

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

DATE: March 27, 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 Chairman	Executive Director Emeritus, SEWRPC
Roger Caron	President, Racine Area Manufacturers and Commerce
David L. DeAngelis	Village Manager, Village of Elm Grove
Michael Falaschi	President, Wisconsin Internet
Barry Gatz	Network Supervisor, CenturyTel
Michael E. Klasen	Director, Regulatory Affairs, AT&T
Jeff M. Lowney	Vice President/General Manager, Time Warner Telecom
Jeff Mantes	Commissioner of Public Works, City of Milwaukee
George E. Melcher	Director, Office of Planning and Development, Kenosha County
Paul E. Mueller	Administrator, Washington County Planning and Parks Department
Rob N. Richardson	Director, Racine County Information Systems
Steven L. Ritt	Attorney at Law, Michael Best & Friedrich
James W. Romlein	Managing Director, MV Labs, LLC
Darryl Winston	Director of Data Services, City of Milwaukee Police Department
Gustav W. Wirth, Jr.	SEWRPC Commissioner

Members Absent

William R. Drew Vice Chairman	Vice-Chairman, SEWRPC; Executive Director, Milwaukee County Research Park
Bob Chernow	Chairman, Regional Telecommunications Commission
Michael Long	Attorney-at-Law, Murn and Martin, SC
Bennett Schliesman	Director, Kenosha County Emergency Management /Homeland Security
Dale R. Shaver	Director, Waukesha County Department of Parks and Land Use
Michael Ullicki	Vice President and Chief Technology Officer, Norlight Telecommunications

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.

CONSIDERATION OF THE MINUTES OF THE MEETING OF FEBRUARY 6, 2007

Chairman Bauer noted that copies of the minutes of the seventeenth meeting of the Reconstituted Regional Telecommunications Planning Advisory Committee held on February 6, 2007, had been distributed to all members of the Committee for review prior to the meeting. He asked the Committee to consider approval.

Mr. Richardson called attention to the third paragraph on page 9 of the minutes, noting that it was he and not Mr. Ritt that had asked the question about Project Lightspeed service.

There being no further corrections or additions, on a motion by Mr. Wirth, seconded by Mr. Winston and carried unanimously, the minutes of the meeting of February 6, 2007, were approved as corrected.

CONSIDERATION OF PRELIMINARY DRAFT OF PAGES ONE THROUGH TWENTY-SIX OF 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 pages 1 through 26 of 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* 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.

Mr. Evenson called attention to the text on pages 3 and 4 relating to analyses and forecasts, and suggested that all of the text under this heading be removed from Chapter VII and substituted for the previously approved text under Item 3, on page 2, of Chapter II, entitled Basic Principles and Concepts. The Committee concurred in the proposed change.

Mr. Klasen called attention to a typographic error in the last sentence of the second paragraph on page 6, in which the word "Spring" should be "Sprint."

Mr. Falaschi called attention the last sentence in the first paragraph on page 7, indicating that the phrase "must be carried out in cooperation with" was confusing. A brief discussion ensued, upon the conclusion of which it was agreed that the phrase be changed to "were presumed to be deployed by." Mr. Klasen noted that the statement made in the second sentence of this paragraph was not true with respect to AT&T facilities since, under Federal law AT&T must permit any ~~Alcatel~~ *facilities-based* service provider to lease space in an AT&T central office for equipment. That provider can then install its own fiber optic cable from the central office to a remote node, and lease from AT&T the copper wire distribution subloops from the node to the user premises. Mr. Klasen stated that this Federal requirement applied only

to AT&T and not to other ILEC carriers. A brief discussion followed upon which it was agreed by the Committee that the first full paragraph on page 7 would be revised by the staff to reflect Mr. Klasen's comment.

[Secretary's Note: The first paragraph on page 7 was revised by the staff to read as follows:

“As the dominant ILEC in Southeastern Wisconsin, AT&T owns most of the copper lines required to implement any FTTN wireline plan. Under Federal law, AT&T must make these copper lines available to other ~~At&T~~ *facilities-based* based service providers. The AT&T must lease space in AT&T central offices to other providers; those providers may then install their own fiber optic cable connections from the central offices concerned to remote nodes; and the AT&T must then make their copper line distribution facilities available for use by the other providers under appropriate lease agreements. Any FTTN plan applying to areas beyond the AT&T service areas must be based on ILEC carriers that own copper distribution lines to homes, businesses, and institutions. FTTN extensions beyond AT&T service areas were, therefore, presumed to be deployed by other ILEC's operating within the Region such as Century Tel and Verizon North.”]

Mr. Ritt called attention to Figure 1 on page 8, noting the inconsistency between the title and the last note in the diagram. Chairman Bauer agreed, noting that the last note concerned should have read “fiber-to-the node (FTTN)” and not “fiber-to-premises (FTTP).”

Mr. Wirth also called attention to the note on Figure 1, on page 8 which read “fiber to within 3,000 feet of home on average 5,000 feet maximum.” He noted that rapidly changing technology may be expected to increase these figures over time, and suggested that the reference to distances be deleted from the figure. A brief discussion ensued in which Mr. Klasen supported the suggested deletion, while Mr. Falaschi and Dr. Schlager supported retaining the references to distances as helpful to an understanding of the current capabilities of the technology concerned. At the conclusion of the discussion, it was the consensus of the Committee to leave the note on the Figure as submitted.

Mr. Ritt called attention to certain inconsistent terminology used in the Chapter, noting that on page 5 the technology concerned was described as “localized fiber to the premises,” while on page 9 it was described as “fiber-to-the user.” A brief discussion ensued in which Mr. Evenson supported the consistent use of the phrase “localized fiber-to-the premises” instead of “to the user,” since the later could be incorrectly assumed to include mobile users. Upon the conclusion of the discussion, it was the consensus of the Committee to use the term “localized fiber-to-the premises” throughout the text. Dr. Schlager noted that this would require changing the related acronyms in each case from FTU to FTTP.

Chairman Bauer noted that the title of Figure 3 on page 11 should be changed from “AT&T Wisconsin Network Upgrade Layout” to “Evolution of Network from Digital Subscriber Line (DSL) Service to Fiber to the Node Service”; and that the title of Figure 4 should be changed from “Network Diagram” to “Fiber to the-Premises Network Diagram.”

Mr. Klasen called attention to the costs set forth in Table 2, pages 19 and 20, and Table 3, page 21. He noted that the text on page 4 implicitly raised the issue of scalability of the network plans, and asked how the costs provided were related to such scalability; that is, whether the costs given were considered stable over a range of network sizes and capacities, or was subject to change with increases in size and capacity in response to changes in market penetration. Dr. Schlager indicated that the capital costs presented in the tables concerned were presumed to be those incurred at the time of plan implementation, and were further

presumed to be unaffected by scalability, since the plan networks would be designed to provide, in the judgment of the staff, ample capacity to accommodate expanding demand with "take-rates" up to 50 percent of the customer base. Dr. Schlager indicated that this adequacy would, as a part of the comparative plan evaluation process, be assessed through the conduct of analyses of the network capacities concerned using the traffic engineering formulas referenced on page 4 of the text.

In answer to a question by Mr. Falaschi, Dr. Schlager indicated that the take-rate was defined as the ratio of the actual users of a network to the potential users in a defined service area. Accordingly, he said, in a service area containing, for example, 600 households, a take-rate of 50 percent would indicate that 300 of the households could be expected to engage the service of the proposed network.

Mr. Ritt called attention to the costs set forth in Table 2 on page 19 relating to the development of a base station on a new site, and asked whether those costs included site acquisition. Dr. Schlager indicated that they did not, upon which Mr. Ritt suggested, and the Committee concurred, that this be noted by an appropriate footnote to the Table.

[Secretary's Note: The suggested footnote has been added to Table 3 on page 21.]

In answer to a question by Mr. Ritt concerning the project management and engineering services item identified in Table 2 on page 20, Dr. Schlager indicated that the necessary project management and engineering services could be provided through either the public or private sectors as plan implementation proceeded.

Mr. Ritt called attention to the base station rental cost estimate set forth in Table 3 on page 21 of \$4.00 per foot, per month, indicating that he questioned whether this cost was realistic, and indicated further that he had similar concerns about some of the other costs given in Tables 2 and 3. Chairman Bauer noted that the costs set forth in Table 2 and 3 had been reviewed and approved by the Committee as a part of its review and approval of SEWRPC Planning Report No. 51. He indicated that the costs presented had to be considered within the context of the public planning process. The costs presented were for use in the first, or system, level of planning, and that if the system level plans were approved and implementation initiated, a second level of facility planning would follow in which the cost estimates would be refined as the more detailed facility plans are prepared. A third level of planning would follow, he said, involving final design and the preparation of construction plans and specifications in which the cost estimates would be again reconsidered and refined as may be necessary. He indicated that public officials familiar with this planning process understood that the cost estimates related to a given system plan, could be expected to change as the planning proceeded from system level to facility level to final design level; this understanding being based upon long standing experience in the planning and engineering of public works.

In answer to a question by Mr. Falaschi, Dr. Schlager indicated that the high gain preamplifiers referred to in the text on page 22 were indeed commercially available. In answer to a further question by Mr. Falaschi, Dr. Schlager indicated that the high gain preamplifier application envisioned did not violate Federal Communications Commission (FCC) wattage limitations since the hardware was designed so that the gain applied to the incoming signals was not the same as the gain applied to the outgoing signals, the later being maintained below the FCC wattage limitations for transmission.

Chairman Bauer noted that the costs set forth on page 22 for the community based wireless plan were incomplete and that, while the costs given for the backhaul stations were, as required, regional costs, the costs given for the access facilities are only for the Cedarburg/Grafton area. He indicated that the staff would expand those access costs to regional costs, the text would be appropriately amended, and the

Committee would see the revised costs in a revised version of the third full paragraph on page 22 to be submitted with the minutes of this meeting.

[Secretary's Note: The section of the Chapter dealing with costs has been revised. The revised draft is included in the copy of the Chapter attached to these minutes.]

Mr. Falaschi noted that there were now service providers within the Region operating in the 5.8 GHz band, and asked whether implementation of the proposed regional wireless plan would not result in unsatisfactory interference in that band. Dr. Schlager indicated that, under the second level of facility planning, either the Commission or a private sector consultant would conduct field tests in the service area concerned in order to assess any problems related to interference, as well as other problems, related to clutter and masking. He indicated that in the extensive field tests conducted to date by Commission staff, no problems of interference were found. Mr. Falaschi noted that the tests referred to were in an area of the Region where existing transmissions in the 5.8 GHz band width were absent, and that the experience might be quite different in areas of the Region served by Century Tel and TDS. Dr. Schlager agreed, but indicated that the required field tests should reveal any interference problems and these could then be addressed in facility design. Dr. Schlager noted in this respect, that the Commission's inventory indicated that there were 1,010 existing base station antenna sites located within the Region, all of which could be considered as alternative co-location sites if the field testing in an area indicated that a different distribution of antennas would be required to abate any interference found.

Mr. Falaschi asked whether the Commission had obtained preliminary operating costs for the use of fiber optic cable service extended to existing antenna sites. Dr. Schlager indicated that based upon the limited experience to date, such operating costs appeared to range from \$55 to \$150 per megabit per second of capacity per month. Mr. Lowney observed that the costs concerned would be variable and site specific.

There being no further questions or comments, on a motion by Mr. Caron, seconded by Mr. Melcher, and carried, the preliminary draft of pages 1 to 26 of 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* was approved as amended, with Messrs. Gatz, Klasen, and Ritt voting no, the three dissenting members indicating that the reason for their vote was that the companies which they represented objected to the Commission preparing a telecommunications plan.

NEW BUSINESS

Mr. Klasen noted that AT&T had expanded their new broadband service to include 44 local municipalities and asked that the relevant references in Chapter V previously approved by the Committee be changed accordingly. There being no objections from the Committee, the staff was directed to make the change.

[Secretary's Note: The change requested by Mr. Klasen was made on pages 14 and 39 of Chapter V of SEWRPC Planning Report No. 53.]

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, June 5, 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. Caron, seconded by Mr. Mueller, and carried unanimously, the meeting was adjourned at 3:30 PM.

Respectfully Submitted,

Lynn G. Heis
Committee Secretary

KWB/lgh
06/20/07
#126278 V1 - T/C Minutes 18th Meeting

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 set forth in 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 basis for the selection of a recommended plan. The recommended plan set forth in Chapter VIII of this report, 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 alternative plans presented herein are not intended to impede the development or implementation of 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 alternative telecommunications plans presented in this chapter represent a mixture of wireline and wireless communications technologies. In designing these alternative plans the cost effectiveness of deploying each technology concerned was taken into account. The alternative plans presented emphasize the access element of communications networks, since this element represents the primary constraint 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 the remainder of the 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, set forth in the succeeding chapter of this report, 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 basic structure of the system plan. Analyses of the network capacities 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.

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.

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 premise. 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 would operate using the 802.11g standard at 2.4 GHz with 802.11a backhaul at 5.8 GHz, while regional networks would operate with the 802.11a standard and WiMAX (802.16) for backhaul. The WiMAX backhaul links would 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~~ *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 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.~~

As the dominant ILEC in Southeastern Wisconsin, AT&T owns most of the copper lines required to implement any FTTN wireline plan. Under Federal law, AT&T must make these copper lines available to other Alcatel based service providers. The AT&T must lease space in AT&T central offices to other providers; those providers may then install their own fiber optic cable connections from the central offices concerned to remote nodes; and the AT&T must then make their copper line distribution facilities available for use by the other providers under appropriate lease agreements. Any FTTN plan applying to areas beyond the AT&T service areas must be based on ILEC carriers that own copper distribution lines to homes, businesses, and institutions. FTTN extensions beyond AT&T service areas were, therefore, presumed to be deployed by other ILEC's operating within the Region such as Century Tel and Verizon North.

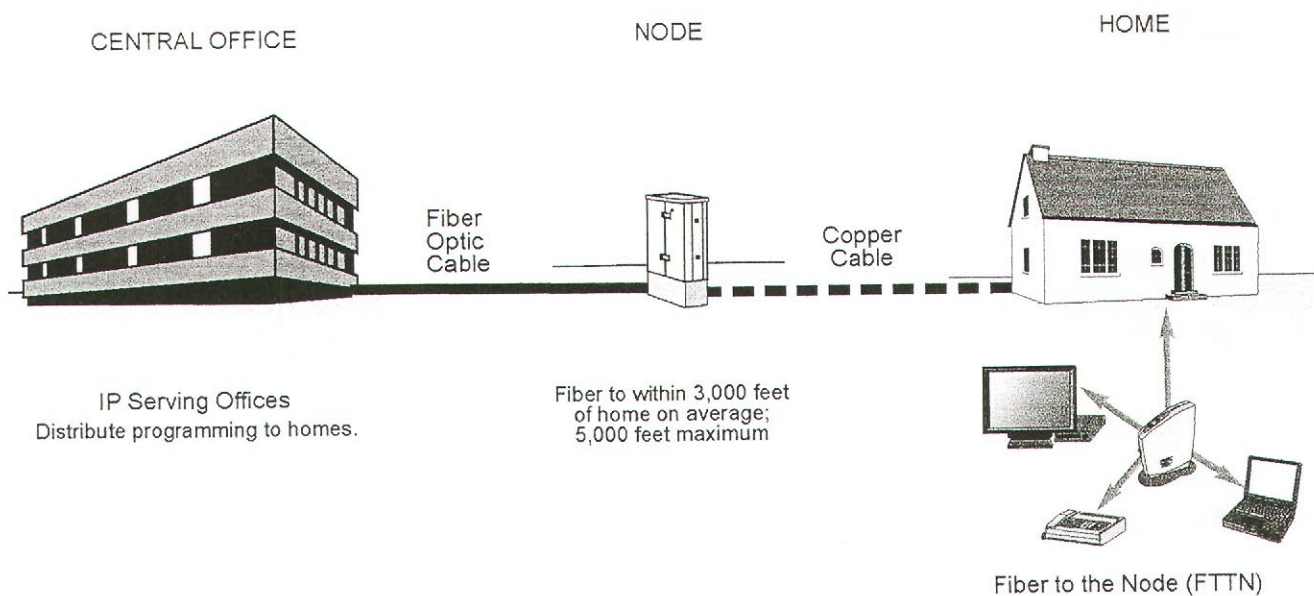
The AT&T FTTN broadband communications network is based on Alcatel's 7330 Intelligent Services Access Manager, ISAM. The 7330 ISAM is connected by fiber optic cable with the local central office and serves as a remote distribution point for broadband traffic to users over existing twisted pair copper 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:

Figure 1

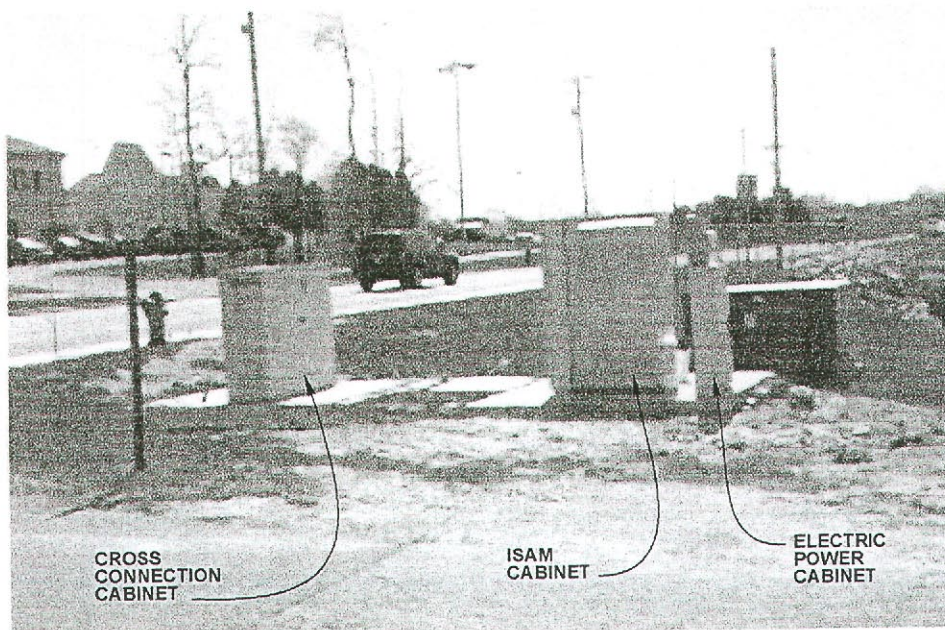
FIBER TO THE NODE WIRELESS TELECOMMUNICATION TECHNOLOGY



Source: AT & T and SEWRPC.

Figure 2

TYPICAL INTELLIGENT SERVICE ACCESS MANAGER (ISAM)



Source: AT & T and SEWRPC.

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 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.

Localized ~~Fiber-to-the User~~ Premises (FTTP) (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) Premises (FTTP) 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.

Figure 3

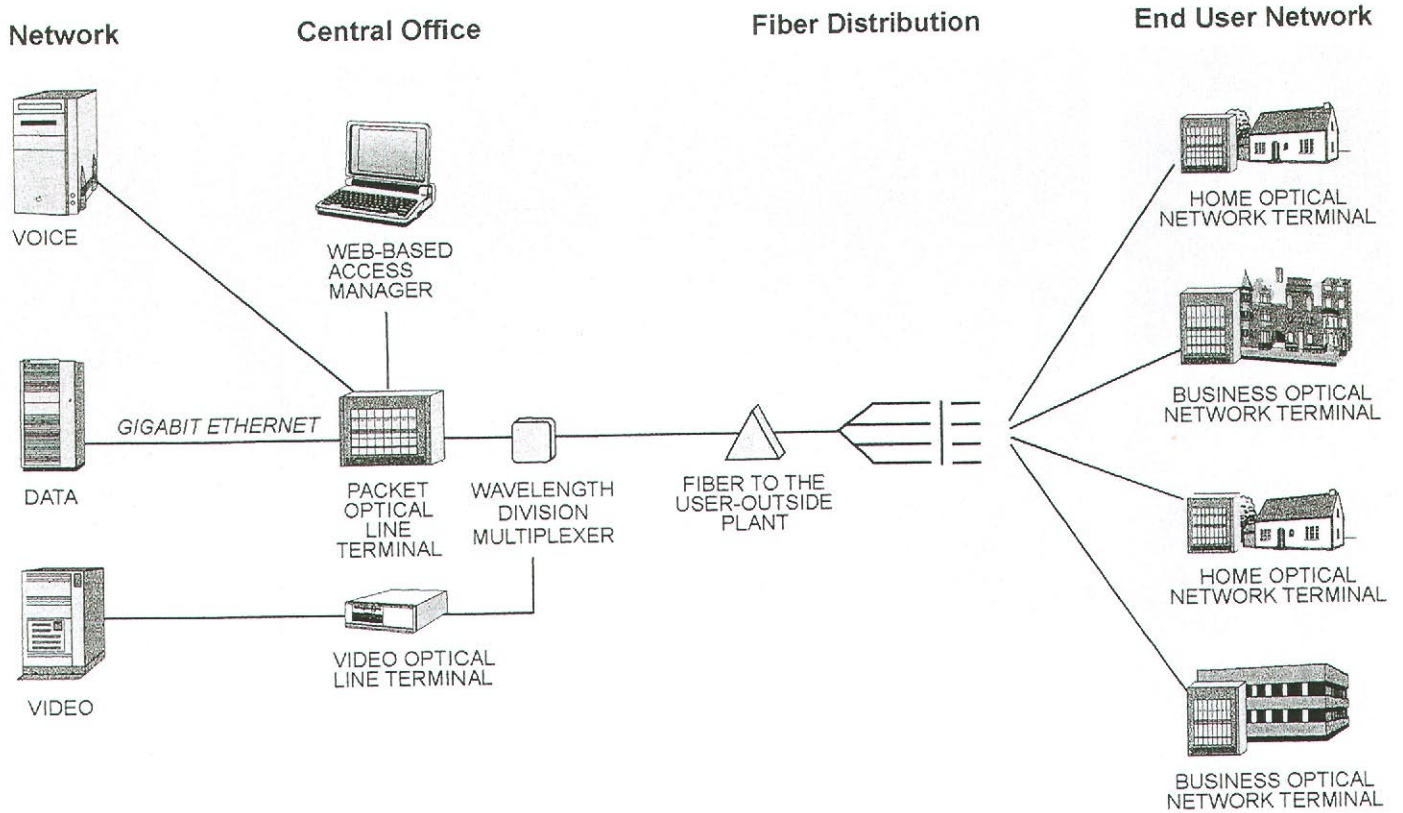
EVOLUTION OF NETWORK FROM DIGITAL SUBSCRIBER LINE (DSL) SERVICE TO FIBER TO THE NODE SERVICE



Source: AT & T and SEWRPC.

Figure 4

FIBER TO THE PREMISES NETWORK DIAGRAM



Source: ALCATEL and SEWRPC.

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.

2. Business Optical Network Terminal (B-ONT)

This components terminates the PON fiber optical 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.

ALTERNATIVE PLANS

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 WiFiA 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)~~ Premises (FTTP) Wireline Plan

This plan is based on Alcatel 7340 FTTP 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.

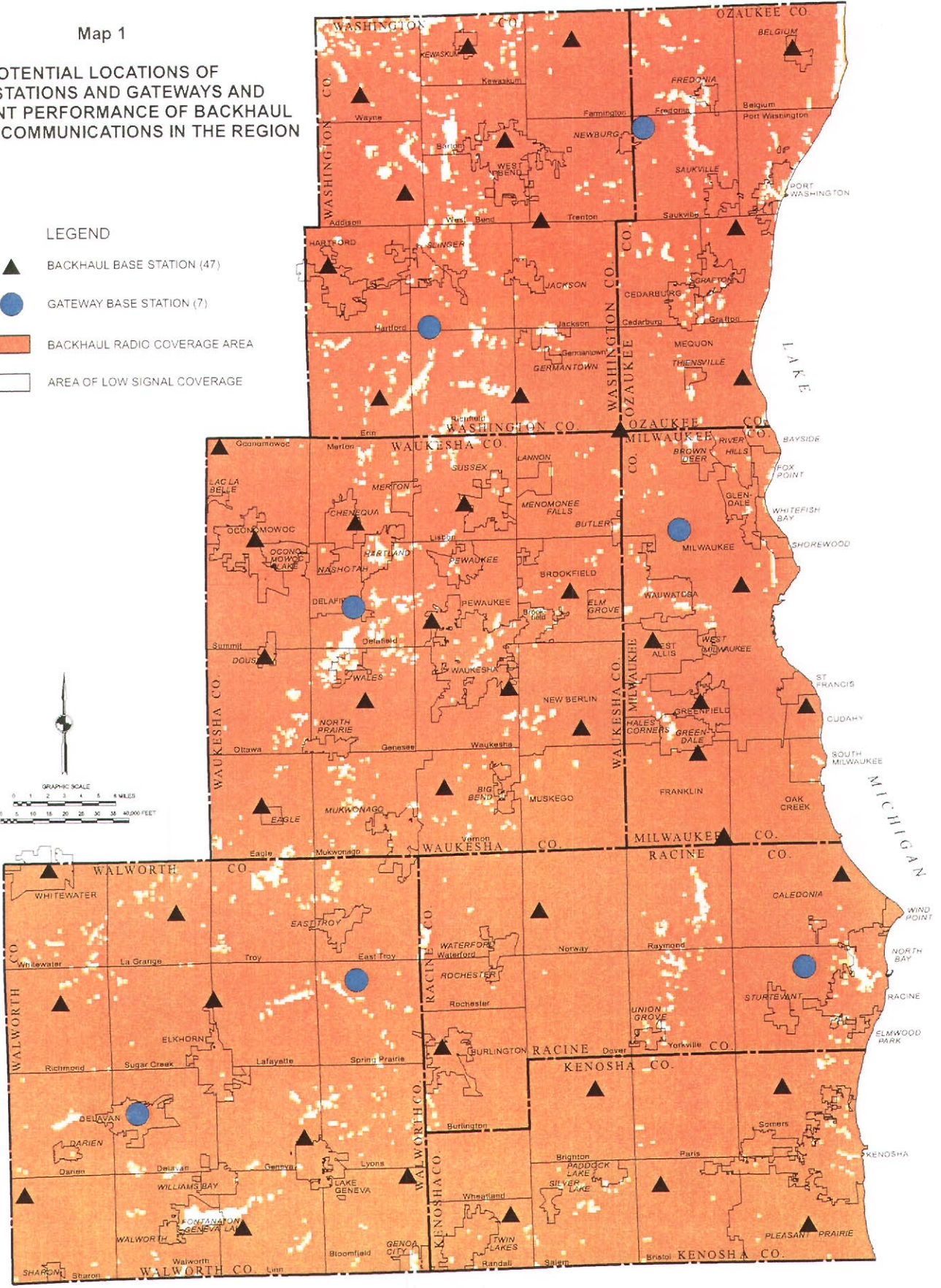
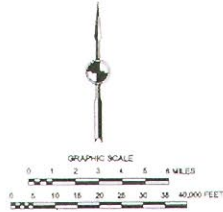
Individual community level wireless plans would be prepared by the Commission, or by consultants or potential providers, upon request of the local unit or units of government concerned. An example of a community wireless plan for an urban area of the Region -- for the City of Cedarburg and Village of Grafton area of Ozaukee County -- is presented in SEWRPC Planning Report No. 51. This 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.

Map 1

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

LEGEND

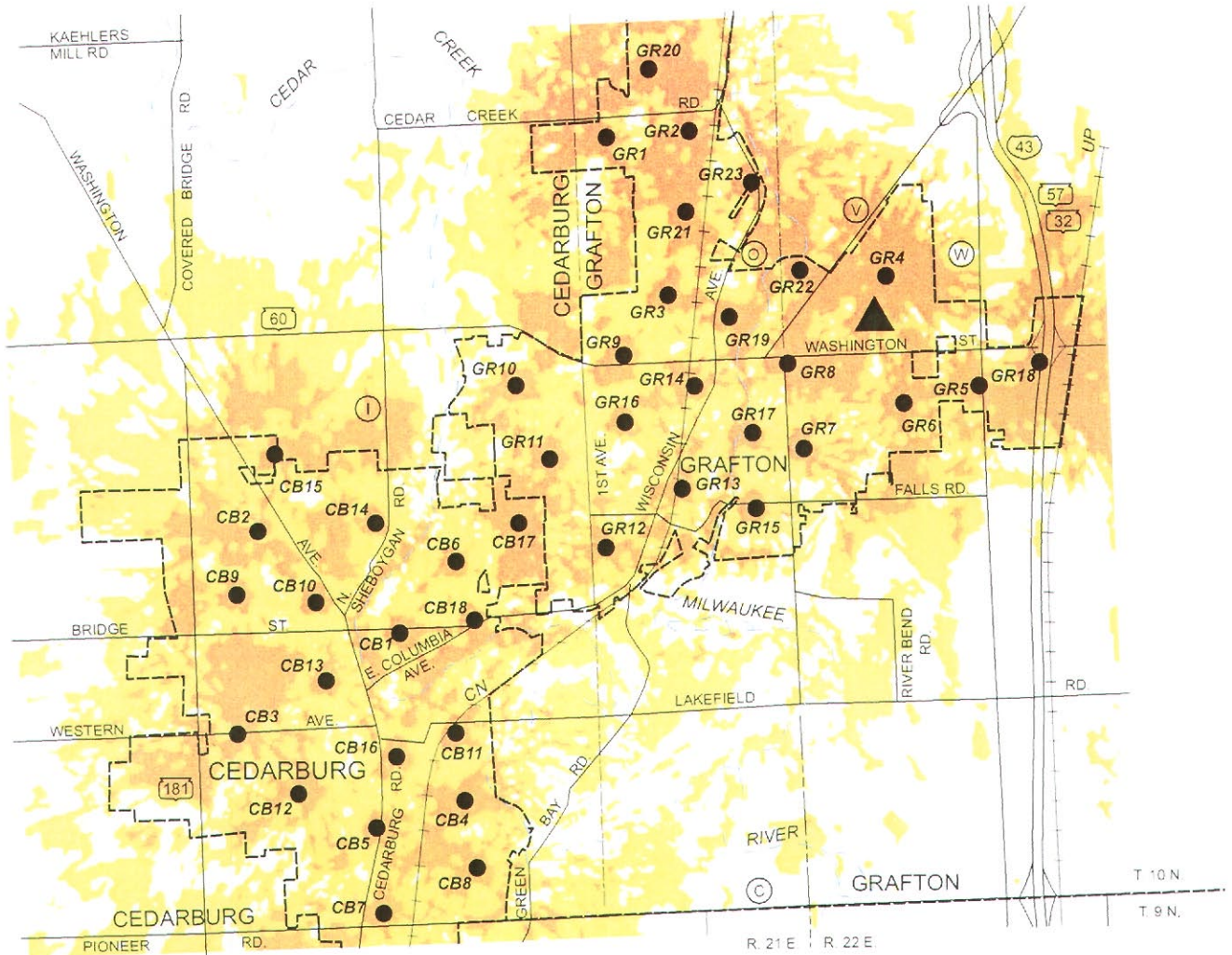
- ▲ BACKHAUL BASE STATION (47)
- GATEWAY BASE STATION (7)
- BACKHAUL RADIO COVERAGE AREA
- AREA OF LOW SIGNAL COVERAGE








Source: SEWRPC.

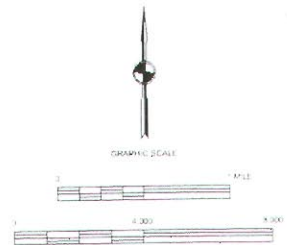
Map 2

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

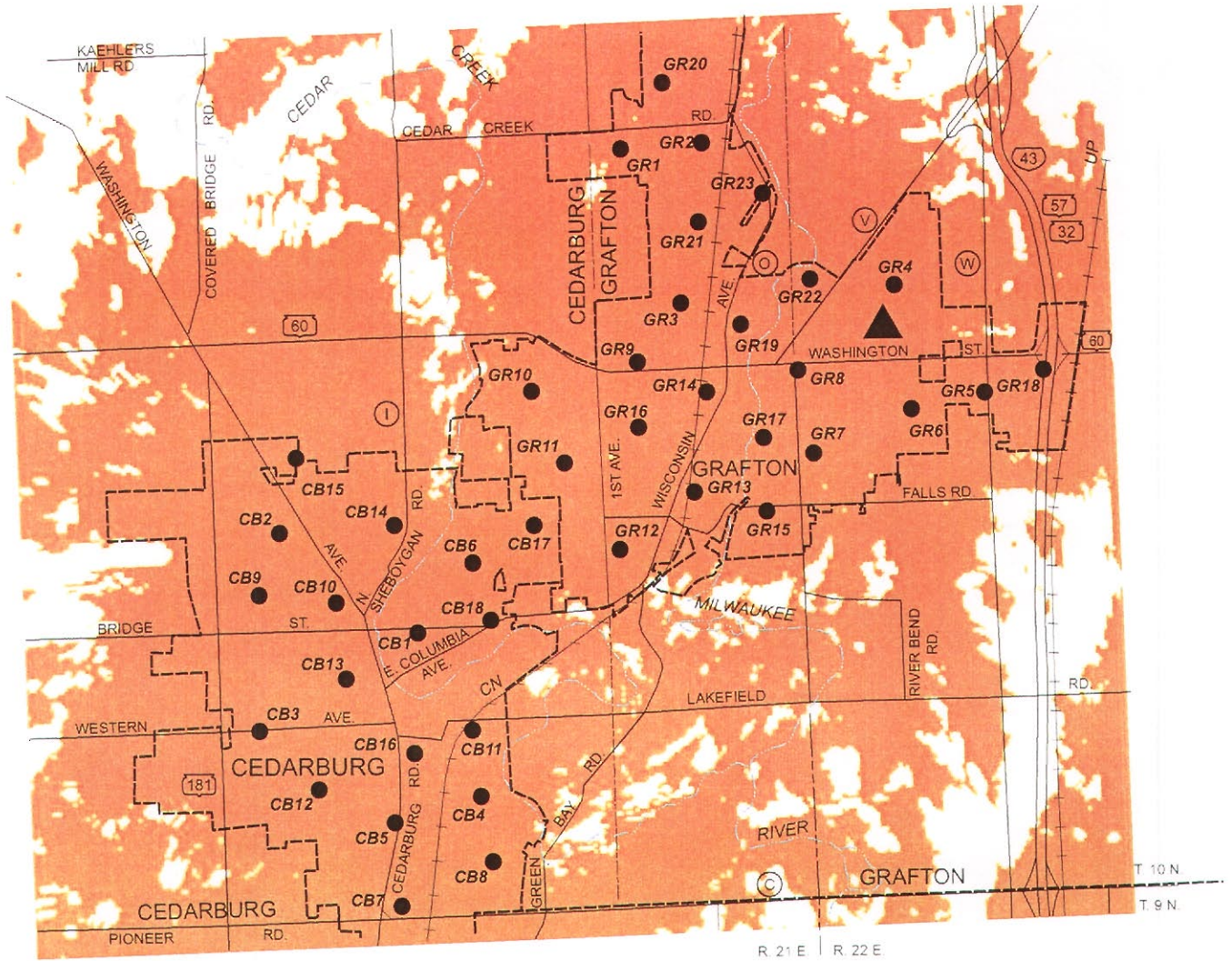
-  EXISTING BASE STATION TO BE USED FOR WIMAX APPLICATION
-  RECOMMENDED LOCATION OF WiFi ACCESS POINT
- GR3** IDENTIFICATION NUMBER (SEE TABLE 1)
-  RECEIVED POWER AT REMOTE -70dBmW TO -79dBmW, THROUGHPUT: 24 Mbps to 54Mbps
-  RECEIVED POWER AT REMOTE -79dBmW to -87dBmW, THROUGHPUT: 6 Mbps to 24 Mbps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



Source: SEWRPC.

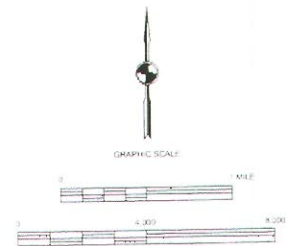
Map 3

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. Internet Connection 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: The base station costs do not include any costs of land acquisition for site. Base station operators are often required to have liability insurance in the range of \$1 to 3 million for each base station site, and may be required to post performance bonds for the potential removal of structures upon abandonment. The base station costs do not include these insurance or removal contingency costs.

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:

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 \$1,700 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 cost 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.~~

Costs

The infrastructure capital cost for an urban community wireless plan are typified by the wireless plan for the Cedarburg-Grafton area of Ozaukee County. The cost of the access infrastructure of this plan is estimated at \$353,000 for 41 access points in the required network. Operating costs for each access point, as detailed in Table 3, are estimated at about \$37 per month per station, or about \$1,500 per month for all 41 access points.

To estimate the cost of providing the access infrastructure for the Region as a whole, the cost for the Cedarburg-Grafton area were expanded utilizing a regional multiplier of 57.5. This multiplier represents the ratio of the Cedarburg-Grafton urban service area to the total urban service area within the Region, the urban service areas being approximated by the adopted sanitary sewer service areas within the Region as those areas are shown on Map 4. As delineated on that map, the Cedarburg-Grafton area encompasses an area of 16.9 square miles, while the aggregate total area of all such urban service areas within the Region, encompasses an area of 975.4 square miles. Utilizing this multiplier, the total access infrastructure cost for urban community wireless areas within the Region approximates \$20.3 million. Similarly, the attendant operating costs would total approximately \$87,000 per month.

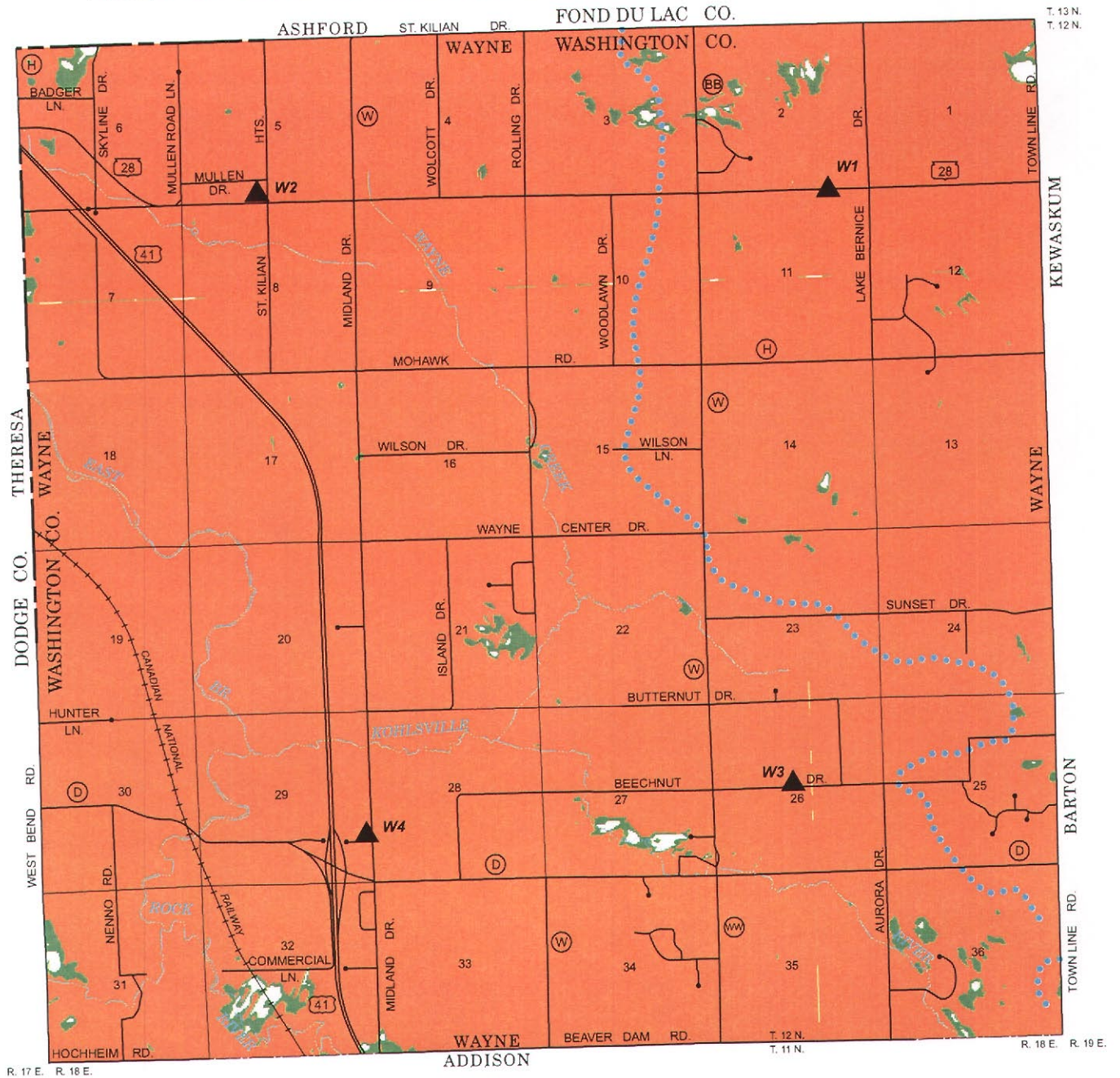
The infrastructure capital cost of the backhaul network for the Region, consisting of 47 base stations and seven gateway stations, as shown on Map 1, totals \$2.1 million dollars, assuming use of co-located sites. The operating cost of a backhaul station may be expected to range from \$7,900 to \$8,500 per month depending upon the type of installation, for a total operating cost of about \$459,000 per month for all 47 base stations and seven gateway stations required.

The infrastructure capital cost for a rural community wireless plan are typified by such a plan for the Town of Wayne, Washington County. As shown on Map 5, four access points are required to serve the entire approximately 36 square mile area of the Town. The cost of the access infrastructure plan is estimated at about \$8,200 for the four access points in the required network. Operating costs for each access point are estimated at about \$37 per month, per station, or about \$148 per month for all four access points. Applying a regional multiplier of 47.6¹ the total access infrastructure cost for rural community wireless areas within the Region approximates \$3.9 million. Similarly, the attendant





¹ Derived by subtracting the aggregate total regional urban service area of 975.4 square miles from the total area of the Region of 2,689.8 square miles and dividing the remainder by 36 square miles.

Map 5

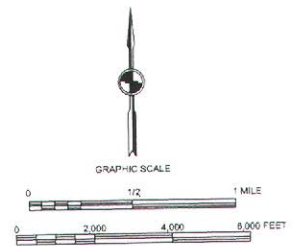
POTENTIAL LOCATIONS OF WiFi ACCESS POINTS AND ATTENDANT PERFORMANCE OF ACCESS NETWORK FOR FIXED USERS IN THE TOWN OF WAYNE: ACCESS POINT TO REMOTE



LEGEND

-  ACCESS POINT LOCATIONS
- W3** IDENTIFICATION NUMBER
-  RECEIVED POWER AT REMOTE:
GREATER THAN -113.0 dBmW,
THROUGHPUT: 24 Mbps TO 54 Mbps
-  RECEIVED POWER AT REMOTE:
-121.0 TO -113.0 dBmW,
THROUGHPUT 6 TO 24 Mbps
-  AREA NOT WITHIN ACCEPTABLE COVERAGE

Source: SEWRPC.



operating costs total about \$7,000 per month. Since the access points would utilize the same backhaul station as would the urban community access station, no additional backhaul station capital or operating costs would be entailed.

Thus, the total capital cost of community based wireless plan would approximate \$26.3 million. The total operating cost would approximate \$553,000 per month.

Regional Wireless Plan

A major shortcoming of the community-based wireless plan is its dependence upon community-by-community action for implementation. This may result in the creation of residual areas of the Region without broadband service. Since a major objective of the broadband regional wireless plan is universal service, an alternative regional wireless plan was developed. 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 would 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 6 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 Connections

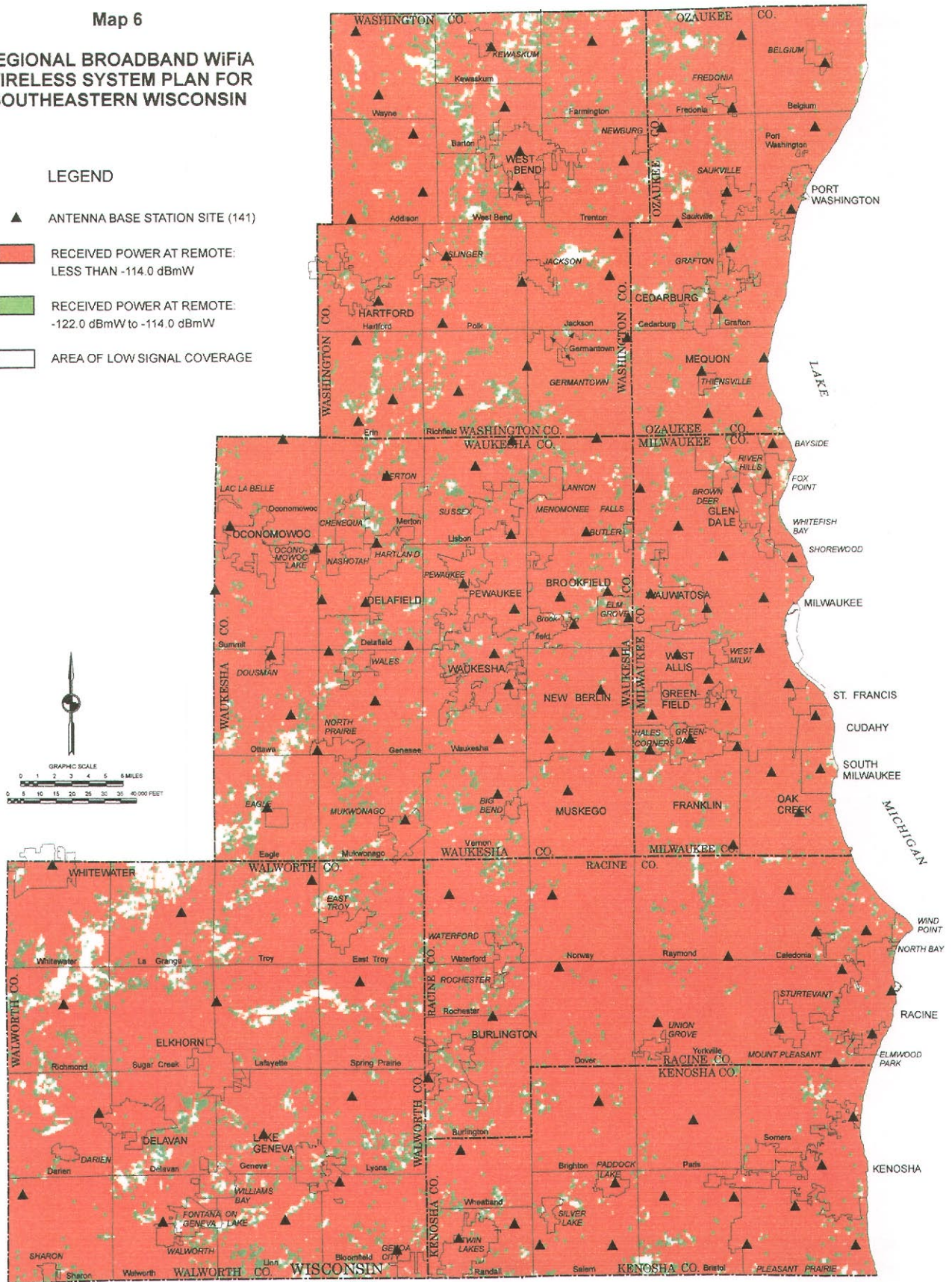
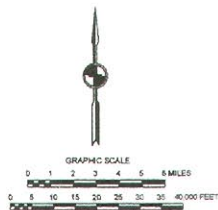
Because of the expected high network traffic volume, fiber optic gateway interconnections would be made at each antenna base station site. Such interconnection implies fiber optic cable

Map 6

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.

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.

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.

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 Table 2 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 including the cost of fiber optic interconnections. Additional systems infrastructure costs relate to the cost of bringing fiber to each of the 141 sites. These costs, estimated in cooperation with Time Warner Telecom and Charter Communications, approximate \$2.8 million. Thus, the total capital cost of this alternative plan is estimated to be \$6.4 million. Operating costs are estimated at \$987,000 per month based on a rate of \$7,000 per month for a capacity of 100 megabits per second at each site.

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