of Walworth and Washington counties. This plan will be specified to offer the following features:

1. Frequency Band

The regional wireless system would operate in the unlicensed 5.8 GHz band separate and non-interfering with the 2.4 GHz community wireless band.

2. Technology

System operation would be based on IEEE 802.11a WiFi OFDM technology.

3. Antenna Base Stations Sites

The network infrastructure would be based on 141 existing antenna tower sites installed on a co-location basis. An antenna height of 30 meters was assumed although that height could vary from site to site. A four sector antenna configuration is employed.

4. Antenna Site Density

The antenna site density, as shown in Map 4 would vary with higher densities provided in urban service areas. This variation is required, in part, because of the higher building “clutter” in urban areas, and in part to serve the heavier traffic volume that may be expected in areas with higher population density.

5. Internet Gateway Connection

Because of the expected high network traffic volume, fiber optic gateway interconnections would be made at each antenna base station site. Such interconnection implies fiber optic cable availability at each site. Since these co-location sites already serve other cellular/PCS wireless networks, there is a high likelihood that fiber optic accessibility is already present at each site.

6. Repeater Sites for Nomadic Users

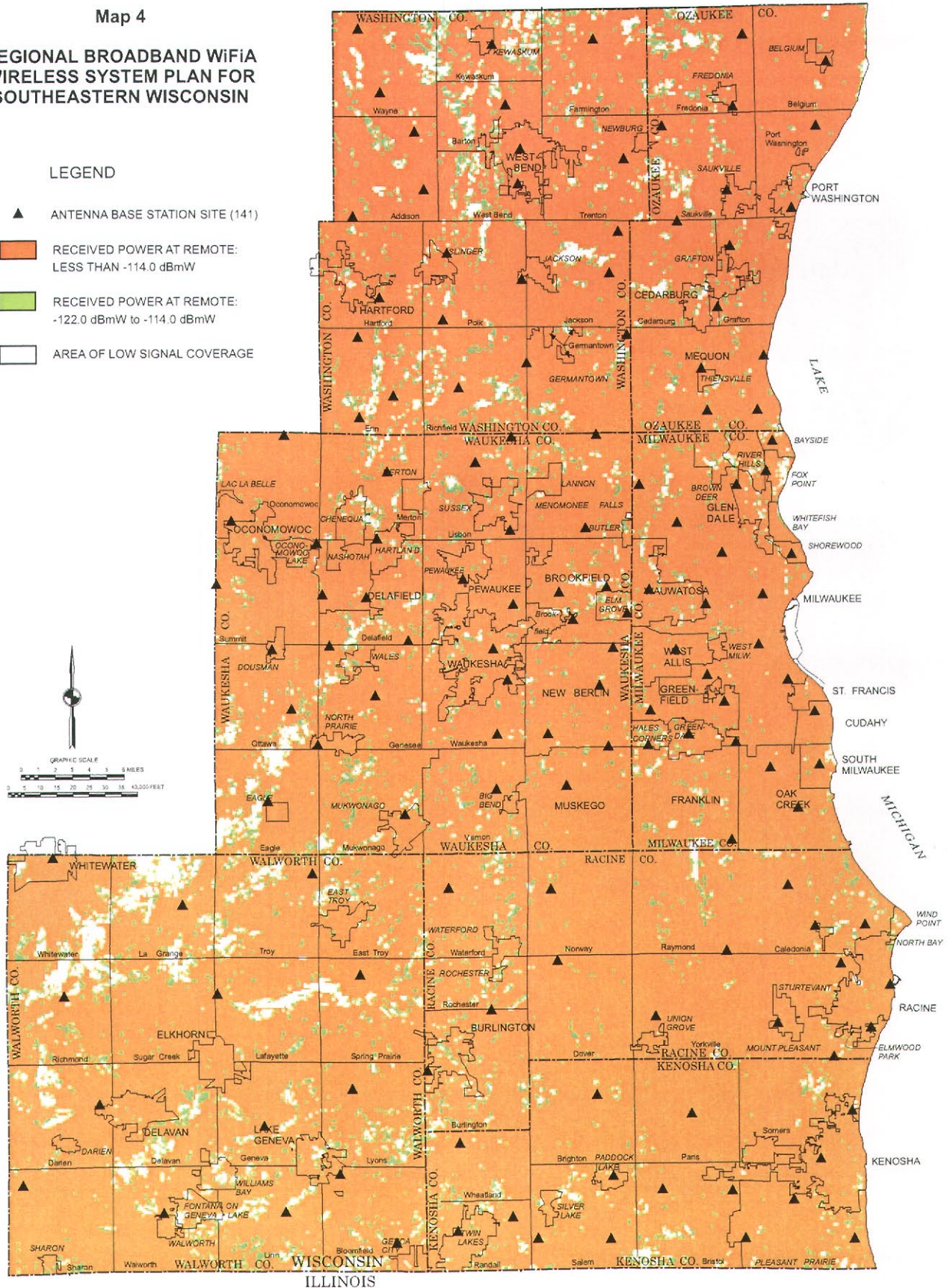
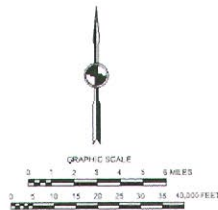
Enhanced service for nomadic users would be provided under this plan with repeater sites located at 6 meter -- lamp pole -- heights in areas requiring such service. With 141 base station sites each having four 90 degree sectors, there are 564 possible sector sites for repeater stations. Many of these sectors may be expected to be in areas unsuitable for extensive nomadic user service. Furthermore, with advancing antenna and electronic technology in laptop computers, the need for repeaters may be expected to decline over time as fixed and nomadic transceivers become more similar in performance characteristics.

Map 4

**REGIONAL BROADBAND WiFi
WIRELESS SYSTEM PLAN FOR
SOUTHEASTERN WISCONSIN**

LEGEND

- ▲ ANTENNA BASE STATION SITE (141)
- RECEIVED POWER AT REMOTE:
LESS THAN -114.0 dBmW
- RECEIVED POWER AT REMOTE:
-122.0 dBmW to -114.0 dBmW
- AREA OF LOW SIGNAL COVERAGE



Source: SEWRPC.

7. Cost Structure

The cost structure of the regional wireless plan as it relates to base station infrastructure equipment would be virtually identical to that estimated for the regional wireless backhaul network. The same 802.11a WiFi equipment would be applicable to both networks. Both provide for four sector operation. This similarity allows for use of the backhaul cost data in estimating the costs of the regional wireless access plan. The regional wireless access plan of necessity has a higher base station site density -- 141 versus 54. The higher density requirement results from the assumed height of the serviced user. In the backhaul plan, it is a six meter -- approximately 20 feet -- access point while in the access plan, it is a two meter approximately six feet user site. While the number of base station sites is larger in the access plan, the unit base station cost is the same.

8. Performance

The network layout as shown in Map 1 is designed to provide 24 megabits per second throughout performance to fixed users for the entire Region. The few sub-performance areas noted on the map also be upgraded using the same repeaters employed to enhance nomadic user.

9. County Representation

The 141 antenna base sites are represented in each of the seven counties as follows: Kenosha 15, Milwaukee 24, Ozaukee 14, Racine 15, Walworth 14, Washington 23, Waukesha 36.

Regional Wireless Plan Costs

The antenna base station equipment costs are detailed in Table 2. Separate cost summaries are provided for both co-location and new sites. Since the plan herein presented is based upon co-located sites, only co-located site cost data were used in the cost estimate. Some of the selected co-location sites may encounter difficulties in arranging with site owners for co-location. There are, however, 1,010 cellular/PCS antenna base station sites in the Region. With this large number of sites, substitute sites should be available in almost all areas so as not to significantly affect the cost of this plan estimate.

The only addition to the Appendix F site cost summary is a \$2,500 fiber optic interconnection which was adjudged as the typical connection charge if fiber optic cable is available at the site. With 141 planned sites in the regional wireless plan and with an estimated site cost of approximately \$25,500, the total estimated capital cost for the required wireless communications infrastructure equipment is approximately \$3,600,000. Additional systems infrastructure costs relate to the cost of bringing fiber to each of the 141 sites if not already available. These costs estimated in cooperation with Time Warner Telecom and

Charter Communications approximate \$_____. Thus, the total capital cost of this alternative plan is estimated to be \$_____. Operating costs are estimated at \$_____.

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