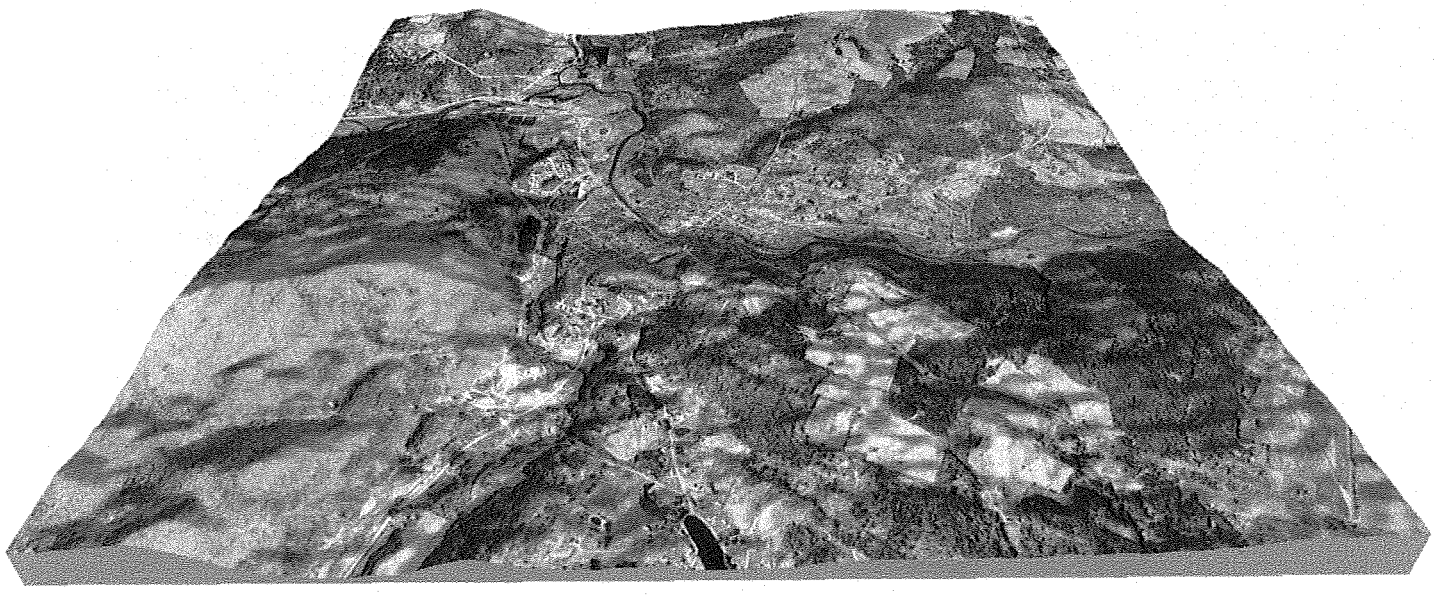
PERSONAL WIRELESS SERVICES
ANALYSIS OF FACILITY NEEDS AND SITING

TOWN OF HARDWICK, VERMONT



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FORWARD

The Town of Hardwick provided funding to the Hardwick Planning Commission / Zoning Board of Adjustment to assess Personal Wireless Service ("PWS") options (and related emergency services) in the Hardwick area.

Currently, there are no large-scale PWS providers serving Hardwick. The Planning Commission / Zoning Board of Adjustment requested this study to evaluate potential locations for PWS providers and their associated towers. We were particularly interested in assessing how much geographical coverage would be provided for particular wireless services from different locations in the Town and at different tower heights.

It is anticipated that the analysis and information derived from this study can forge a common ground for deployment by service providers, while adhering to the community's goals and policies related to the environment. It can also serve as a foundation to evaluate deployment options and the requirements for meeting the industry's standards. The Town's telecommunications bylaw will benefit from the analysis by comparing the results to the regulatory requirements. The engineering analysis examines the options for deployment including stealth (camouflage) facilities to minimize aesthetic impacts, while considering free-standing taller structures to overcome signal obstruction and to achieve economies of scale.

The Telecommunications Act of 1996 ("TCA") limits exclusionary practices for telecommunication facilities. This report is evidence of the community's desire to improve such services while considering the careful siting of such facilities.

Kristina Michelsen, Chair
Hardwick Planning Commission / Zoning Board of Adjustment

1. INTRODUCTION

1.a. There has been tremendous growth in PWS subscribers: more than double nationwide since 1999, from 79,696,083 (12/99) to 167,313,001 (6/04) wireless subscribers, according to the latest available data from the Federal Communications Commission ("FCC").[1] There is also an upward trend in the use of wireless phones as either the primary or - notably - sole device in many households, as reported in numerous industry publications. This is corroborated by the FCC data: In its *Trends* report, sample data from marketing information research firm TNS Telecoms shows average monthly household telecommunications expenditures (for 2003) of $37 for local exchange (wireline) carriers and $41 for wireless carriers.[2] "The premium for using wireless voice services instead of wireline services is expected to drop from 100 percent or double the price last year [2003] to 42 percent by 2007, driving further wireline substitution in the voice market, according to a report from Frost & Sullivan. The report added that in 2007, 49 percent of revenues are expected to come from mobile networks compared with 38 percent in 2000, with the total value of substituted minutes increasing from about $1.6 billion in 2003 to $2.4 billion in 2007."[3] With the large number of evening and weekend rate-plan minutes, wireless subscribers arguably now have an expectation of service inside their residences. Additionally, wireless technology is increasingly utilized to deliver broadband Internet access; at the same time the Internet is more frequently employed to provide telephony (two-way voice) and audio/video services.

1.b. Portions of Hardwick have poor or effectively no terrestrial wireless service. The PWS providers licensed to serve the area have understandably concentrated on more populated towns elsewhere in Vermont. Meanwhile, Hardwick residents and businesses increasingly desire wireless services, both for themselves and to meet the needs of visitors. Furthermore, seasonal residents may wish to use cellular phones in lieu of activating wireline service for just a short time. Although public safety officials periodically warn of overconfidence in wireless services - particularly in the case of campers, hikers and skiers - cell phones also play a role in rescue and other emergency responses. E-911 location capability eventually will greatly improve wireless use in emergencies. Nonetheless, not everyone desires improved service, and a newspaper article last year noted a Vermont resident who said, "...those she has spoken with are more inclined to favor the cell tower-less quality of life."[4] In addition, there are often concerns about base-station radiofrequency ("RF") radiation exposure.

1.c. Passage of the TCA in 1996 did not end debate about a "cell tower-less quality of life" nor fully resolve the question of RF exposure. However, as discussed herein, Congress and the courts have made it clear that towns must not prohibit service or regulate RF exposure beyond FCC guidelines. Such preemptions notwithstanding, the TCA preserves local authority and the Town of Hardwick has considerable latitude in regulating placement of PWS facilities. The Town has already considered tower proposals, from Bell Atlantic NYNEX Mobile ("BANM")[5] in 1997 and, more recently, from Rinker Communications. Since the trends clearly indicate interest by both consumers and industry in improved service, Hardwick will - sooner or later - face more proposals to construct facilities. This analysis examines different PWS

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1 *Trends in Telephone Service*, FCC, 6/21/05. "Carriers with under 10,000 lines in a state are not required to report, so FCC Form 477 data are likely to undercount the total number of wireless lines in service."

2 Households in Alaska and Hawaii are excluded from the analysis.

3 *RCR News*: "Wireless price drops expected to drive further wireline substitution", by Dan Meyer; 8/24/04.

4 *Bennington Banner*: "Arlington wins grant to study cell tower coverage", by Chris Parker; 6/22/04.

5 BANM is the predecessor of Verizon Wireless.

facility siting scenarios and how they might be accommodated under existing zoning, as well as possible zoning revision to accomplish TCA compliance. PWS providers are more likely to respond favorably to suggestions of areas to locate. In any case, this analysis should better prepare the Town for likely, if not inevitable, PWS proposals.

2. BACKGROUND: PERSONAL WIRELESS TECHNOLOGY

2.a. According to the TCA, "the term 'personal wireless services' means commercial mobile services, unlicensed wireless services, and common carrier wireless exchange access services."[6] The services examined in this analysis are, for the most part, a subset of Commercial Mobile (Radio) Services ("CMRS"). According to the FCC,

> "[t]he primary components of CMRS are currently the Specialized Mobile Radio Service (operating in the 800 MHz and 900 MHz bands and authorized under Part 90 of our rules), the Cellular Radiotelephone Service (800 MHz band, Part 22), and the Broadband Personal Communications Service (1900 MHz band, Part 24)."[7]

Under this definition fall the vast majority of wireless telephony services; other personal wireless services include traditional commercial paging services, and more advanced two-way paging and text messaging services offered in the Narrowband Personal Communications Service ("PCS"). Additional FCC information is contained at Appendix 2.

2.b. PWS use of both licensed and unlicensed spectrum is an especially effective means to deploy broadband services, notably for Internet access. This can be particularly attractive in rural areas such as found in Hardwick, where high-speed cable and other wired infrastructure may not be available or cost-effective. Wireless Broadband, used to provide wireless Internet service, is discussed in greater detail at Section 4.

2.c. While the expectation of in-building/in-residence wireless services, including telephony, is more recent, continuous service along major roads is taken for granted in a mature CMRS environment. Most of the original cellular customers in Vermont employed higher-power vehicular phones with fixed antennas, but the trend is toward smaller hand-held portable or pocket phones. These devices present a greater service challenge since their lower power and poorer antennas generally make it more difficult to communicate with base stations.

2.d. Most personal wireless services are considered to be line-of-sight ("LOS") technology because coverage in the upper microwave RF spectrum is generally limited to the area where you could see the antenna were it not for trees and buildings. While sight is not a literal requirement (so-called LOS signals bend - diffract - appreciably around obstacles), RF propagation is impaired by hills, buildings and trees - particularly when the base-station antenna is lower. Shadowing, blockage and, particularly, distance from the transmitter will generally be even more critical with the use of low-power hand-held transmitters. Signals that graze the treetops or experience blocked paths do not always mean there will be no useable communication, but these situations ideally should be avoided.

2.e. More formidable PWS coverage requirements are presented by the higher-frequency broadband Personal Communications Services ("PCS"). PCS operates close to 2GHz, and

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[6] 47 U.S.C. § 332(c)(7). The relevant language of TCA Section 704 is attached as Appendix 1.

[7] FCC WT Docket No. 02-353, "In the Matter of Service Rules for Advanced Wireless Services in the 1.7 GHz and 2.1 GHz Bands", Footnote 6, 11/7/02.

these higher frequencies make communication even more difficult than for the below-1GHz frequencies used for cellular, SMR[8] and narrowband PCS services. This explains why areas noted as problematic for PCS may be ones where cellular and SMR customers can ordinarily place calls. Comparisons of PCS and cellular coverage are shown throughout the Propagation Study. According to the Federal Communications Commission ("FCC"),

> "Cellular and broadband PCS services are comparatively similar in quality, price, value added services, and coverage. Broadband PCS is all digital (although analog is not prohibited) and operates in a higher frequency band with additional spectrum capacity in 30 MHz A, B, and C blocks. Cellular continues to maintain analog service offered as Advanced Mobile Phone Service or AMPS in addition to digital service."[9] "Examples of entities holding a significant amount of broadband PCS spectrum include AT&T Wireless and Sprint PCS."[10]

In order to maintain similar, competitive coverage areas, PCS providers ordinarily need more numerous facilities than is the case with cellular or SMR. In general, a PCS facility will have a one-half to 3-mile coverage radius, compared with a 3- to 15-mile radius for cellular/SMR. An important aspect to all these services is that the received signal strength deteriorates rapidly with increasing distance from the source.

2.f. Another PWS provider in Vermont is Nextel, which offers cellular-type service to over 11 million nationwide subscribers.[11] As indicated in Section 2.a. and Appendix 2, (E)SMR is a service regulated separately from the Cellular Radiotelephone Service by the FCC. Because it provides digital telephony, it is considered a "cellular" service. Additionally, the Motorola Integrated Digital Enhanced Network ("iDEN") technology utilized by Nextel enables a feature more like traditional two-way radio, in that it also allows direct connection to family, friends or members of the same business without placing a phone call. The latter can be particularly attractive to small businesses such as local contractors who often need to confer with several people at various locations. Another application could be for businesses to dispatch a service person who, en route, needs to call the customer's phone for clearer directions. This combination of cellphone and digital walkie-talkie capability, as implemented in the iDEN system, is not compatible with the systems of other CMRS providers. This discussion is not intended as an endorsement of the Nextel system; indeed, each provider will point to its own features and benefits, and several now offer phones with walkie-talkie capability. Nextel presently uses spectrum similar to that of the Cellular Radiotelephone Service; cellular propagation modeling shown in Section 6 is appropriate for considering Nextel operation.

2.g. Questions are often asked regarding alternatives, such as satellite phones and roaming coverage. The former is useful for those who must have coverage virtually anywhere in the world, but satellite phones and rates are expensive. Moreover, TCA provisions must be met without regard to availability of satellite service. Roaming coverage allows users to maintain and initiate wireless service when they leave the coverage area of their home provider, albeit

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[8] SMR includes the Enhanced Specialized Mobile Radio ("ESMR") service offered by Nextel.

[9] http://wireless.fcc.gov/services/broadbandpcs/operations/findingserviceprovider.html#differences

[10] http://wireless.fcc.gov/services/broadbandpcs/about/index.html
Note the acquisition of AT&T Wireless Services by Cingular Wireless L.L.C. ("Cingular"). (SBC Communications Inc. controls 60% of Cingular; BellSouth Corp. controls 40% of Cingular.) AT&T Corp. has an agreement to eventually resume use of the AT&T Wireless name in some form; it is expected to offer services though the Sprint PCS network under an agreement made between the two companies. PCS spectrum auctioned in the northeast to Devon Mobile Communications, the Adelphia subsidiary that filed for Chapter 11 protection in 2002, has been transferred to Verizon, U. S. Cellular and others, subject to regulatory approval.

[11] FCC, citing Nextel submissions in WT Docket No. 03-203; 4/2/04. Note that Nextel and Sprint have merged.

at possibly higher cost. Often, the licensee for the subscriber's operating frequencies will change between different geographical areas, and roaming allows seamless - and usually automatic - coverage for the mobile user without regard to who holds the license. This is the primary use for roaming, and is more likely to be seen near state lines as outlined in the Pelham case[12] in New Hampshire. (A customer in Pelham, NH may receive roaming service from a Lowell, MA provider due to her or his proximity to the state border.) Another type of roaming - switching between spectrum blocks licensed to different providers within the same area, known as in-market roaming - is not always seamless and sometimes doesn't work at all. It is contingent on two important factors, the first being that the customer has a phone that is multi-mode in a way that ensures compatibility with the other system. According to a recent FCC statement,

> "Another technical consideration in the context of roaming is that, in order for roaming on digital networks to be successful, a customer must have a handset that employs the same digital standard (*e.g.,* GSM or CDMA) as the carrier on whose network the customer is roaming. Thus, a carrier that uses GSM would not be expected to enter into an agreement with a carrier that uses CDMA, because the customers of each carrier would not be able to access the other carrier's network. This, of course, limits the number of carriers in a given geographic area that can enter into roaming agreements. However, if, in the future, handsets become available that employ multiple digital technologies or software-defined radio capabilities, this may reduce or eliminate technical impediments to the subscribers of any carrier roaming on any other carrier's network."[13]

The second factor is a contractual agreement between the two providers allowing automatic roaming. Since we cannot count on both factors, it is my opinion that roaming is unlikely to be a satisfactory solution to service problems in Hardwick.

2.h. Presently, several licensed PWS providers, including several paging services, have facilities outside the area that offer varying degrees of service, with the best coverage occurring at higher-elevation points in Hardwick. In 1997, as noted earlier, BANM made a proposal for a 150-foot tower on Buffalo Mountain. Because of recent expansion by Verizon Wireless in Vermont, it should be expected that it will eventually seek to revive the Buffalo Mountain proposal, or seek a similar facility in Hardwick. Use of the original BANM site is included in the Propagation Study.

3. EXPECTED DEVELOPMENT & INFRASTRUCTURE REQUIREMENTS

3.a. Current services have moved beyond the original analog (primarily voice) services and now offer email, Internet access and two-way paging. Coming generations will present more features, better messaging and Internet connectivity, as well as video and other innovations. In late 2002, the FCC allocated 90 megahertz of spectrum[14] for what it terms Advanced Wireless Services ("AWS"), including services commonly referred to as "Third Generation". Spectrum allocated close to that of broadband PCS will mean similar coverage considerations; i.e., the higher frequencies are more sensitive to trees, buildings and irregular terrain. AWS

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[12] Second Generation Properties, LP v. Town of Pelham, 2002 WL 31819852 (1st Cir. 2002).

[13] *See* Reexamination of Roaming Obligations of Commercial Mobile Radio Service Providers, WT Docket No. 05-265, *Notice of Proposed Rulemaking*, ¶47; 8/24/05.

[14] In the *Second Report and Order* in ET Docket No. 00-258, the FCC allocated two contiguous 45MHz bands, located at 1710-1755MHz and 2110-2155MHz. Both bands are for fixed and mobile wireless services. In a recent Order on Reconsideration, the FCC made changes to provide additional opportunities for smaller and rural wireless carriers to access this spectrum; *Order on Reconsideration*, FCC 05-149, 8/5/05.

hardware will be physically similar to today's PCS facilities. As discussed later, prices continue to drop while features increase in a way that will make smaller cells more feasible for such applications as fill-in coverage.

3.b. The additional PWS licensees mean the Town of Hardwick should probably anticipate a total of six to ten licensed providers.[15] There will almost certainly be at least one Wireless Internet Service Provider ("WISP") or entity providing wireless broadband services. As explained in Section 7, many of these FCC-regulated wireless services require no license, and there is significant preemption of local authority to regulate certain antenna placement.

3.c. Each wireless telephony provider will first seek coverage, which means adequate signal - for both sending and receiving - to enable a single customer to initiate and complete a call or data connection. This is equivalent to providing the dialtone for a wired phone. It is also necessary to smoothly transfer a customer who moves from one coverage area (cell) to another. Some systems use different frequencies from one cell to another, but what is important is that the transfer (handoff) occur transparently to the user. One necessary component of successful handoff is a certain amount of signal overlap between cells, so that the call isn't dropped from the network during the transfer.

3.d. Today's providers offer numerous channels for simultaneous usage by dozens of subscribers, but increased demand means certain cells will occasionally surpass capacity. This is equivalent to a busy signal with a wired phone. If this happens often enough, the provider will likely need another cell. Where there had been two cells, each capable of a certain number of users, there might now be three cells and a corresponding increase in total capacity. The good news, as wireless systems encounter coverage and capacity problems, is that small-scale solutions are becoming more practical and, as mentioned at 3.a., less expensive. For example, systems based on Distributed Antenna System ("DAS") technology provide PWS coverage of tunnels and building interiors. Increasingly, these have been high-capacity multiple-provider systems; e.g., Boston Convention & Exhibition Center's DAS can handle over 15,000 simultaneous cell-phone calls everywhere in the building. Using DAS for exterior locations is relatively new and has been successful in Nantucket (MA), while a Pittsburgh (PA) field test involved terrain similar to what we find in Hardwick. Exterior DAS systems involve low power and pole-mounted fiber-fed antennas. I do not suggest that this is poised to replace the coverage of a tower-based macro-cell. Indeed, it is my opinion that the jury is still out on how successful these systems can be, particularly with wide-area coverage requirements that include mountainous areas or large water bodies with no utility poles. For now, a DAS approach is promising - on paper - for some residential areas and highway fill-in applications in some rural sections, assuming available utility poles and ability to connect via fiber.

3.e. The question often arises regarding what constitutes "adequate" service, since the FCC and Congress do not directly address it. Several Vermont towns have adopted the -90dBm[16] threshold considered adequate for rural service by the model ordinance developed by the

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[15] Mergers may reduce the number of providers; one entity may control more than one spectrum block.

[16] The dBm is a power level expressed as decibels ("dB") above one milliwatt. The dB is a logarithmic unit used to characterize a ratio (difference). In the case of RF power, if the second level is twice as much power as the first, it is 3dB higher; if the second level is ten times that of the first, it is 10dB higher; if the second is a million times the power of the first, it is 60dB higher. As can be seen, the use of decibels enables describing very large power ratios with modestly sized numbers. Note the use of negative numbers, so that -82dBm is 10dB stronger than -92dBm.

Vermont League of Cities & Towns dating back to 1997. The "rural service" at that time was based on then-common car phones with permanently installed antennas and higher-power transmitters. The most recent (February 2005) revision of that model regulation no longer defines coverage. This is due in part to the shift in the types of phones and the locations where they are used. In objecting to the even lower -95dBm level defined by Concord (Massachusetts), PWS provider T-Mobile's predecessor stated in relevant part:

> "For VoiceStream's network our receiver sensitivity specification for phone makers is -102dBm with 0 gain/loss at the antenna. Then 8db is accounted for with fading losses and 3dB is applied for head/body user loss. After factoring in the variables, this results in a value of -91dB[m] signal strength, which VoiceStream uses for on street coverage."[17]

This is indicative of industry practice employing a margin for signal loss to better assure useable signal. The threshold levels employed herein add a margin to a minimum -102dBm (or similar level) desired for most user phones, with an additional amount to account for in-building losses. It is important to note, however, that current-generation phones often function better than expected. In any case, failure to achieve the minimum level doesn't mean there will be no coverage but, rather, that a less desirable situation is likely that may hinder reliable coverage. Furthermore, users are not always indoors, in which case service will likely be better than what may be suggested by employing in-building thresholds.

3.f. Adequacy of other providers should be examined, but not used as reason to deny. In an interesting Third Circuit decision five years ago, the Court concluded that an applicant must demonstrate that "the area the new facility will serve is not already served by another provider."[18] Such an approach suggests the Town could reject further applications as soon as adequate coverage is achieved by at least one provider. Nonetheless, this is not recommended since it has not been adopted by any other court, and plainly contradicts the competitive goals of the TCA and its provision that local "regulation...shall not prohibit or have the effect of prohibiting the provision of personal wireless service**s**."[19] (Emphasis added.) This is consistent with the underlying basis for the TCA to encourage competition in the provision of telecommunications services.

3.g. Of equal concern is over what area there must be adequate coverage, another point of FCC and Congressional ambiguity. Court decisions originally tended to indicate that there must at least be adequate coverage on principal roads, and we generally assume this to mean the state highways in Hardwick. The Third Circuit Court offered this guideline in its 1999 Ho-Ho-Kus decision:

> "We think it matters a great deal, however, whether the 'gap' in service merely covers a small residential cul-de-sac or whether it straddles a significant commuter highway or commuter railway. Unlike a utility such as electrical power, cellular service is used in transit, so a gap that covers a well-traveled road could affect large numbers of travelers--and the people who are trying to communicate with them. Over the course of a year, the total disruption caused could be quite significant."[20]

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[17] "VoiceStream's Protest Memorandum Relative to §7.8.2.2. 'Adequate Coverage' as Defined in its Bylaw." Submitted to the Town of Concord, MA; 5/17/01.

[18] See *Omnipoint Communications Enters., L.P. v. Newtown Township*, 219 F.3d 240, 242 (3d Cir.), cert. denied, 121 S. Ct. 441 (2000).

[19] 47 U.S.C. § 332(c)(7)(B)Limitations:(i)(II). See Appendix 1 for the entirety of TCA Section 704.

[20] Cellular Tel. v. Zoning Bd. of Adj. of Ho-Ho-Kus, 197 F.3d 64 (3rd Cir. 1999).

A decision last spring in the U. S. District Court for New Hampshire[21] has taken what seems to be a more up-to-date approach, concluding that in-building/in-home service is important:

> "In evaluating the extent of a gap in coverage, courts have considered the availability of both in-vehicle and in-building service. See, e.g., Sprint Spectrum, L.P. v. Willoth, 176 F.3d 630, 643 (2d Cir. 1999). Therefore, the [Dunbarton] ZBA's conclusion, based on town counsel's representation, that in-home service was not pertinent for purposes of satisfying the requirements of the TCA was legal error and was also inconsistent with the evidence of record.[22]"

The Propagation Study herein employs the same levels used in the Dunbarton case. The impact, from a planning perspective, is that the evolution between Ho-Ho-Kus and Dunbarton means that the Town must be prepared to accommodate proposals for larger and/or more numerous facilities to enable in-building/in-home service.

3.h. The issue of whether or not portable phones should be used while the subscriber is driving clouds the question of in-vehicle service. Many drivers now employ hands-free phones and some messaging devices may be used to receive data without interaction with the driver; furthermore, passengers often are the in-vehicle users. Therefore, the Board should consider in-vehicle service to be a valid goal for PWS providers.

3.i. A final, but essential, consideration is that PWS infrastructure requires antennas but not necessarily towers. Sometimes vertical whip antennas are used, but the typical PWS antenna is a panel, shaped like a fluorescent ceiling light panel five to eight feet high.[23] Panel antennas are directional, which means they concentrate the signal in a particular direction. Two or three will often be grouped together, each group facing 3 different directions, equally arranged around the mounting pole or tower. The overall effect may be uniform coverage in every direction, but each set of antennas - known as a sector - has its own signal(s), which increases site capacity. Antennas generally need to be placed with enough height to be effective, which generally means clearing the trees. Some locations are more favorable due to ground elevation relative to nearby topography, which means the mounting structure will not need as much height to sufficiently elevate the antennas. Existing communication towers, buildings, steeples, silos, utility poles and water tanks are often utilized for antenna mounting; if such structures are not available, a new structure will be necessary. In addition to conventional lattice-type towers and monopoles, so-called "stealth" designs may be proposed to conceal antennas, including flagpoles, silos, chimneys, clock towers and even treatment to resemble a tree. See Appendix 8 for typical photographs.

4. WIRELESS INTERNET & OTHER EVOLVING BROADBAND TECHNOLOGY

4.a. In addition to the 915MHz (902-928MHz), 2.4GHz (2400-2483.5MHz) and 5.8GHz (5.15-5.825GHz) ISM (Industrial, Scientific, and Medical) bands - commonly used on an unlicensed basis - the FCC last year proposed use of the 3650-3700 MHz band:

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[21] U.S.C.O.C. v. Dunbarton, 04-CV-304-JD; 04/20/05.

[22] Decision, Footnote 2: "It is true, however, that '[w]here holes in coverage are very limited in number or size (such as the interiors of buildings in a sparsely populated rural area, or confined to a limited number of houses or spots as the area covered by buildings increases) the lack of coverage likely will be de minimis so that denying applications to construct towers necessary to fill these holes will not amount to a prohibition of service.' Willoth, 176 F.3d at 643-44. In this case, the ZBA rejected all evidence of gaps in service to homes and did not find that any such gaps were merely de minimis."

[23] A specification sheet for a typical antenna can be found at Appendix 6.

> "...[A] growing number of WISPs are emerging with the intention of providing an alternative to DSL and cable for high-speed connections into the home or office. The use of unlicensed RF devices appears to have proven to be ideally suited to bridge the gap, especially in rural areas, where cable or DSL services have been slow to arrive. Small entities with limited resources have stepped in to provide such service in areas that other service providers have not prioritized. In numerous fora, these providers have expressed a desire for additional spectrum that could be used on an unlicensed basis, especially on a higher-power basis. These providers have stated that existing spectrum available for unlicensed operation is not adequate to accommodate Wireless Metropolitan Area Networks (MANs) or broadband access in all rural areas. In short, we see that there is a growing demand for higher-powered unlicensed devices operating at lower frequencies where the combination of propagation characteristics and higher power are more conducive to longer-range communications."[24]

In 2004, then-Chairman Michael Powell formed a Wireless Broadband Access Task Force, to develop recommendations that will further the deployment WISPs, and the Commission proposed unlicensed use of vacant broadcast television spectrum, subject to interference restrictions.[25] Subsequently, the Multipoint Distribution Service and Multichannel Multipoint Distribution Service were renamed the Broadband Radio Service, and this spectrum for licensed services expanded in the 2495-2690 MHz band.[26] Also in 2004, the Commission adopted several Part 15 rule changes that should be particularly advantageous for unlicensed broadband service providers in rural areas like Vermont. The changes facilitate use of smart antennas and ease regulatory impediments to deploying other advanced technologies.[27]

4.b. Wide-area wireless broadband involves slightly different protocol than wireless computer networking found inside a home or office, but the primary difference is higher power and bigger antennas to cover the larger area outside residential/business buildings. Indeed, the providers may use antennas and heights comparable to cellular/PCS base stations, such as Cisco Aironets and 5.8 UNII[28] Adaptive Broadband radios utilized by BroadBand Solutions Company, providing a very respectable maximum data throughput of 13Mbps to 80% of Utah's Salt Lake Valley. More common - at least initially - will be smaller rooftop whip or panel antennas which, in turn, may connect to a Wi-Fi access point inside. A typical system, as proposed in Hartford (VT), is shown at Appendix 9. MeshNetworks Inc. has developed the technology to handoff between access points at freeway speeds, maintaining broadband data rates. Orange County (FL) Fire Rescue has employed MeshNetwork's self-forming networking technology for 4 years, which enables first responders to create an instant incident data communications system. After last year's Hurricane Charley, this technology was used to quickly connect mobile command centers and provide secure data and video surveillance for county, state and federal officials. It is expected that mesh-network technology will be widely employed in service restoration following Hurricane Katrina.

4.c. Access Broadband over Power Lines ("Access BPL") - also known as Power Line Communications or Power Line Broadband - typically uses medium-voltage overhead or underground power lines (between 1,000 to 40,000 volts) to deliver Internet and other broadband services to neighborhoods. The municipally owned Manassas, Virginia electric company has deployed a test Access BPL system, while North Carolina's Progress Energy has partnered

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[24] Notice of Proposed Rulemaking (FCC 04-100), ref: ET Dockets 04-151, 02-380, and 98-237; 4/15/04.
[25] Notice of Proposed Rulemaking (FCC 04-113), ref: ET Dockets 04-186 and 02-380; 5/13/04.
[26] Report & Order and Further Notice of Proposed Rulemaking (FCC 04-135) ref. WT Docket 03-66; 6/10/04.
[27] Report & Order (FCC 04-165), ref: ET Docket 03-201; 7/8/04.
[28] Unlicensed National Information Infrastructure.

with Internet provider EarthLink in a commercial trial near Raleigh. Nationwide, there have been at least four commercial ventures and several dozen field trials. However, Access BPL has been strongly opposed by several groups, including the American Radio Relay League, Inc., representing amateur radio (ham) operators concerned about interference.[29] Nonetheless, last October the FCC adopted new rules for Access BPL systems.[30]

4.d. WISP equipment generally involves antennas and transceivers (a transmitter and receiver); the exception would be the BPL interface that connects the medium-voltage line to the customer line at the pole transformer. The FCC, as discussed further in Section 7, largely preempts local regulation of customer antennas, and Section 8 discusses FCC preemption regarding interference.

5. PROPAGATION STUDY BACKGROUND & METHODOLOGY

5.a. Many residents experience poor or even non-existent coverage, particularly in Hardwick's lower elevation areas. Once it has been determined that a new facility is necessary, it is logical to look first at higher-elevation areas, since greater elevation generally means a wider coverage area. With the exception of the Memorial Building, all of the sites suggested by the Town have relatively good elevation. Several factors typically work against development of the highest sites: First, it is especially difficult to obtain permits for a new tower on any mountain or ridgeline, as evidenced by opposition to the original Buffalo Mountain tower proposal. Second, site-development costs quickly escalate if access roads must be built and electricity brought in over a considerable distance. Third, interference may be harder to control because antenna placement too high makes it likelier that signals will undesirably travel to a distant point, or that receiving antennas will pick up distant unwanted signals. The final factor - as will be seen with the study of Woodbury Mountain - is that locating on mountains often moves the facility too far from populated problem areas.

5.b. The Board suggested possible facilities on Bridgman,[31] Hopkins, Ward and West Hills; two sites on Buffalo Mountain; the site for the proposed FM broadcast station; and the Memorial Building. George Hemmens and Nancy Kish marked these locations on an orthophoto and provided geographic coordinates. In addition, I checked the FCC database[32] for antenna locations, adding the existing Rinker station KDS417 using its licensed coordinates. Hardwick municipal radio facilities are primarily in the village area at ground elevation similar to that of the Memorial Building with presumably similar coverage. The exception is a facility - WPEC653 - licensed to the Hardwick Electric Department on a short tower close to the location already suggested at West Hill. The results of the suggested West Hill location should be similar to that of WPEC643 if it were replaced with a taller structure. Additionally, I located the original BANM site on Buffalo Mountain and added Cook Hill as a promising location. It has a good view of Greensboro and Caspian Lake, and also Route 14 along Lake Elligo heading north toward Craftsbury. The assumption was that Cook Hill might help with coverage of the northern part of Hardwick.

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[29] See http://www.arrl.org/tis/info/HTML/plc/

[30] Amendment of Part 15 regarding new requirements and measurement guidelines for Access Broadband over Power Line Systems, ET Docket Nos. 03-104 and 04-37, *Report & Order*, FCC 04-245; 10/14/04.

[31] "Bridgman Hill" uses the proposed Rinker tower site. The 12/2/04 ZBA decision notes that "[t]he proposed site is near an existing antenna" and that location is labeled "KDS417".

[32] See Appendix 4 for FCC license data.

5.c. The study area (Figure 1, with site locations and daily traffic data) is comprised of the entirety of the Town of Hardwick. Figure 2 shows a three-dimensional area topographic map.

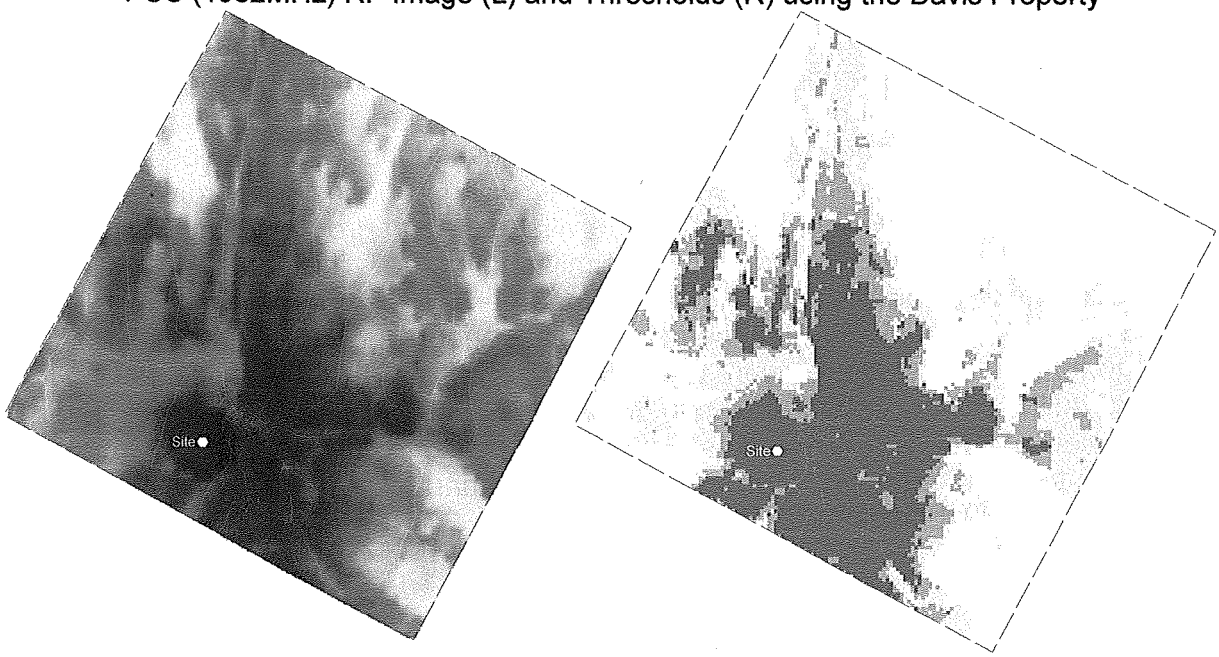
5.d. Thirteen sites, including ten in the Town of Hardwick, were included in the propagation analysis; several were analyzed with different antenna heights. The Town (study area) was divided into a grid of 17,249 hypothetical reception points spaced 250 feet apart, with the same points used for each analysis. In attempting to illustrate how radio waves travel to the desired destination, the analogy is often made between RF propagation and visible light. Better than shining a light is utilization of "real-world" computer modeling, which takes into account signal attenuation and bending caused by the particular terrain and ground cover. All analyses employed the widely accepted Okumura[33] RF signal propagation model.

> "The Okumura approach is probably the most widely quoted of the available models. It takes into account not only urban, suburban, and rural environments, but also describes the effects of different kinds of terrain. All phenomena and effects can be computed well in practice."[34]

The modeling utilized 30-meter-resolution digital terrain data, with adjustments for U.S. Geological Survey land-use/land-cover data and manually corrected obstruction data. It has been my experience that Okumura results are quite accurate for the type of terrain found in this part of Vermont. The model performs pertinent reliability factoring, but it must be realized that there will be seasonal variation due to the effect of foliage at PWS frequencies. Conservative parameters, chosen to avoid overly optimistic results, are spelled out in Appendix 5.

5.e. The Okumura prediction (below, left) shows varying signal, darker being stronger. This is challenging to interpret, since we need to know if the signal level is effective or not. Therefore, the study results (Figures 3 through 32, and Table 1) are presented in the format shown to the right, indicating if a study point meets one of three thresholds for on-street, in-vehicle or in-building service. (Threshold results for the right-hand plot are shown in Figure 3.)

PCS (1962MHz) RF Image (L) and Thresholds (R) using the Davis Property



[33] "Field Strength and Its Variability in VHF and UHF Land-Mobile Radio Service," Yoshihisa Okumura, et al., *Review of the Electrical Communications Laboratory*, Vol. 16, No. 9-10, Sept.-Oct., 1968.

[34] *Radio Propagation in Cellular Networks*, p. 261; Nathan Blaunstein, Ph.D.; Artech House Publishers, 2000.

6. PROPAGATION STUDY RESULTS

6.a. Industry practice is to employ sufficient loss margins to reliably guarantee useable signal, and remember that current-generation phones will often function better than expected. For the study, the Okumura supposition was that results are indicative of 75% of the locations at that point. Each coverage plot displays three signal levels[35] and the lowest (-92dBm) is considered adequate by many providers for "on-street" coverage. (Note that -98dBm is the lowest acceptable level by any such provider that I routinely review, and most other providers now feel that is too low.) See the earlier discussion at 3.e. and 3.g. The next stronger (darker) -87dBm level corresponds to the minimum adequate level for "in-vehicle" coverage. Finally, the strongest (darkest) -82dBm level is indicative of even better service and is a level strong enough to make up for additional losses likely inside a building. Since the Okumura parameters were cautiously chosen, it is likely that a slightly larger area will receive adequate coverage.

6.b. Coverage plots are for signal transmitted from the tower, known as the forward link. In the case of communication between a base station and a hand-held phone, the signal from the phone - the reverse link - presents the greater challenge. Calculating and mapping the reverse link is less precise due to variability in user devices, but the forward link values have been chosen to closely predict the overall ability to communicate. Propagation using PCS spectrum is less favorable, so the study depicts conservative expectation of PCS, along with cellular performance.

6.c. Each site analysis shown in Figures 3 through 32 employed identical antenna and power output parameters at the antenna center-line ("C/L") height indicated for either cellular or PCS, with the exception of Figures 9 and 10. They show UHF and high-band VHF public-safety operation and the antennas and power levels are typical for full-duplex (two-way) service. To further facilitate site comparison, many analyses used a 97-foot[36] C/L, which should acceptably clear the trees in most cases with enough margin for collocation. Note that the actual design would no doubt show some variation from one provider to another. The following comments are with respect to coverage shown in Figures 3 through 32:

- Fig. 3 - Buffalo Mountain: Davis property, PCS coverage with a C/L height of 97'. Compare this with the RF image plot on the previous page, which shows what appears to be fairly consistent shading (signal) to the north along Route 14. As it turns out, much of the image area fails to meet even the -92dBm threshold.
- Fig. 4 - Buffalo Mountain: Davis property, cellular coverage (97' C/L). Note the improvement over PCS, and solid coverage of the village area.
- Fig. 5 - Buffalo Mountain: Town property, PCS coverage (97' C/L).
- Fig. 6 - Buffalo Mountain: BANM original site, PCS coverage (97' C/L). Tallying the "Below -92 dBm" results (where lower is better), the higher BANM site leaves fewer locations with inadequate coverage. The Davis site, however, does a better job with the village due to its better view of, and proximity to, that area.
- Fig. 7 - Buffalo Mountain: BANM site, cellular coverage (97' C/L).
- Fig. 8 - Buffalo Mountain: BANM site, cellular coverage using the original proposed height (147' C/L). Even this height doesn't help fill in along the lower-elevation state roads at locations more than 2 or 3 miles from the site.

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[35] Remember the earlier discussion of negative numbers: -92dBm is 10dB weaker than -82dBm.

[36] This assumes a 6-foot panel antenna with the top at 100 feet above ground level, so the center is at 97 feet.

Fig. 9 - Buffalo Mountain: BANM site, UHF coverage (97' C/L). This is what might be expected for base/mobile public-safety communications using UHF spectrum.

Fig. 10 - Buffalo Mountain: BANM site, VHF coverage (97' C/L). This is what might be expected for base/mobile public-safety communications using VHF spectrum. What we see, with lower public-safety operating frequencies, is considerable improvement compared with PCS.

Fig. 11 - Woodbury Mountain: cellular coverage (97' C/L).

Fig. 12 - Round Knoll (Woodbury): cellular coverage (97' C/L). This location was used in an earlier filing with the FCC for the new FM station allocated to Hardwick.

Fig. 13 - Bridgman Hill: PCS coverage (97' C/L).

Fig. 14 - Bridgman Hill: cellular coverage (97' C/L).

Fig. 15 - Bridgman Hill: PCS coverage (122' C/L). This is based on 125' structure height.

Fig. 16 - Bridgman Hill: PCS coverage (147' C/L). This is based on 150' structure height.

Fig. 17 - Bridgman Hill: PCS coverage (172' C/L). This is based on 175' structure height.

Fig. 18 - Bridgman Hill: cellular coverage (172' C/L). Probably the most optimistic plot from this site, since it is unlikely antennas would be mounted higher due to the owner's desired plans for the top of the structure. Even at this height, areas along state highways to the east, north and west would still have inadequate coverage.

Fig. 19 - KDS417, the existing licensed Rinker facility: PCS coverage (97' C/L).

Fig. 20 - Memorial Building: PCS coverage (72' C/L) assumes a 75' pole or mounting structure. Note the good coverage of the village area.

Fig. 21 - FM broadcast, proposed site: PCS coverage (97' C/L).

Fig. 22 - FM broadcast, proposed site: cellular coverage (172' C/L). The assumption is that the FM antenna(s) will be at the top. This location is not particularly helpful, partly due to its distance from likely problem areas.

Fig. 23 - West Hill: PCS coverage (97' C/L).

Fig. 24 - West Hill: cellular coverage (97' C/L).

Fig. 25 - Cook Hill: PCS coverage (97' C/L).

Fig. 26 - Cook Hill: cellular coverage (97' C/L). As previously mentioned, Cook Hill could be helpful for its coverage of Greensboro and Route 14 along Lake Elligo heading north toward Craftsbury.

Fig. 27 - Hopkins Hill: PCS coverage (97' C/L).

Fig. 28 - Hopkins Hill: cellular coverage (97' C/L).

Fig. 29 - Ward Hill: PCS coverage (97' C/L).

Fig. 30 - Ward Hill: cellular coverage (97' C/L). Ward Hill would provide good coverage of East Hardwick and Route 16 heading northeast toward Greensboro Bend.

Fig. 31 - Aggregate (cellular) using Bridgman Hill (172' C/L) and BANM sites (147' C/L) together. This is probably the best case for a 2-tower scenario.

Fig. 32 - Aggregate (PCS) using Bridgman Hill (172' C/L) and BANM sites (97' C/L). Note that aggregate coverage in an actual review would also consider coverage from other neighboring cells. Even in 1997, BANM submitted a then-existing coverage map that showed some coverage of the Town of Hardwick, mostly at favorable elevation.

6.d. Propagation was studied assuming a non-directional antenna to better judge the RF ability in every direction. In actual practice, providers will probably not use omni-directional antennas for several reasons: First, by breaking up the coverage circle into several sectors, more conversations can be achieved by using different channels, frequency and/or power in each sector. Second, the antennas may be used to limit signal sent in certain directions to reduce interference to and from other cells. A typical arrangement uses 3 sectors, equally

spaced, each with 120° beamwidth antennas; while each sector has a separate coverage pattern, the aggregate of the three is 360° - fairly circular. On the other hand, where the goal is specific - for instance coverage in a valley - two sectors might aim a narrower beam in each direction up and down the highway.

6.e. There is sometimes skepticism about computer modeling accuracy, compared with actual measurements. A drive test can be a useful tool, often used in conjunction with, and to fine-tune, the computer model. It can also confirm the status of various provider signals. Its most serious drawback is that it is a one-time snapshot of conditions at that particular moment, and denotes signal level of a particular receiver. The results, often confined to the drive route, must then be extrapolated to picture the larger area. What the computer modeling yields can be more indicative of the wide range of receivers and conditions (including varying foliage), and over the general coverage area instead of just the road(s) under test at a particular moment. Another use of testing is to fine-tune a design for a particular site, especially if computer modeling is ambiguous about the lowest effective antenna height. The goal of this Analysis is to explore what is possible, and it is not practical or necessary to actually design a system to the point of testing every site.

6.f. In addition to the plots, results can be found in Table 1. To summarize, it appears that no single site can reasonably provide service over the entirety of the Town of Hardwick. This is based on the propagation studies using an antenna above 97' C/L. In the case of Buffalo Mountain, based on earlier opposition, it appears likely that a structure greater than 150 feet would face strong opposition. In the case of the proposed Rinker tower, it is unlikely that antennas could be located high enough to provide town-wide coverage. Therefore, a combination of two or more facilities may be necessary to provide adequate coverage of the entirety of Hardwick. Micro-cell, repeater and DAS solutions might be an answer for some remaining highway sections where there is a coverage gap.

7. LOCAL REGULATION OF PWS FACILITIES

7.a. Most areas of local land-use jurisdiction were specifically preserved by the TCA, but it is important to understand what was preempted. For instance, Section 704 of the Act prohibits the Town of Hardwick from regulating "on the basis of the environmental effects of radio frequency emissions to the extent that such facilities comply with the Commission's regulations concerning such emissions."[37] While it is acceptable to require demonstration of need and to employ rigorous review, the Town must act without undue delay, not discriminate among providers, and avoid decisions that would effectively prohibit personal wireless services.

7.b. The Town of Hardwick has adopted Zoning Bylaw "Section 4.15 Telecommunication Facility" (see Appendix 3 for Proposed Draft changes dated 9/20/05). It makes it easier to construct a "Small Scale" facility. Exceptions are made for certain residential television and radio antennas and satellite dishes, for citizens band radio, and for public/safety replacement equipment. There are limitations on a new tower's height above its surroundings; generally, not more than 20 feet above average tree line and in no case exceeding 180 feet. The Bylaw has a number of requirements relating to setbacks, lighting, noise, etc.; it encourages an-

[37] 47U.S.C.§332(7)(B)(iv). The complete text of Section 704 is contained at Appendix 1.

tenna collocation on new and existing towers and structures, and requires a tower's owner to reasonably allow collocation of other PWS providers.

7.c. The following addition should be considered for the bylaw approval criterion regarding lighting:

> "Unless required by the Federal Aviation Administration (FAA), no lighting of towers is permitted. In any case where a tower is determined to need obstruction marking or lighting, the applicant must demonstrate that it has or will request the least visually obtrusive marking and/or lighting scheme in FAA applications. Copies of required FAA applications shall be submitted by the applicant."

This builds on the FAA reference already in the bylaw. The reason for its importance is due to applicant discretion over obstruction marking schemes. While lighting is always required for towers over 200 feet, the choice of strobe lights or flashing red lights is often up the applicant, and what may be more cost effective might not be less obtrusive.

7.d. The bylaw exemption for residential antennas needs to be expanded, especially given bylaw prohibition of wireless telecommunications facilities on residential buildings. The FCC limits local restrictions not just on residential radio-television antennas but on the vast majority of customer-end antennas[38] as long as they are within certain limits. (Generally, the FCC considers this to mean antennas one meter or less in diameter, and support masts twelve feet or less above the roofline.) Implementing TCA Section 207, the FCC extended its over-the-air reception device ("OTARD") rules to include customer antennas that receive and transmit telecommunications and other fixed wireless signals, stating:

> "We recognize that today's revision of the OTARD rules will extend the benefits of that [sic] rules to fixed wireless devices that have the capability to transmit as well as receive signals. We emphasize that all FCC-regulated transmitters, including the subscriber terminals used in fixed wireless systems, are required to meet the applicable Commission guidelines regarding radiofrequency exposure limits.[39] We also reiterate that the OTARD rules provide an exception for "a clearly defined, legitimate safety objective" provided the objective is articulated in the restriction or readily available to antenna users and is applied in a non-discriminatory manner and is no more burdensome than necessary to achieve the articulated objectives.[40] We believe it is incumbent upon fixed wireless licensees, including satellite providers, to exercise reasonable care to protect users and the public from radiofrequency exposure in excess of the Commission's limits. Generally, we expect subscriber antennas to be installed so that neither subscribers nor other persons are easily able to venture into and interrupt the transmit beams. Such interruptions can degrade the quality of service to the subscriber and ultimately reduce the value of the carrier's service. Thus, providers have economic incentives to avoid temporary interruptions of signal quality that are likely to motivate them to install antennas in locations where such interruptions are less likely to occur."[41]

7.e. The Town may regulate larger or taller customer-end facilities, as previously noted, as well as installations involving valid safety or historic preservation concerns. The FCC, clarifying that it does not consider that customer-end facilities fall under its PWS facility definition, was unequivocal in acknowledging local jurisdiction regarding so-called hub sites:

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[38] Customer antennas can be business or residential.

[39] *See* Guidelines for Evaluating the Environmental Effects of Radiofrequency Radiation, ET Docket No. 93-62, *Report and Order*, 11 FCC Rcd 15123, 15124, 15152 (1996); 47 C.F.R. §§ 1.1307(b)(1), 1.1310.

[40] 47 C.F.R. §1.4000(b).

[41] *See* Competitive Networks Report and Order, FCC 00-366, released 10/25/00; ¶117.

"We believe that, in the context of Section 332(c)(7), the term "personal wireless service facilities" is best read not to include customer-end antennas. The Section defines "personal wireless service facilities" as facilities "for the provision of personal wireless services." Although the term taken by itself could be read to include customer-end facilities, a narrower reading which limits the term to a facility that "provides" the service, *i.e.*, the carrier hub site, is not only reasonable, but also, as discussed below, better reflects the statutory provisions and goals of the 1996 Act in general and those of Section 332(c)(7) in particular. Thus, we find that Section 332(c)(7) does not prevent the Commission from restricting state and local government regulation of these antennas. We note, though, that nothing in this decision affects the well-established rights of state and local governments under Section 332(c)(7) to regulate the placement, construction, and modification of carrier hub sites.[42]" [43]

7.f. As will be seen in this and the following section, the FCC substantially controls regulation of RF radiation exposure and interference. One exception is that local officials may reasonably inquire into licensee compliance with FCC RF exposure guidelines. Hardwick's existing (draft) language, which seeks demonstration and commitment to guideline compliance, is acceptable. However, requiring RF measurement as part of a compliance demonstration requirement is probably unenforceable. I recommend compliance determination in accordance National Council on Radiation Protection and Measurements ("NCRP") Reports 86 and 119. The FCC adopted NCRP guidelines, outlining compliance determination in Office of Engineering & Technology Bulletin 65, "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields". While these documents outline methodology to determine compliance with Maximum Permissible Exposure ("MPE") levels, the FCC acknowledged TCA ambiguity regarding local authority to require testing, stating, "Neither the text of the Act nor the legislative history indicates to what extent localities are permitted to request that personal wireless service providers demonstrate compliance with our RF guidelines."[44]

The FCC later established this policy:

1. In this *Report and Order*, we address the issues raised in the Commission's Notice of Proposed Rulemaking regarding the Commission's review of requests for relief from impermissible State and local regulation of personal wireless service facilities based on the environmental effects of radiofrequency (RF) emissions.[45] Specifically, we provide that such requests under Section 332(c)(7)(B)(v) of the Communications Act of 1934, as amended,[46] shall be filed as petitions for declaratory ruling, and we establish certain required and recommended procedures regarding the service of pleadings and comment periods in such proceedings. We believe that these procedures will facilitate the prompt resolution of petitions seeking relief from the Commission under Section 332(c)(7)(B)(v), while ensuring that State and local governments have an opportunity to respond to issues raised in the context of these proceedings.

2. We also conclude that the other issues raised in the *RF Procedures Notice* are best addressed through case-by-case adjudication, and we therefore terminate our

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[42] See, e.g., Communications Company of Charlottesville v. Board of Supervisors of Albemarle County, 211 F.3d 79, 86 (4th Cir. 2000).

[43] Competitive Networks Report and Order; ¶109.

[44] Second Memorandum Opinion and Order and Notice of Proposed Rulemaking, FCC 97-303, ¶139.

[45] Procedures for Reviewing Requests for Relief From State and Local Regulations Pursuant to Section 332(c)(7)(B)(v) of the Telecommunications Act of 1934, WT Docket No. 97-192, *Second Memorandum Opinion and Order and Notice of Proposed Rulemaking*, 12 FCC Rcd 13494, 13540-60, ¶¶ 115-54 (1997) (*RF Procedures Notice*), *aff'd Cellular Phone Taskforce v. FCC*, 205 F.3d 82 (2d Cir. 2000) (*Cellular Phone Taskforce*).

[46] 47 U.S.C. § 332(c)(7)(B)(v).

consideration of these issues in the rulemaking context. In light of developments since the *RF Procedures Notice* was released, we now believe that binding rules globally resolving these issues are neither necessary nor appropriate. In particular, we note the recent release by the Commission and the Local and State Government Advisory Committee (LSGAC) of *A Local Government Official's Guide to Transmitting Antenna RF Emission Safety: Rules, Procedures, and Practical Guidance* (*Local Official's Guide*).[47] We expect that the *Local Official's Guide* will facilitate the common sense resolution of disputes regarding demonstrations of compliance with the Commission's RF emissions rules, without resort to litigation or other formal dispute resolution."[48]

7.g. Finally, many facility proposals will require Act 250 review including,

"...any support structure proposed for construction, which is primarily for communication or broadcast purposes and which will extend vertically 20 feet, or more, in order to transmit or receive communication signals for commercial, industrial, municipal, county or state purposes, shall be a development under this chapter, independent of the acreage involved."[49]

Presumably, Act 250 review is necessary for new stealth structures.[50]

8. RADIOFREQUENCY INTERFERENCE & (NON-IONIZING) RADIATION

8.a. The FCC has requirements relating to RF interference, primarily between licensees since this is where interference is likely. Interference is unlikely beyond the calculated blanketing zone, which is just a few feet for power levels anticipated at most PWS facilities. Interference is always possible, particularly with poorly designed consumer electronics equipment, but unlikely. The usual cause of interference - higher power operation typical of broadcast AM, FM and television - is not foreseen in Hardwick with the exception of whatever tower may be approved for the new FM station. Nonetheless, it is impossible to state with absolute certainty that there will never be interference to nearby electronic equipment. Moreover, Town authority to regulate regarding interference was effectively preempted by the refusal of the U. S. Supreme Court to hear the Freeman case.[51] Although the subject was Nextel interference to certain types of public safety services - not an issue for the Town's current public safety frequencies - the FCC confirmed its authority to regulate interference two years ago.[52]

8.b. Each licensee must comply with FCC RF radiation exposure requirements for the general population, as well as to employees and contractors who have access to the antennas.

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[47] *A Local Official's Guide to Transmitting Antenna RF Emission Safety: Rules, Procedures, and Practical Guidance* (June 2, 2000), available at http://www.fcc.gov/wtb/siting. The LSGAC is a body of elected and appointed local, State, and tribal government officials appointed by the Chairman of the FCC. It provides advice and information to the Commission on key issues that concern local and State governments and communicates State and local government policy concerns regarding proposed Commission actions.

[48] Report and Order, FCC 00-408, adopted November 13, 2000.

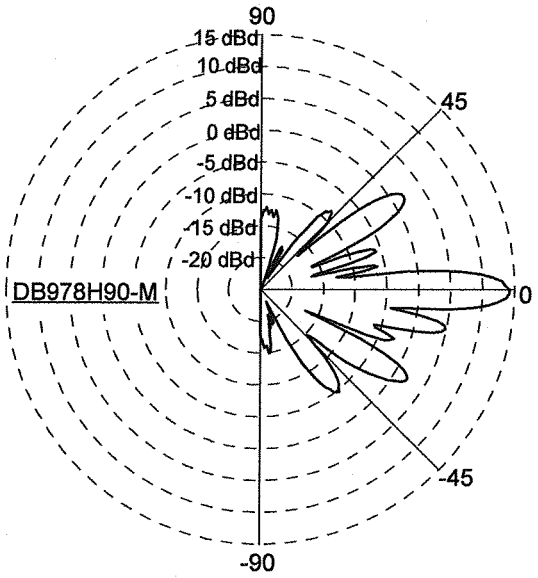
[49] 10 V.S.A. § 6001c. Jurisdiction Over Broadcast and Communication Support Structures and Related Improvements.

[50] One concealment provider, Stealth Network Technologies, Inc., provided photographs of typical concealment that are included in Appendix 8. More examples are on its website: www.stealthsite.com.

[51] Freeman, et al., v. Burlington Broadcasters, Inc. et al., Petition for Writ of Certiorari to the U. S. Court of Appeals for the Second Circuit; denied October 2, 2000.

[52] "Petition of Cingular Wireless L.L.C. for a Declaratory Ruling that Provisions of the Anne Arundel County Zoning Ordinance are Preempted as Impermissible Regulation of Radio Frequency Interference Reserved Exclusively to the Federal Communications Commission", FCC Memorandum Opinion and Order in WT Docket 02-100, adopted 7/3/03.

Typical PCS Antenna Vertical-Plane Radiation Pattern



By examining the PWS antenna pattern above, it can be seen that radiation is primarily a narrow beam aimed at the horizon (0°). At relatively small angles (depression angles) below[53] the horizon, antenna gain drops dramatically. The unit of measurement for this plot is the decibel or dB; as explained at Footnote 16, a 3dB decrease results in half the power. At a depression angle of less than 4° (below horizontal), the effective radiated power is halved. Even if possible to be directly in front of the antenna, typical power levels are such that MPE would be exceeded only within about ten feet of the antenna. Assumption that exposure is taking place at the same height as the particular antenna is the basis for the previously noted Local Official's guide. The FCC would almost certainly feel that compliance in most low-power cases can determined by means of calculations.

8.c. Accessibility is often the key to assuring MPE compliance, so fencing and other restrictive (anti-climbing) measures on the ground are quite important. As discussed in Section 7, the Town is pre-empted from regulating based on health concerns relating to RF radiation. The types of facilities envisioned in this analysis will operate at quite low power.

9. CONCLUSIONS & RECOMMENDATIONS

9.a. If the Rinker proposed tower on Brigman Hill is built, it cannot provide coverage of the entire Town of Hardwick. Similarly, the 1997 BANM proposed tower cannot cover the entire Town. If both towers were built, it would be close (96%), although only 83% of locations would meet the in-building threshold.[54] Nonetheless, it appears that some sort of two-tower scenario might reasonably be supplemented by repeater or DAS coverage.

9.b. Antenna placement on mountain or hill locations examined just outside the Town does not appear to be particularly helpful. Cook Hill, however, it might prove beneficial for Greensboro and Craftsbury coverage and secondarily help the northern part of Hardwick. The site of the proposed FM station is not particularly good for Hardwick coverage.

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[53] Downward from the antenna, as indicated by a negative angle.
[54] See Table 1.

9.c. Micro-cell, repeater and Distributed Antenna Systems may extend or fill in coverage, but are probably not yet cost-effective for larger scale implementation in a way that would eliminate using towers. Nonetheless, developments in this area should be watched.

9.d. The current setback and height restrictions are defensible, particularly since there is provision allowing the ZBA latitude in the approval process.

9.e. The following recommendations should be considered:

1. Expand exemptions to comply with the FCC OTARD rules.

2. Add the FAA lighting-scheme language suggested at 7.c.

3. Determine when collocation is important enough to allow greater height, and assert the expectation of good-faith effort by applicants to meet collocation goals. The ZBA should be able to weigh something beyond generalized applicant statements in this regard. In its 1997 Savoie decision, the Vermont Environmental Board was instructive concerning "good-faith" effort regarding collocation:

> "Once all technically feasible alternatives are ascertained (in this case, largely with the assistance of the Appellants), a project applicant that is bound by the collocation provisions of the Regional Plan must conduct good faith negotiations with the owner or operator of each and every existing facility to collocate on one of those existing facilities. Only after both a search manifesting all due diligence to ascertain available alternative sites, and a good faith negotiation with the singular objective of successful collocation, will the Applicants have satisfied the burden that is assigned to them under Policies 2 and 4 of the [Windham] Regional Plan. The Applicants may not simply telegraph their desire to be unsuccessful in the negotiation. Rather, an applicant must aim to succeed in the negotiation to secure [facility] space."[55]

9.f. Finally, it should be clear that Personal Wireless Services are rapidly increasing and evolving in ways that may require periodic updating of this Analysis and relevant regulations. No set schedule is recommended, and subsequent applications will probably point to areas for further review and revision.

10. STATEMENT OF MARK F. HUTCHINS

10.a. I am a Radiofrequency Engineer and a former broadcast station owner and communications site landlord. I obtained my first FCC license in 1965, and hold lifetime FCC General Radiotelephone Certificate PG0111356. I am a 34-year Senior Member of the Society of Broadcast Engineers ("SBE"), Certified (#1098, Life Certification) as a Senior Broadcast Engineer by the SBE since 1977. I am a 7-year Member of the Institute of Electrical and Electronics Engineers ("IEEE"), IEEE Antennas & Propagation Society, IEEE Microwave Theory & Techniques Society, and the IEEE Standards Association. I also belong to the Vermont Planners Association.

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[55] Re: Gary Savoie d/b/a WLPL and Eleanor Bemis, Land Use Permit Application #2W0991-EB (Reconsideration), Findings of Fact, Conclusions of Law, and Order (Aug. 27, 1997).

10.b. For 39 years I have prepared, and been signatory to, numerous applications before the FCC. For the past 12 years, I have been the FCC frequency coordinator for Part 74 spectrum below 2 Gigahertz in Vermont, and am well versed in facility collocation. I am experienced in RF design and analysis, and have been retained to perform terrain analysis, coverage/propagation modeling, spectrum compliance/coverage testing, system design/integration and non-ionizing radiation surveys. My clients have included Cox Broadcasting, Hearst-Argyle Television, Hubbard Communications, Cingular Wireless, U. S. Cellular, Vermont Public Radio, the Atlanta Board of Education and many individual FCC licensees.

10.c. I chaired the engineering panel for the 1996 Vermont Law School international RF/Microwave Conference, and was one of two independent engineers who assisted the 1997 FCC radiation study of the multiple-emitter Mount Mansfield communications site. The Vermont Environmental Board submitted results of my RF studies - crucial to land use permit decisions - to the FCC in two Rulemaking proceedings. The National League of Cities and the National Association of Telecommunications Officers and Advisors cited my comments in one of these FCC proceedings to support their reply comments. I authored the chapter on RF exposure prediction and measurement for the book "Cell Towers: Wireless Convenience? Or Environmental Hazard?" published in 2001 (ISBN 1-884820-62-X).

10.d. Numerous local, regional and state planning bodies have employed me to review facility applications and conduct workshops. I have submitted evidence and been qualified to testify before municipal bodies, district environmental commissions, the Vermont Environmental Court, and state and federal courts. Senator Jeffords invited me to meet with FCC Chairman William Kennard and Vermont leaders prior to the 1998 Hardwick public hearing on tower siting. I met again with Senator Jeffords in 1999, following my presentation to Senate and House staff involved in facility siting legislation. I regularly assist in the development and review of regulations, and perform comprehensive wireless telecommunications planning.

10.e. Neither myself individually, nor my corporation, have any business or financial relationship with any entity in the Town of Hardwick, with the exception of the Town. I no longer accept site-acquisition work on behalf of any PWS providers or tower developers, and have not done so for over five years.

10.f. This analysis was prepared personally or under my direct supervision.

Mark F. Hutchins

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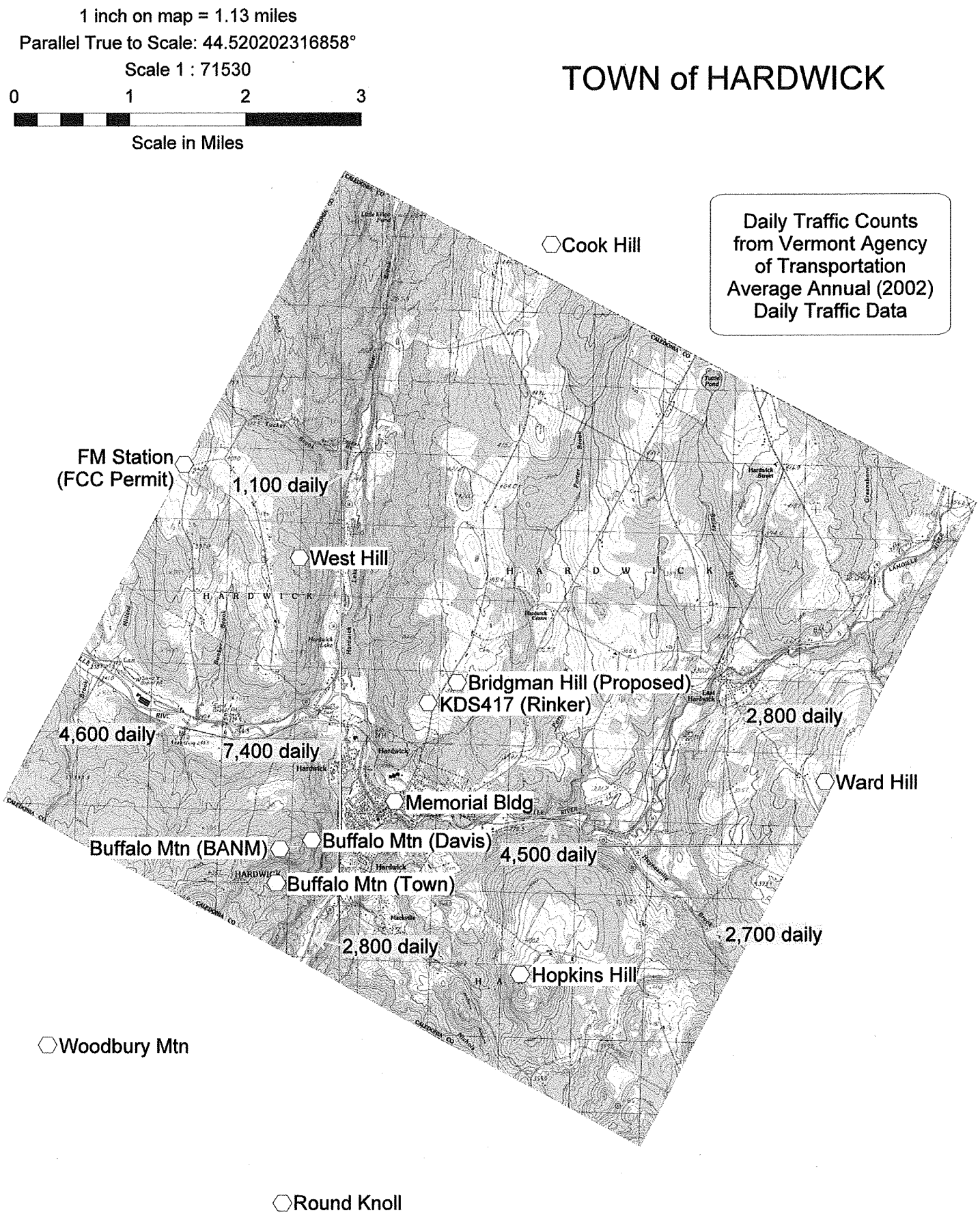

FIGURE 1 - Study Locations & Daily Traffic Counts

TOWN of HARDWICK

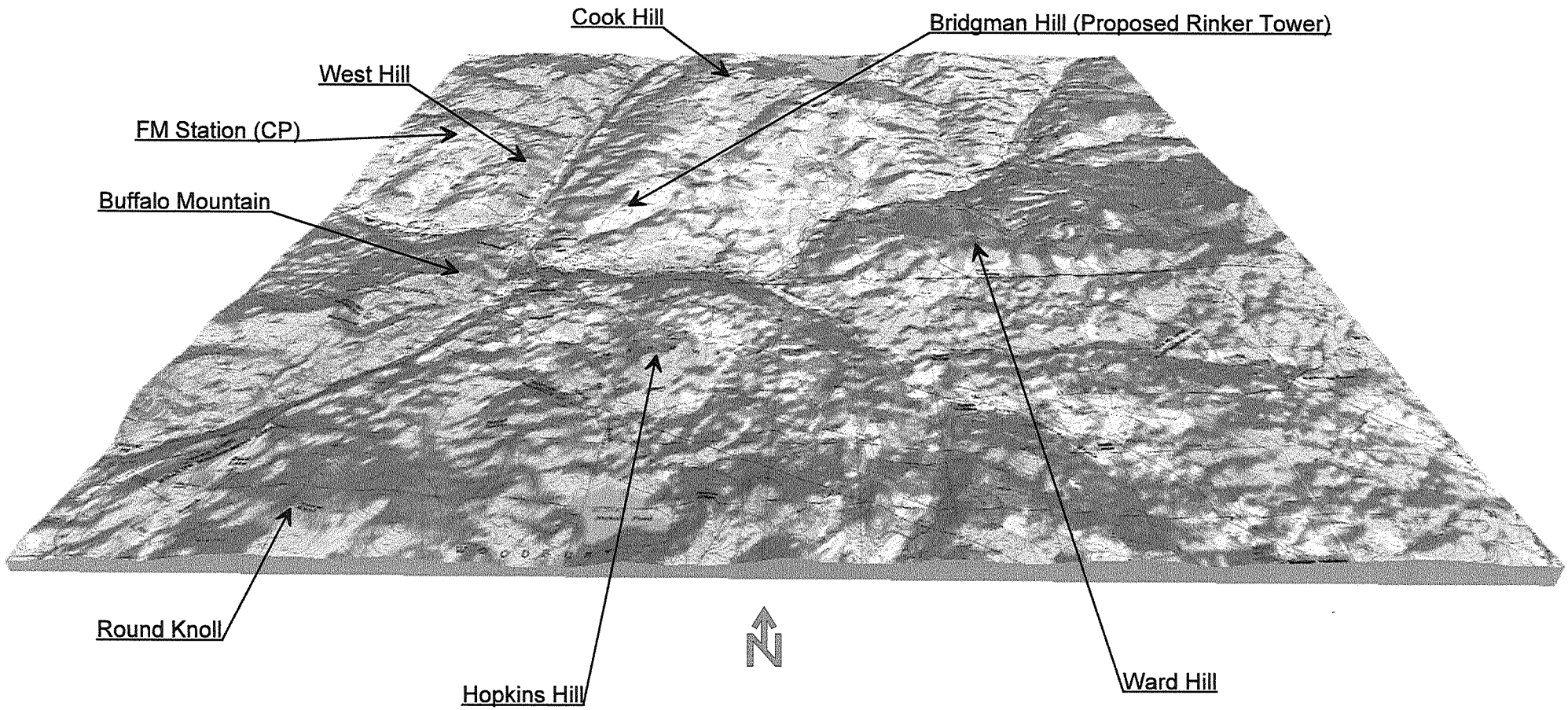

FIGURE 2 - Area View

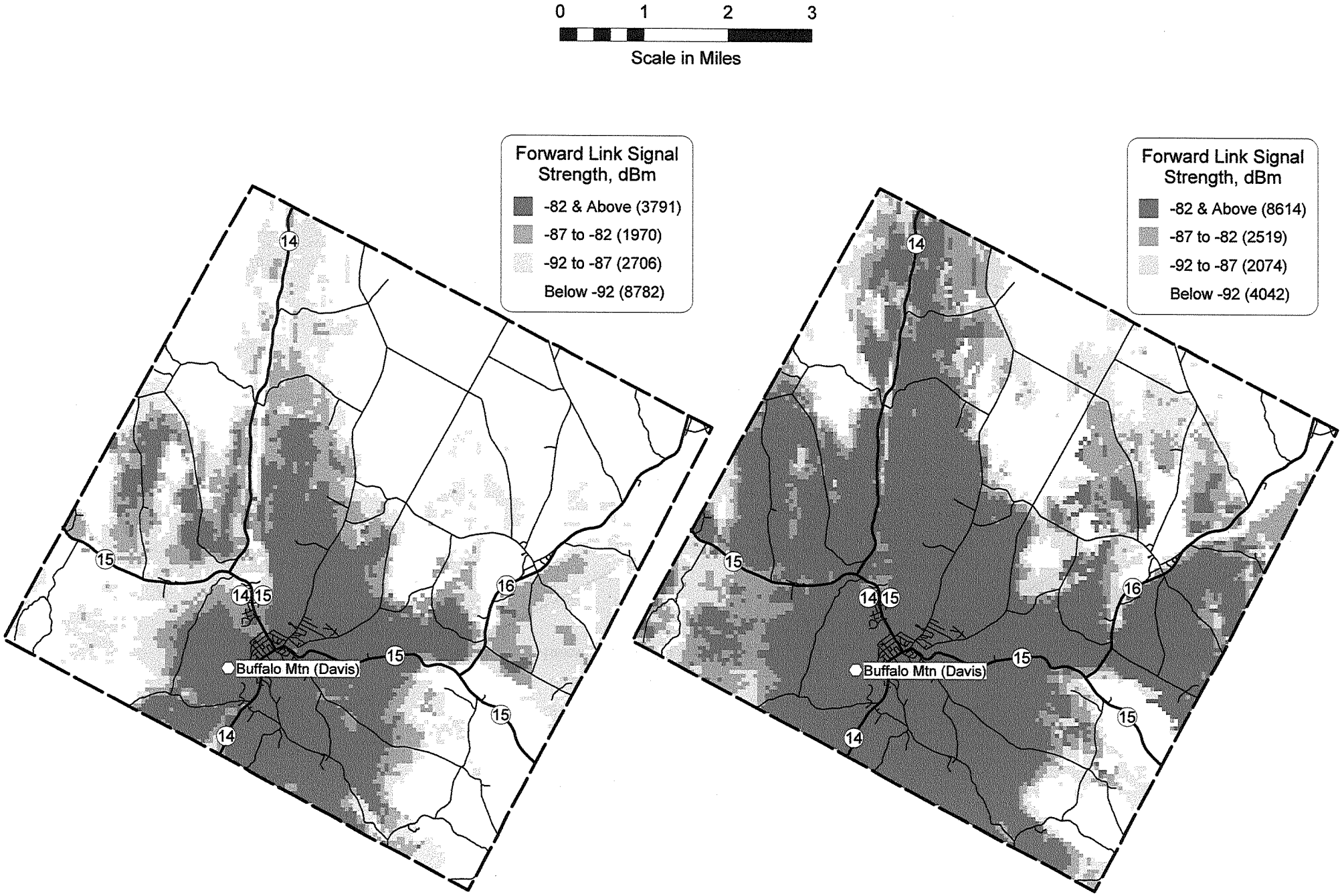

FIGURE 3 - Buffalo Mtn: Davis @ 97' C/L - PCS

FIGURE 4 - Buffalo Mtn: Davis @ 97' C/L - Cellular

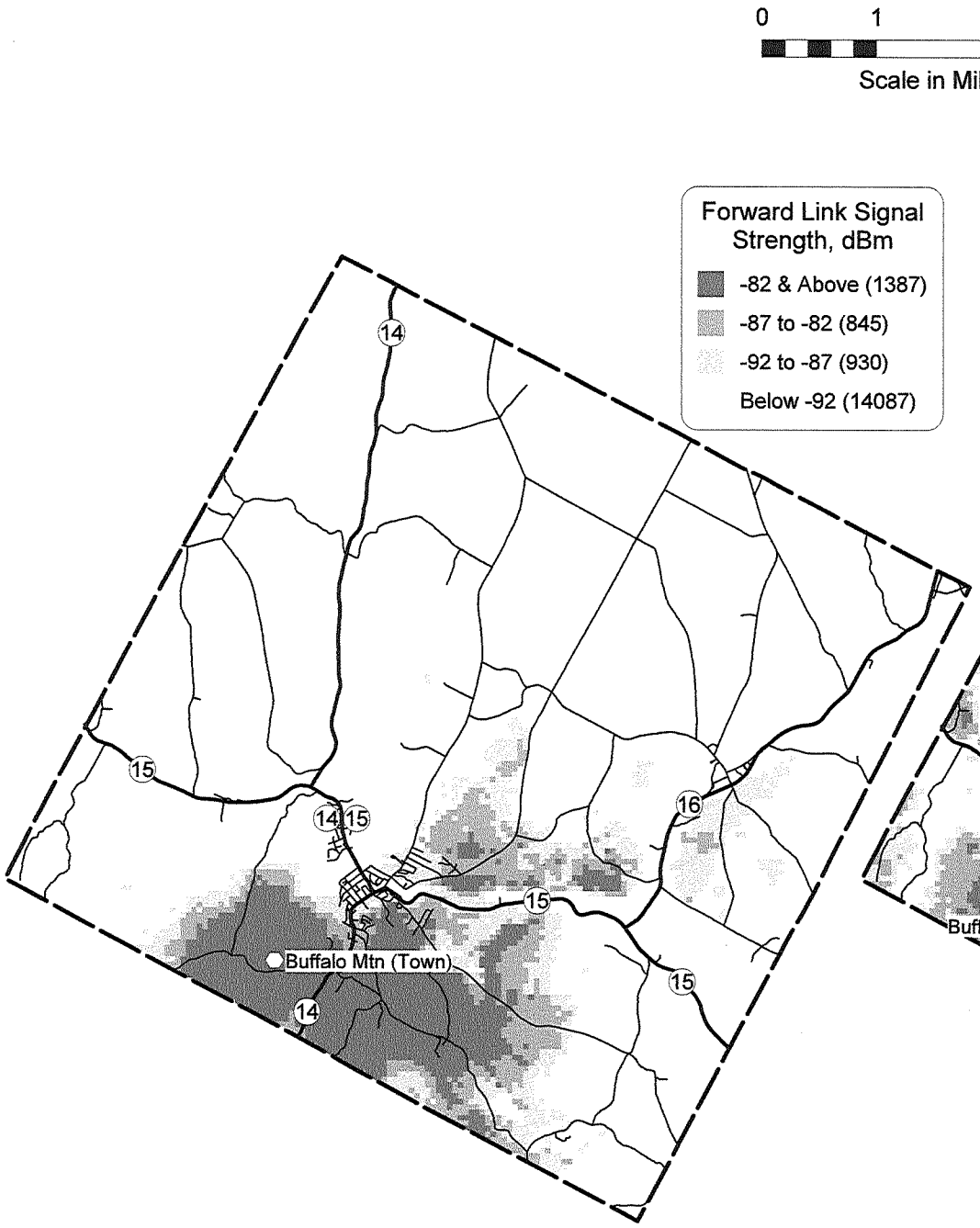

FIGURE 5 - Buffalo Mtn: Town @ 97' C/L - PCS

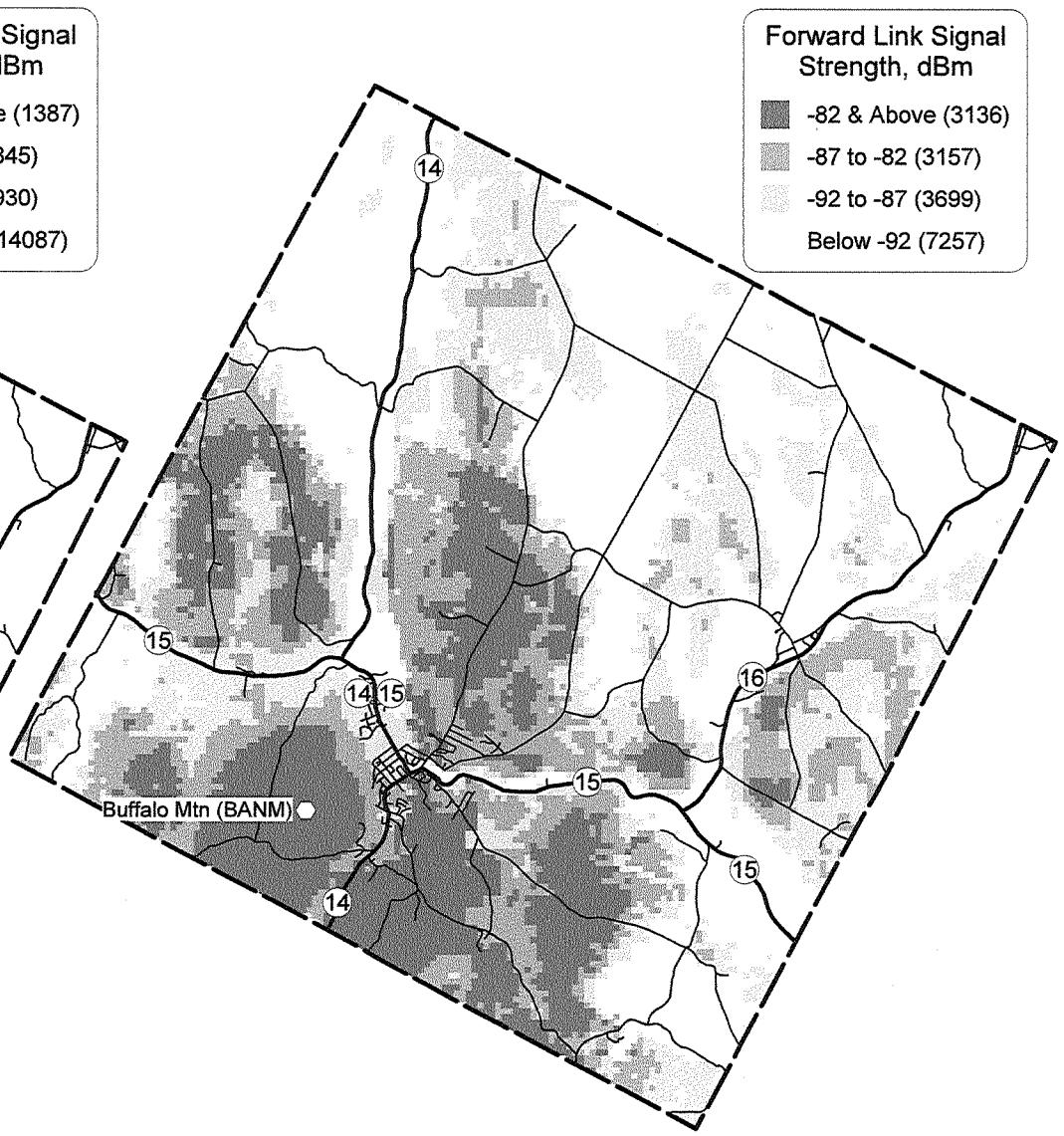

FIGURE 6 - Buffalo Mtn: BANM @ 97' C/L - PCS

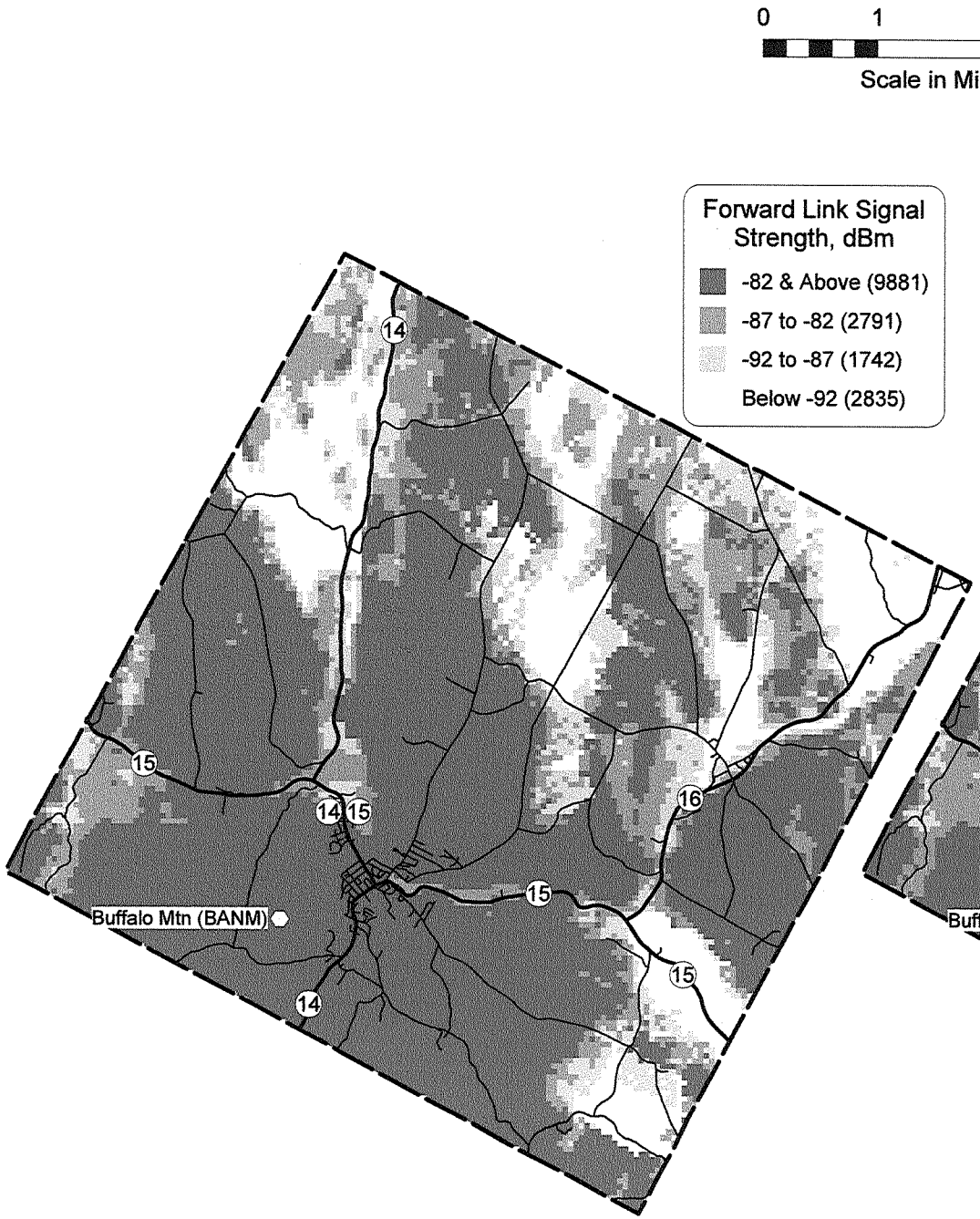

FIGURE 7 - Buffalo Mtn: BANM @ 97' C/L - Cellular

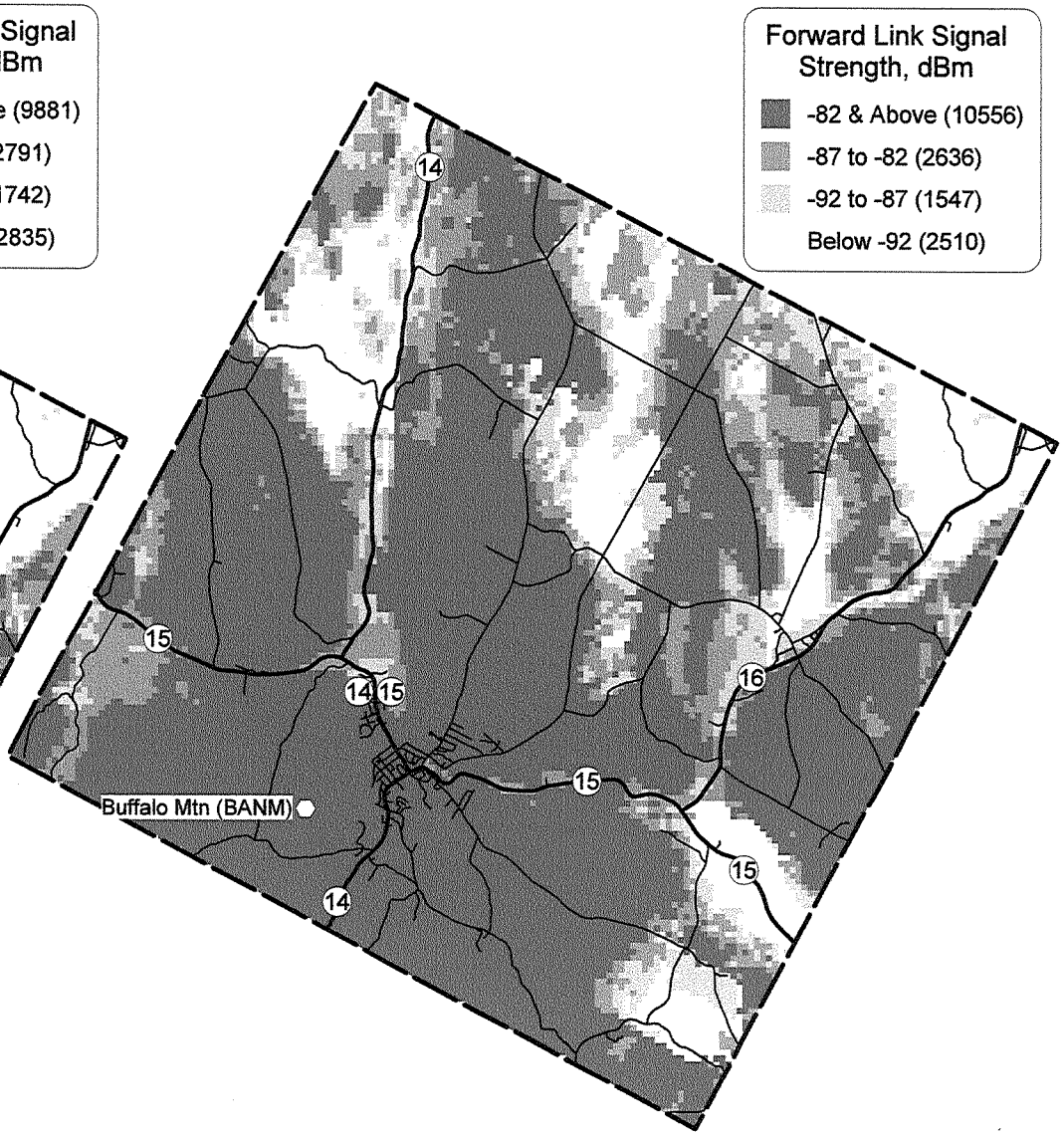

FIGURE 8 - Buffalo Mtn: BANM @ 147' C/L - Cellular

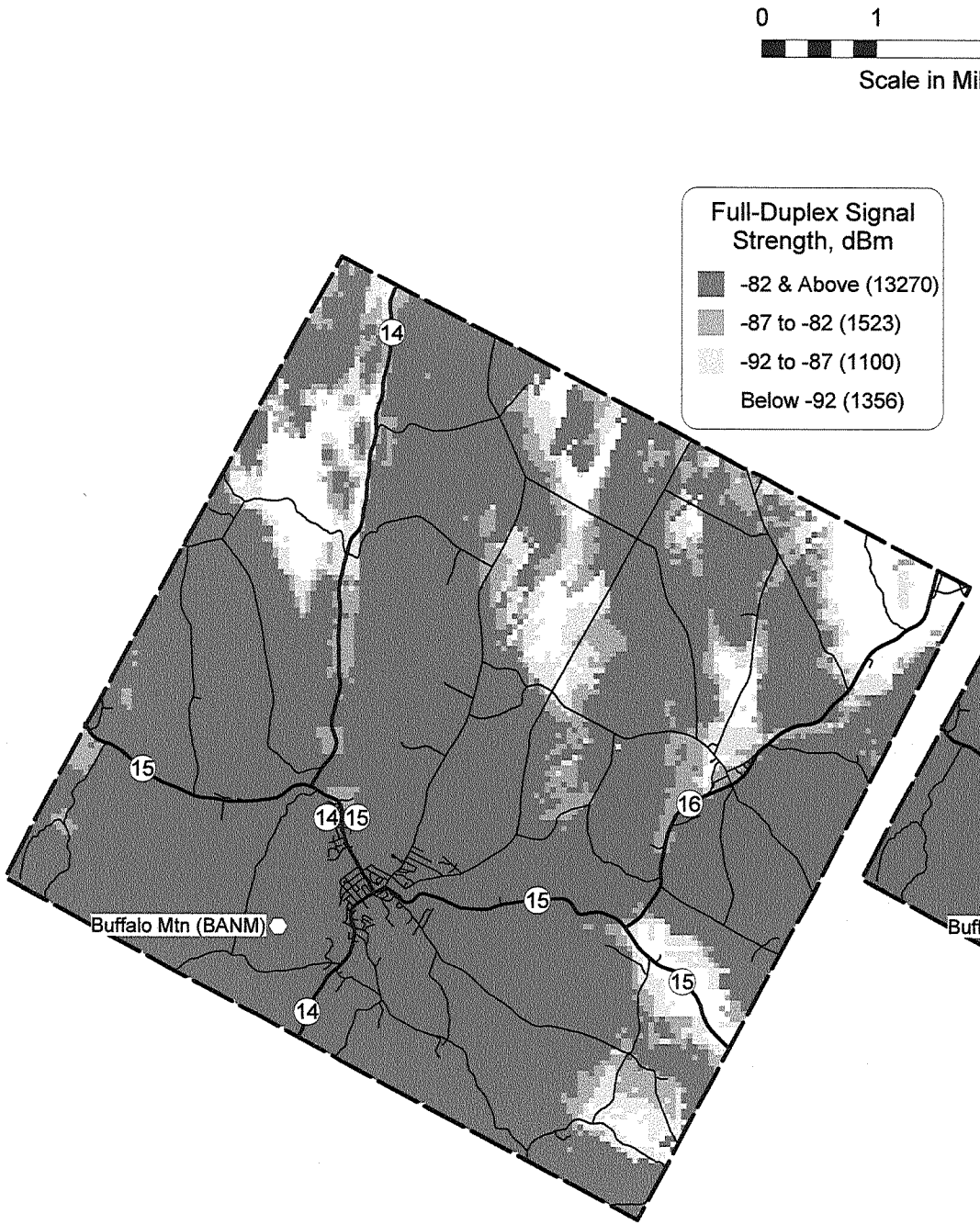

FIGURE 9 - Buffalo Mtn: BANM @ 97' C/L - UHF

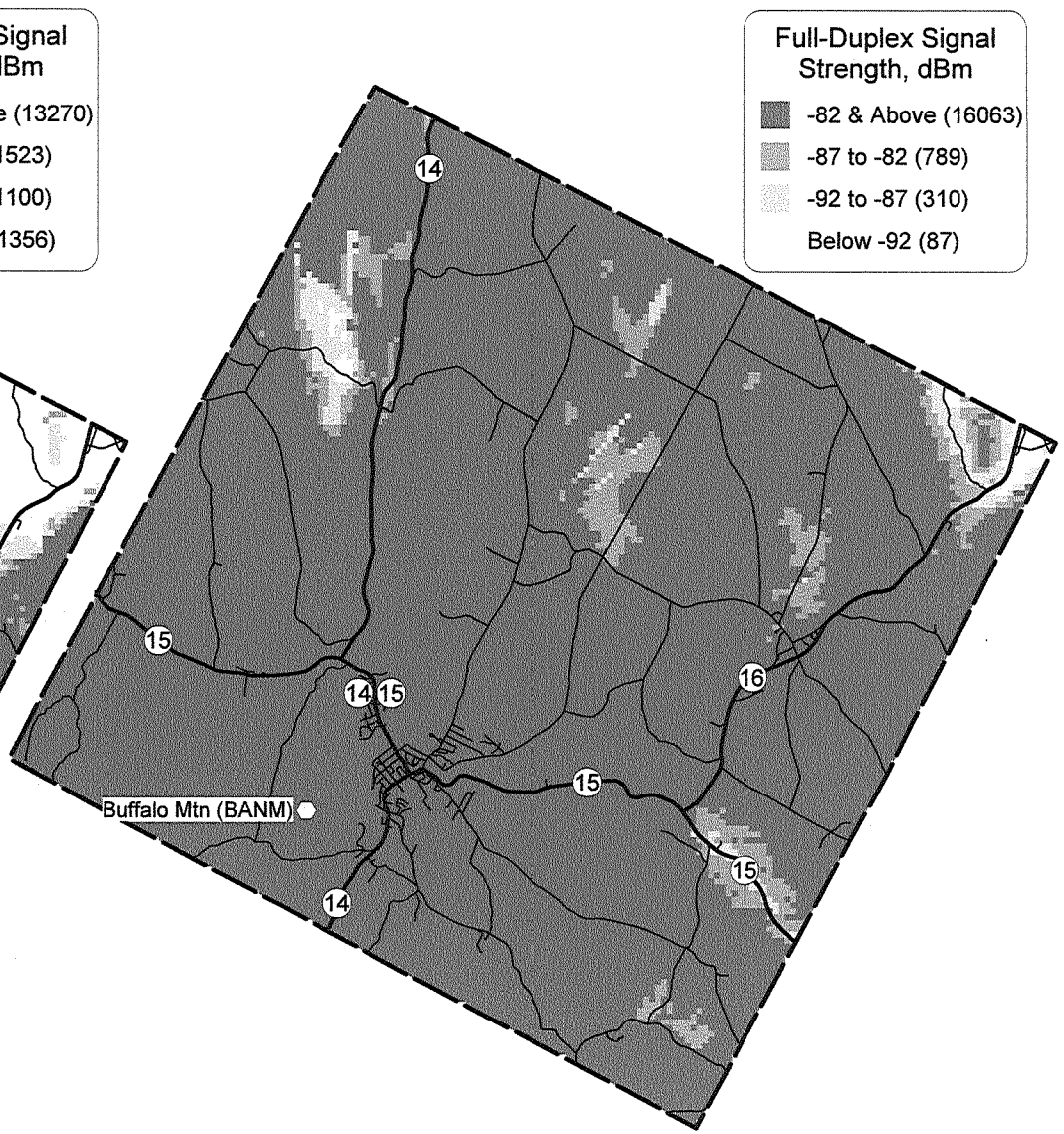

FIGURE 10 - Buffalo Mtn: BANM @ 97' C/L - VHF

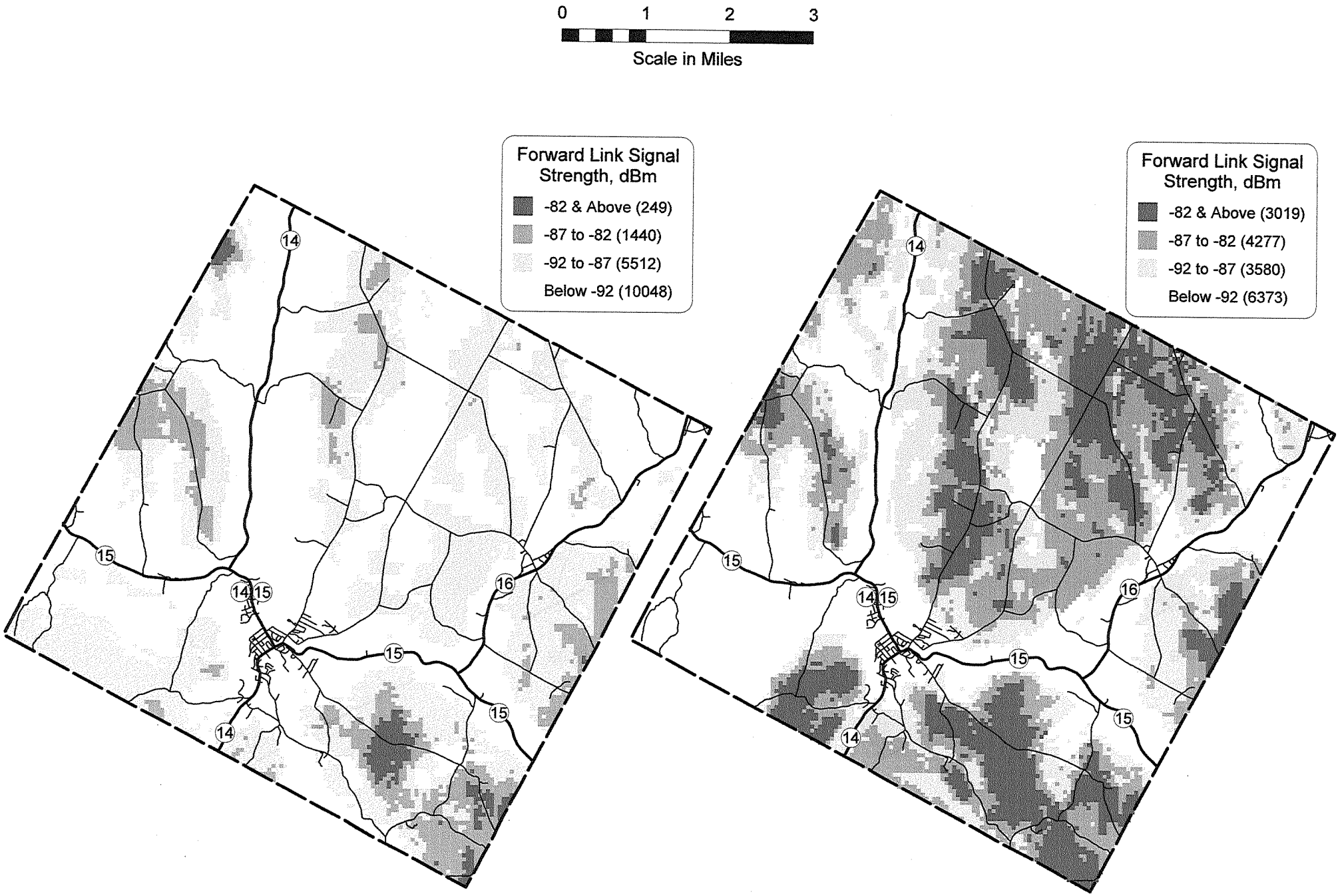

FIGURE 11 - Woodbury Mtn @ 97' C/L - Cellular

FIGURE 12 - Round Knoll @ 97' C/L - Cellular

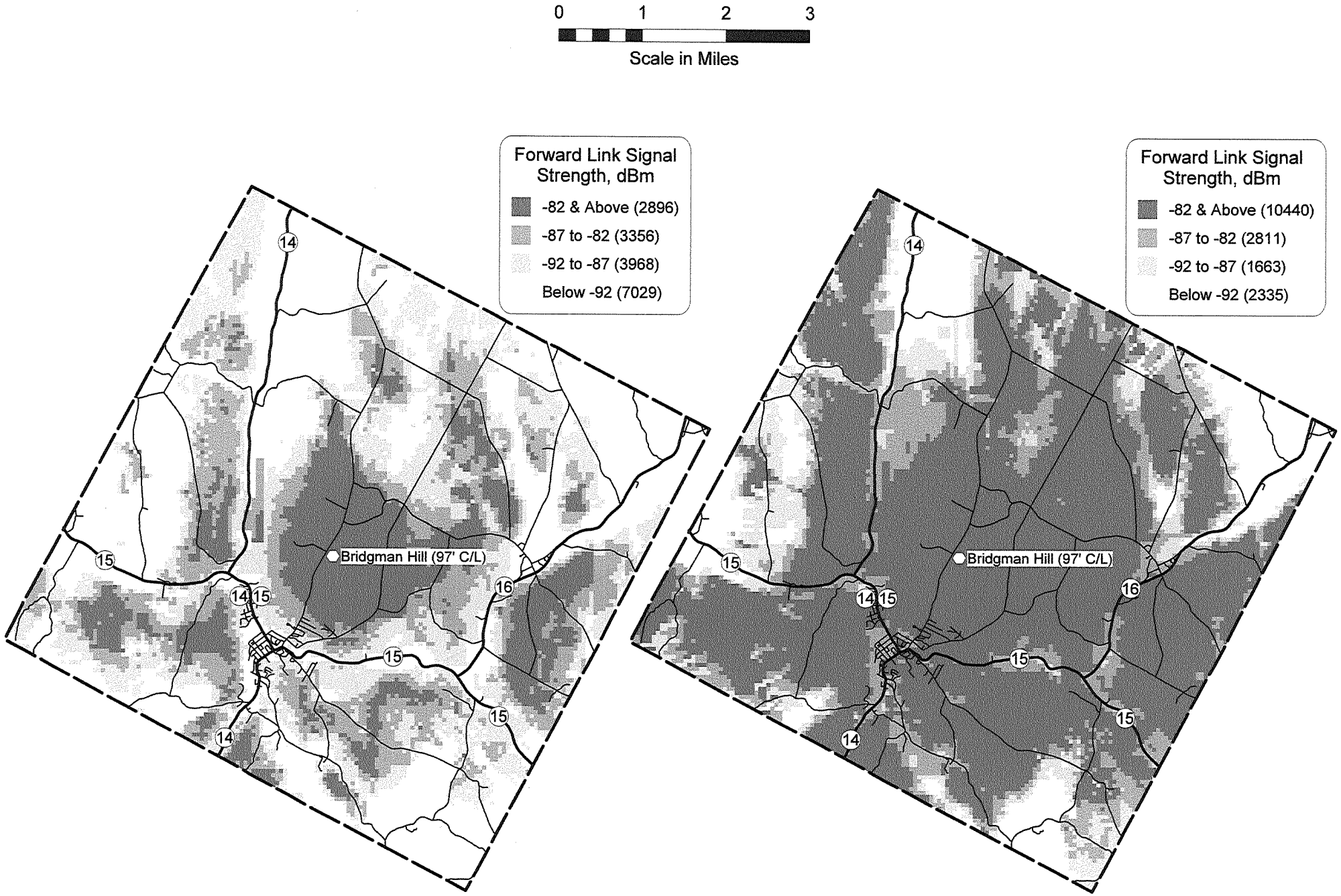

FIGURE 13 - Bridgman Hill @ 97' C/L - PCS

FIGURE 14 - Bridgman Hill @ 97' C/L - Cellular

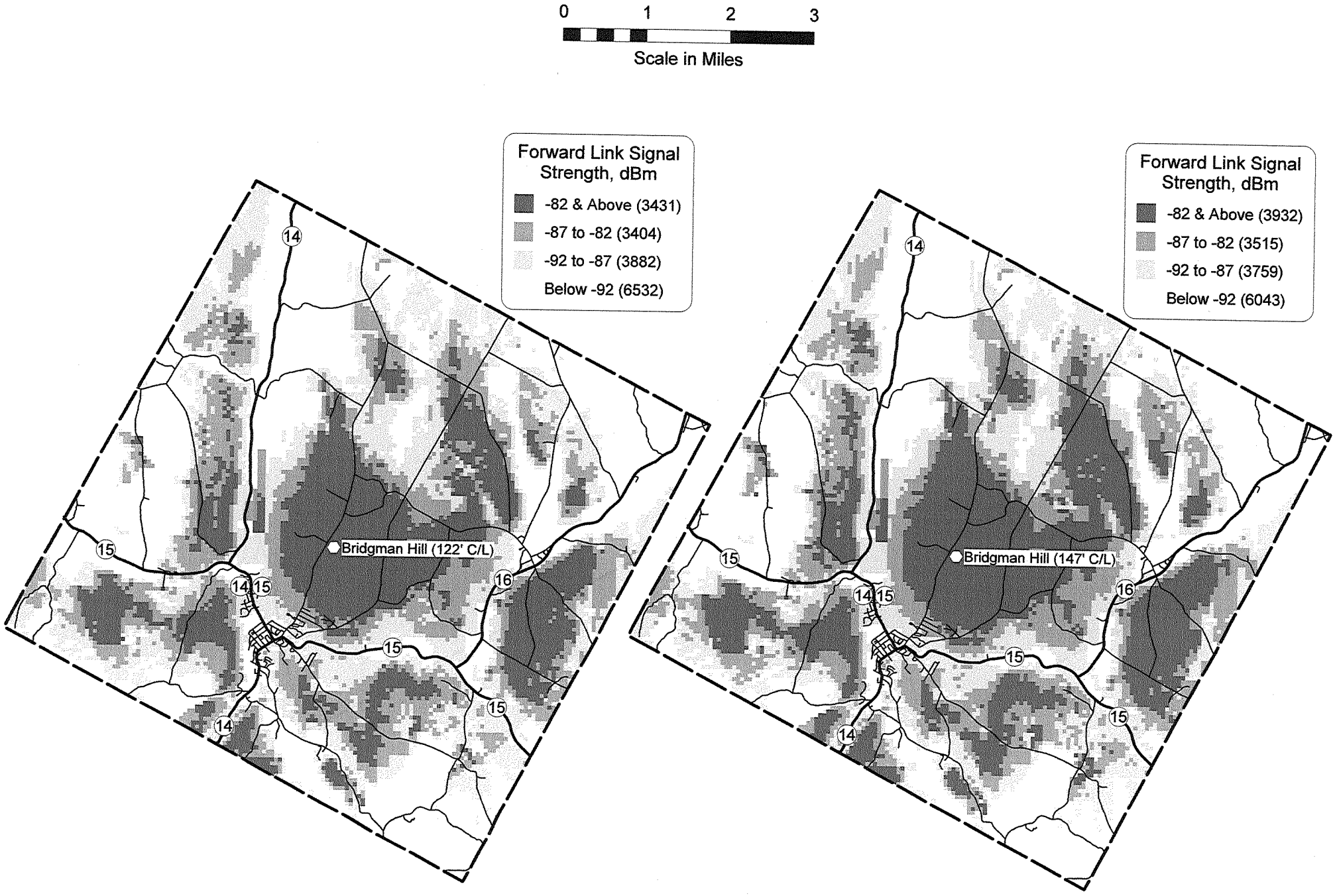

FIGURE 15 - Bridgman Hill @ 122' C/L - PCS

FIGURE 16 - Bridgman Hill @ 147' C/L - PCS

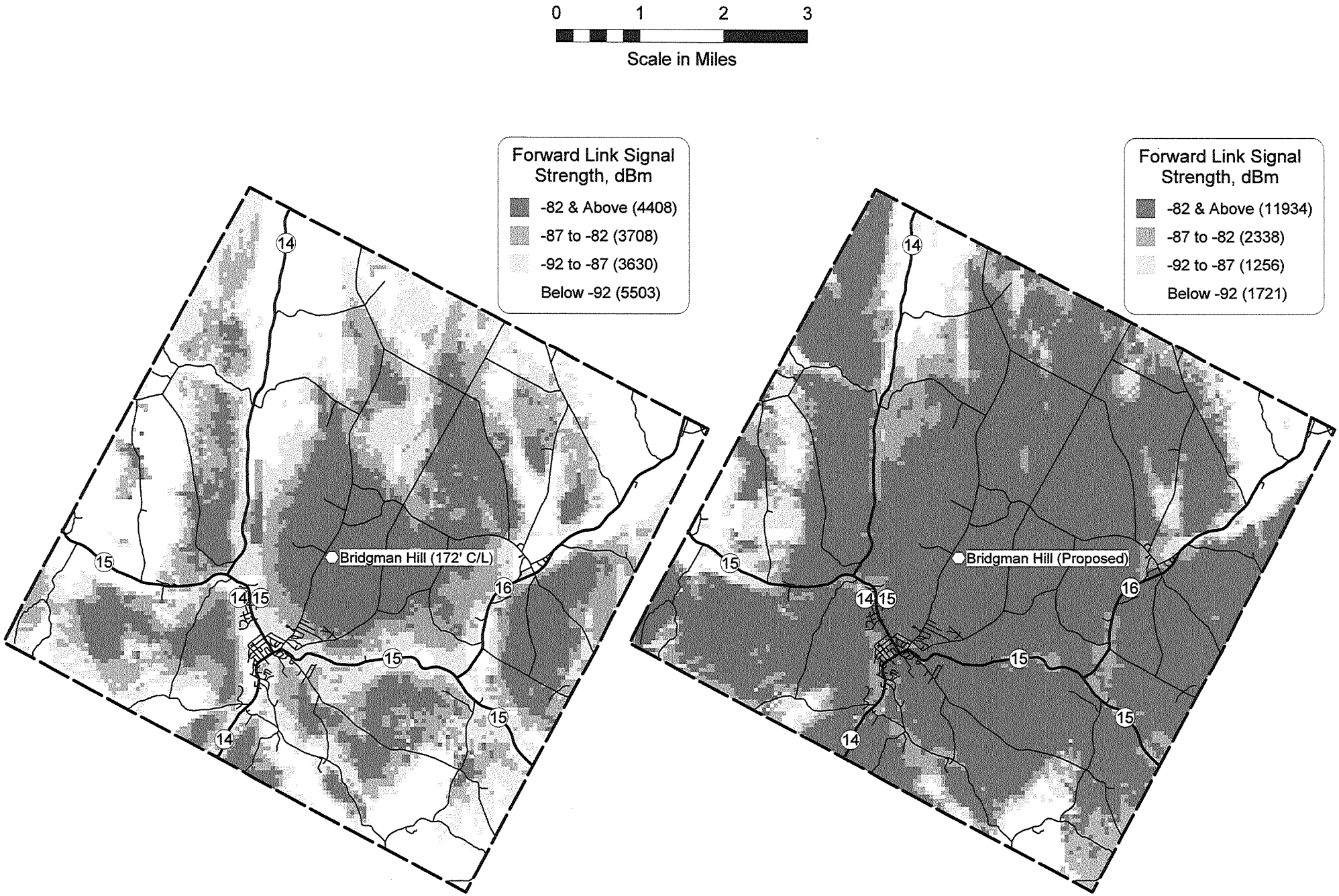

FIGURE 17 - Bridgman Hill @ 172' C/L - PCS

FIGURE 18 - Bridgman Hill @ 172' C/L - Cellular

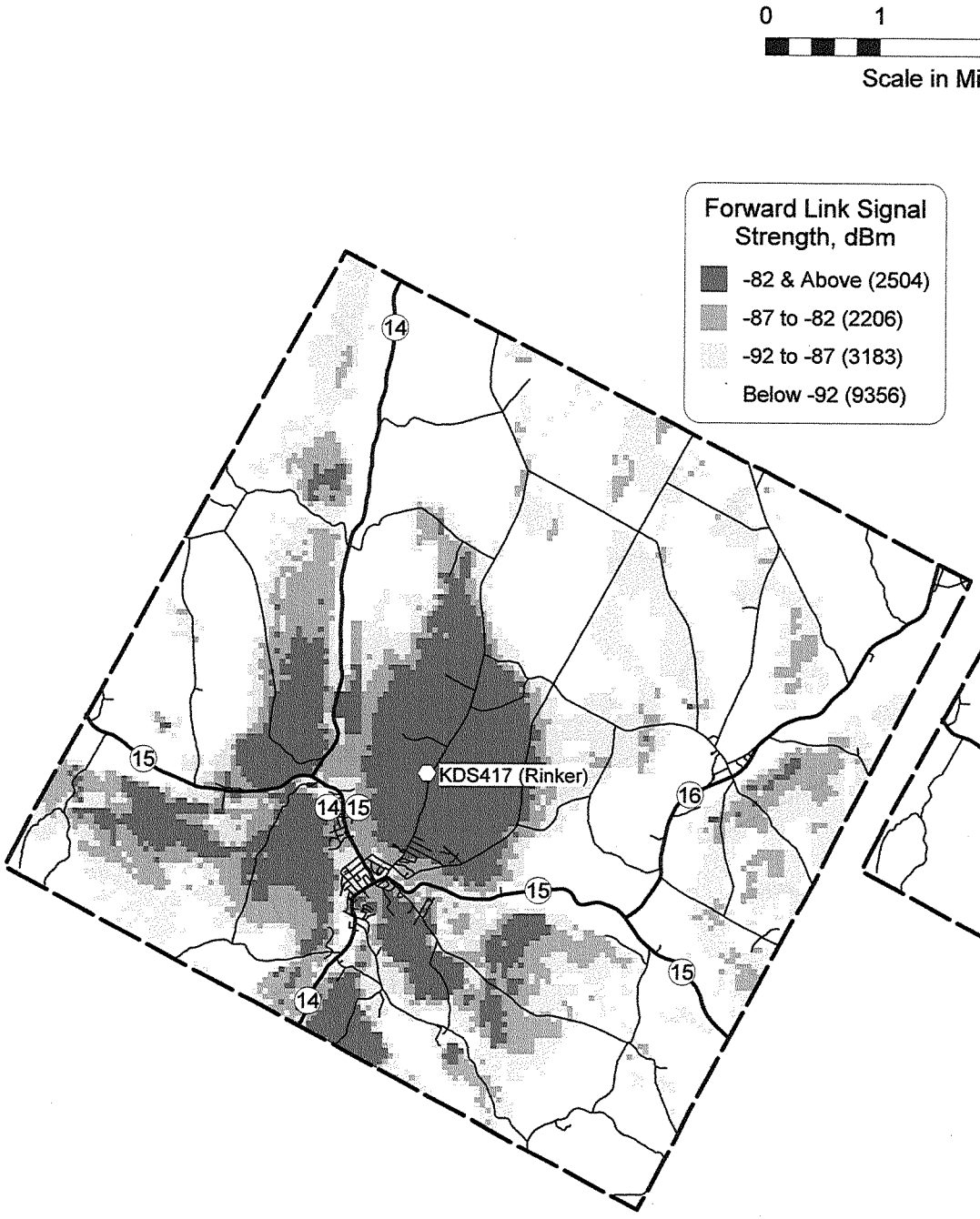

FIGURE 19 - KDS417 (Existing Rinker) @ 97' C/L - PCS

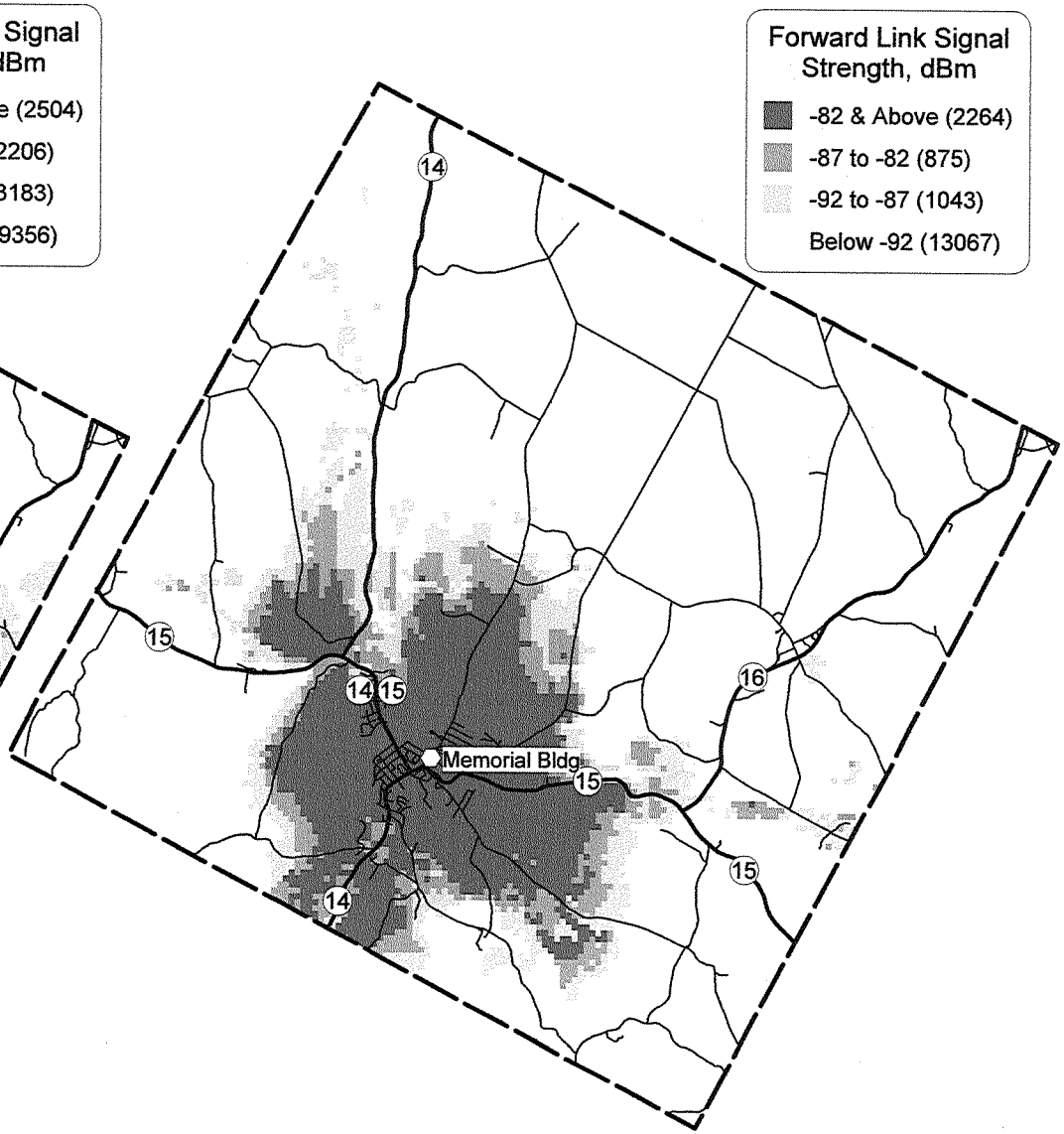

FIGURE 20 - Memorial Building @ 72' C/L - PCS

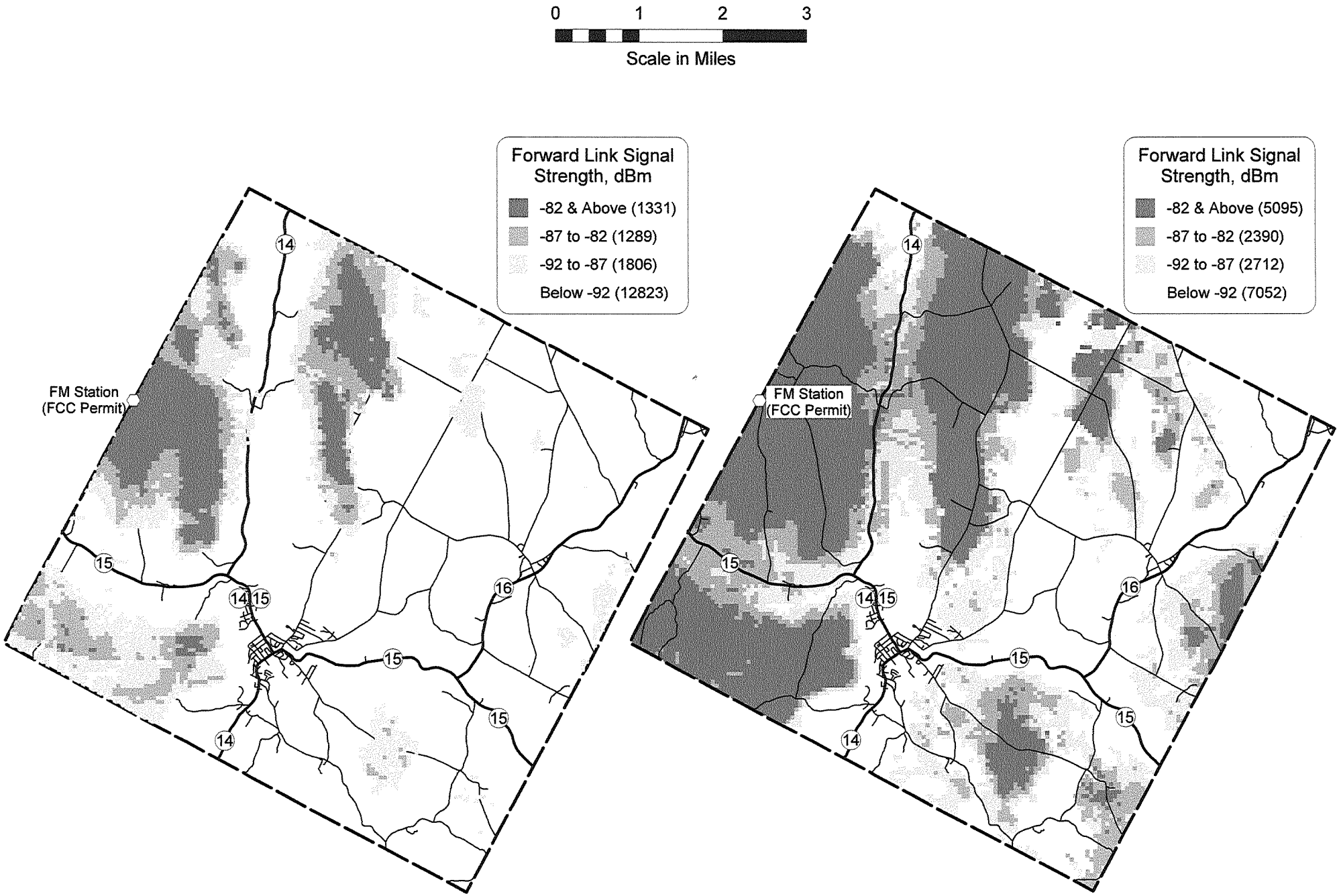

FIGURE 21 - FM Site @ 97' C/L - PCS

FIGURE 22 - FM Site @ 172' C/L - Cellular

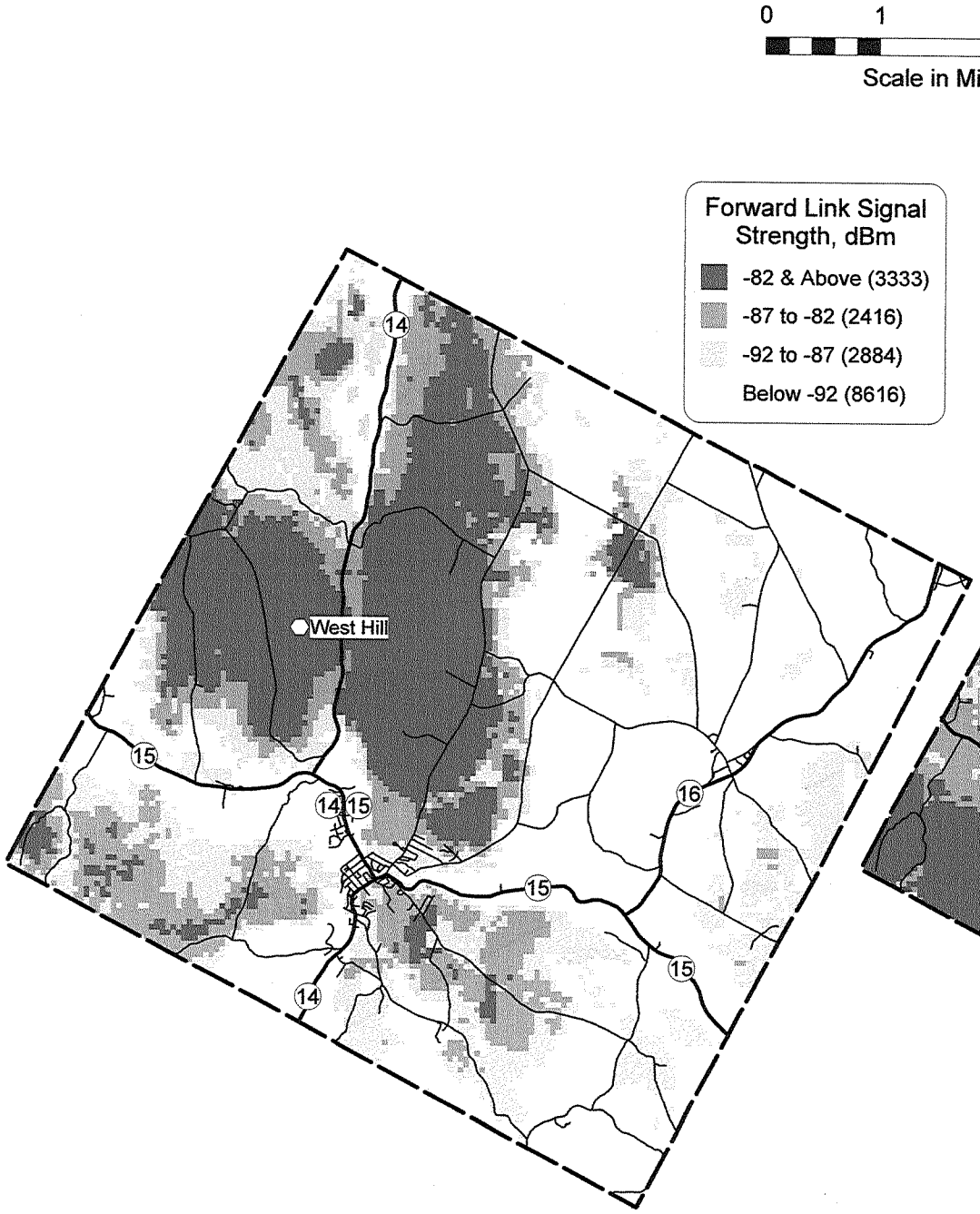

FIGURE 23 - West Hill @ 97' C/L - PCS

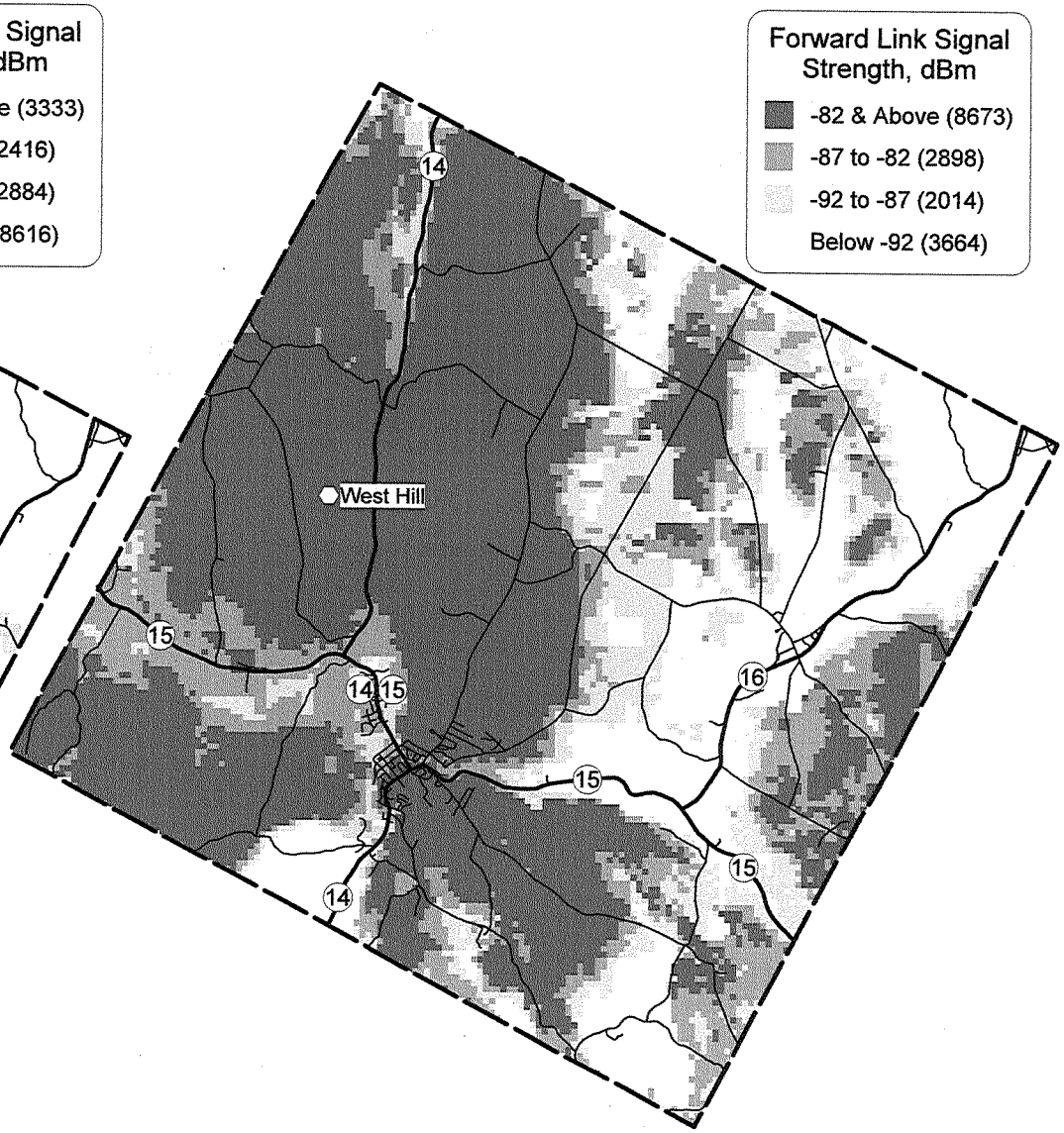

FIGURE 24 - West Hill @ 97' C/L - Cellular

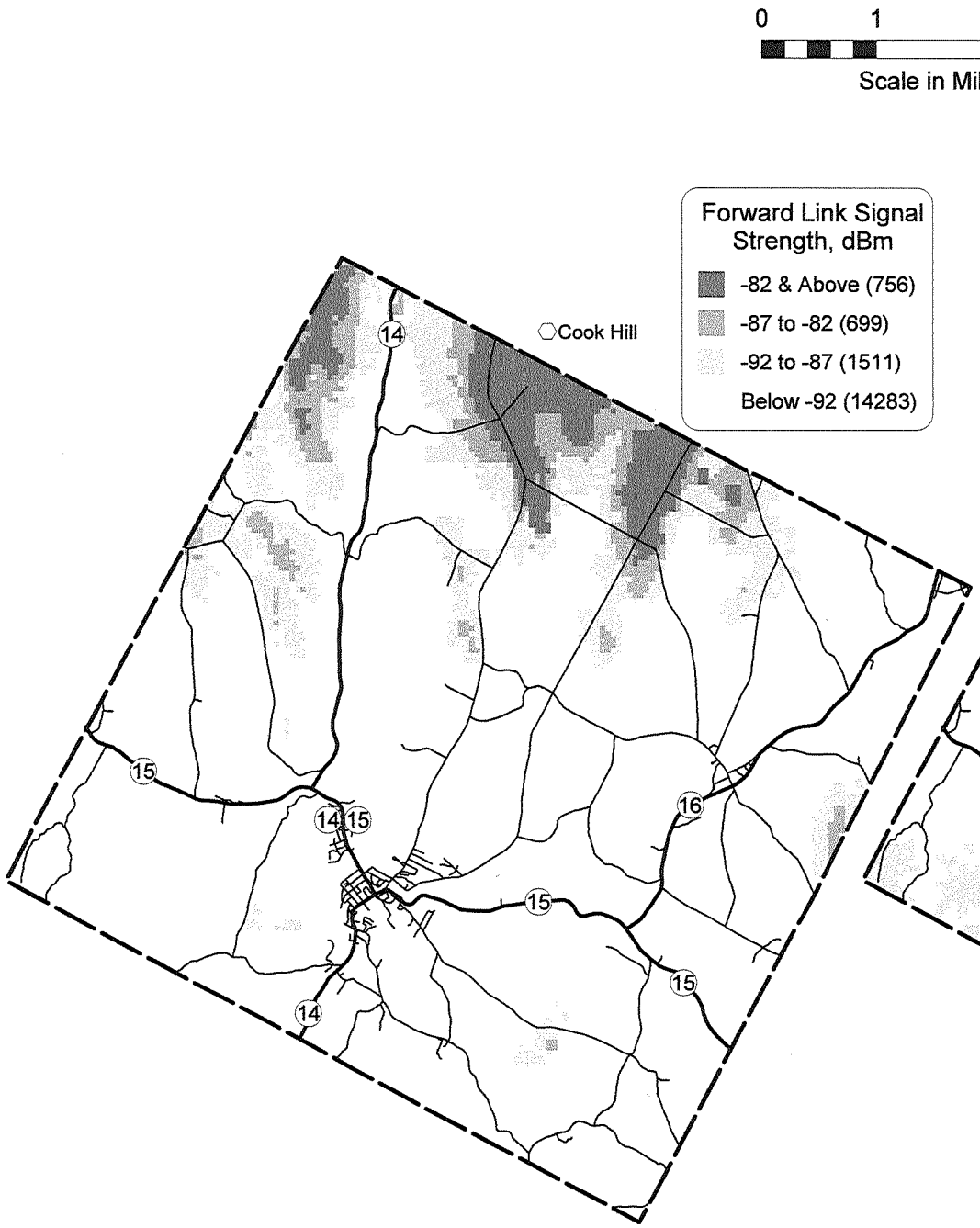

FIGURE 25 - Cook Hill @ 97' C/L - PCS

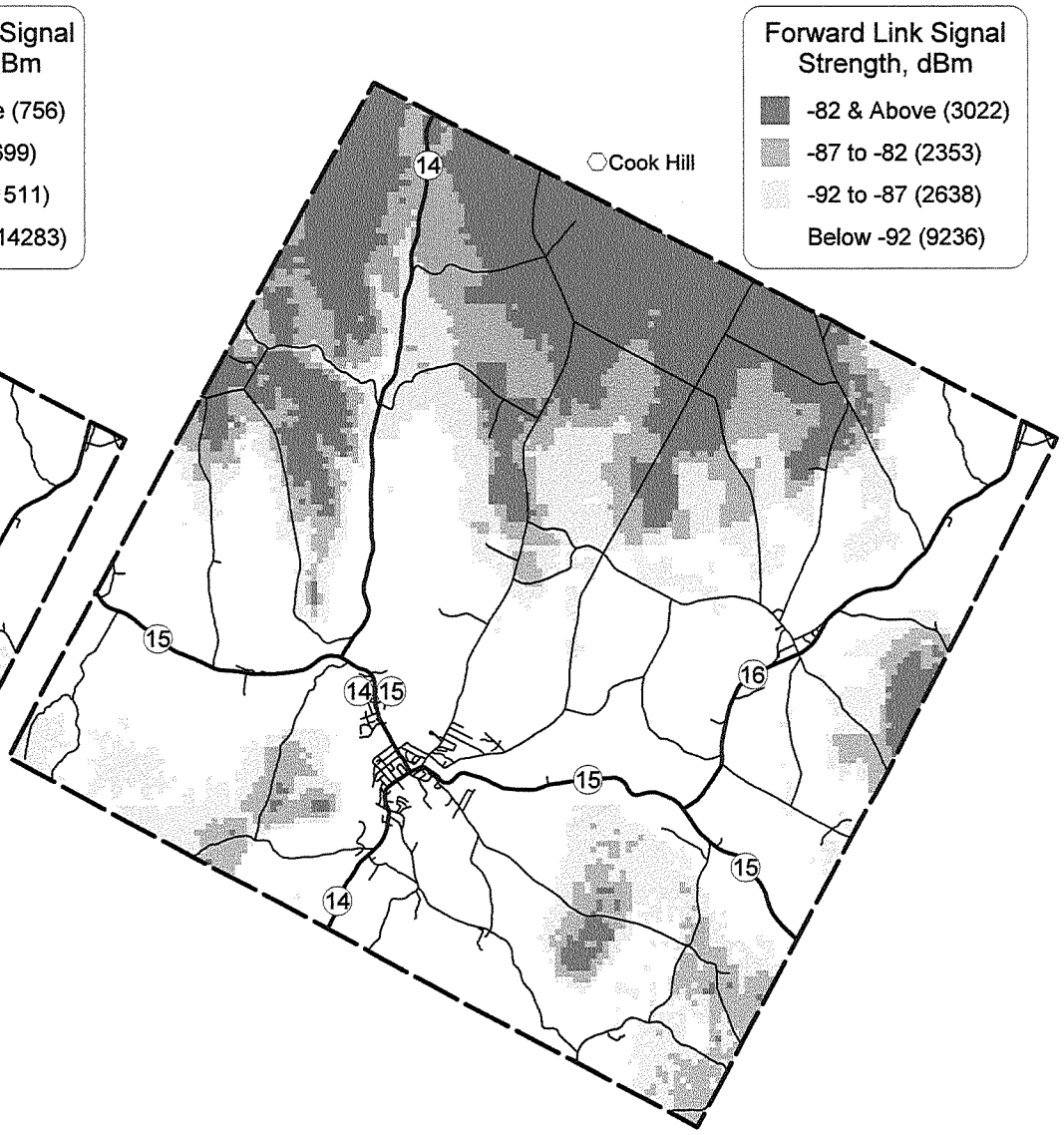

FIGURE 26 - Cook Hill @ 97' C/L - Cellular

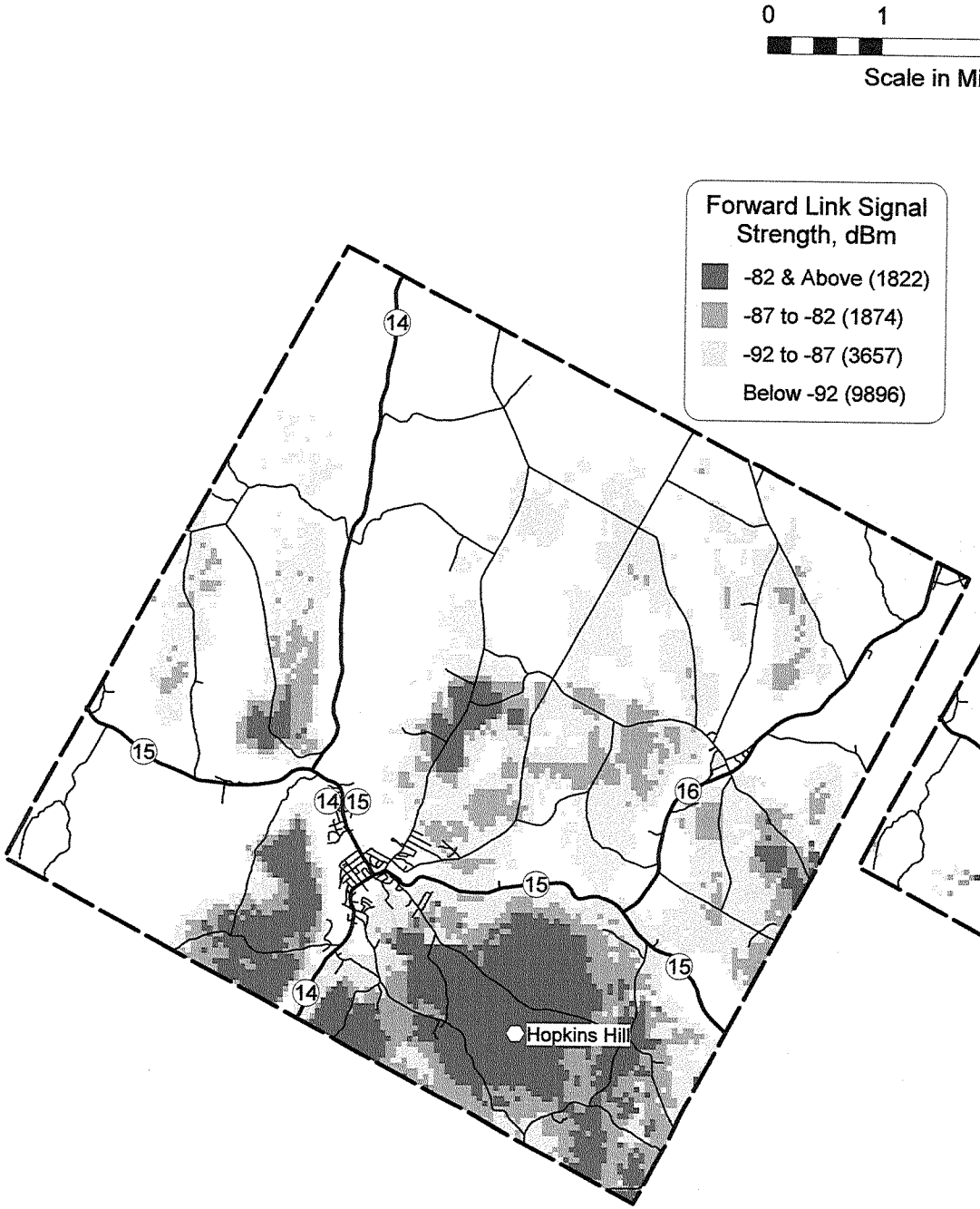

FIGURE 27 - Hopkins Hill @ 97' C/L - PCS

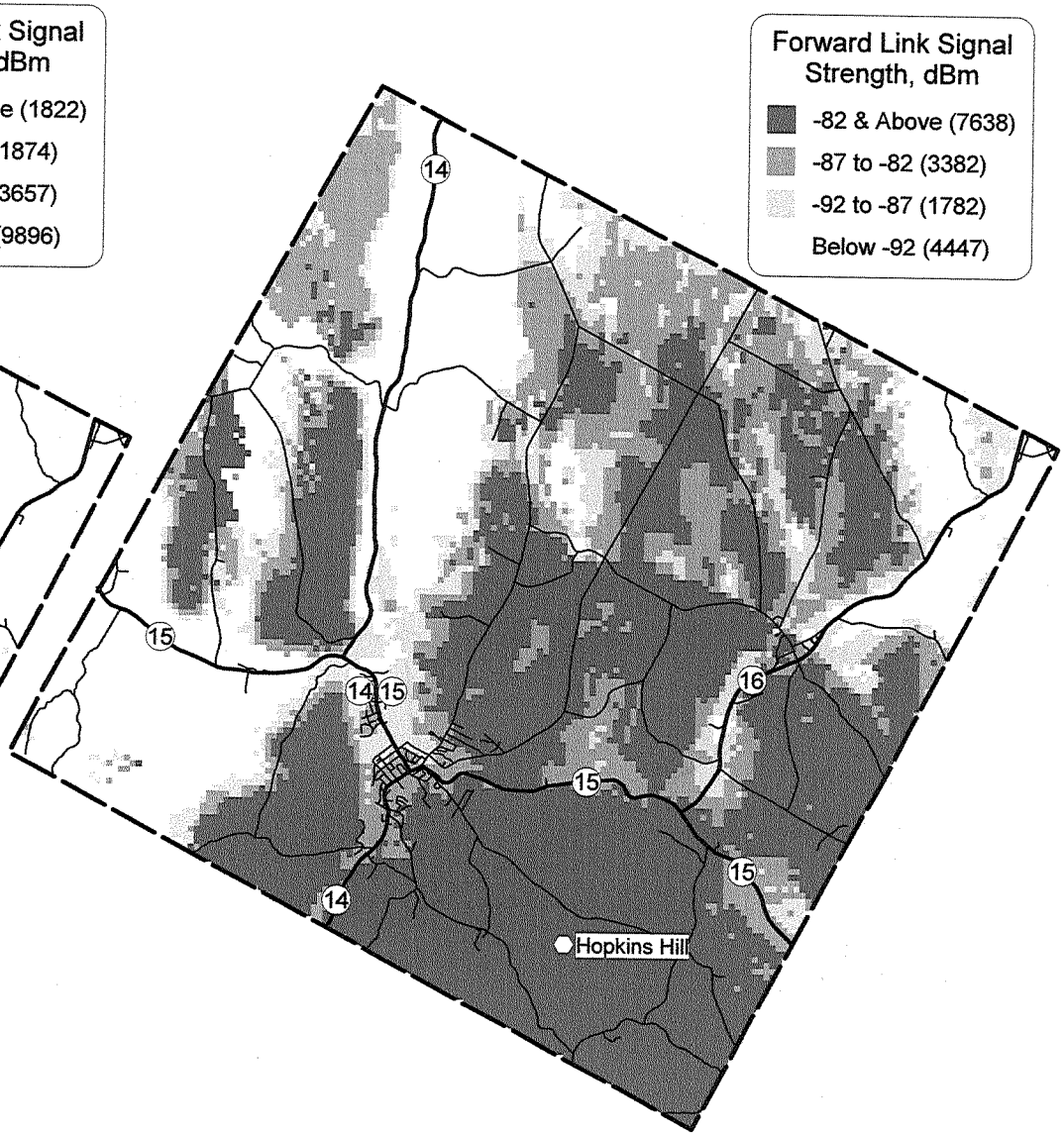

FIGURE 28 - Hopkins Hill @ 97' C/L - Cellular

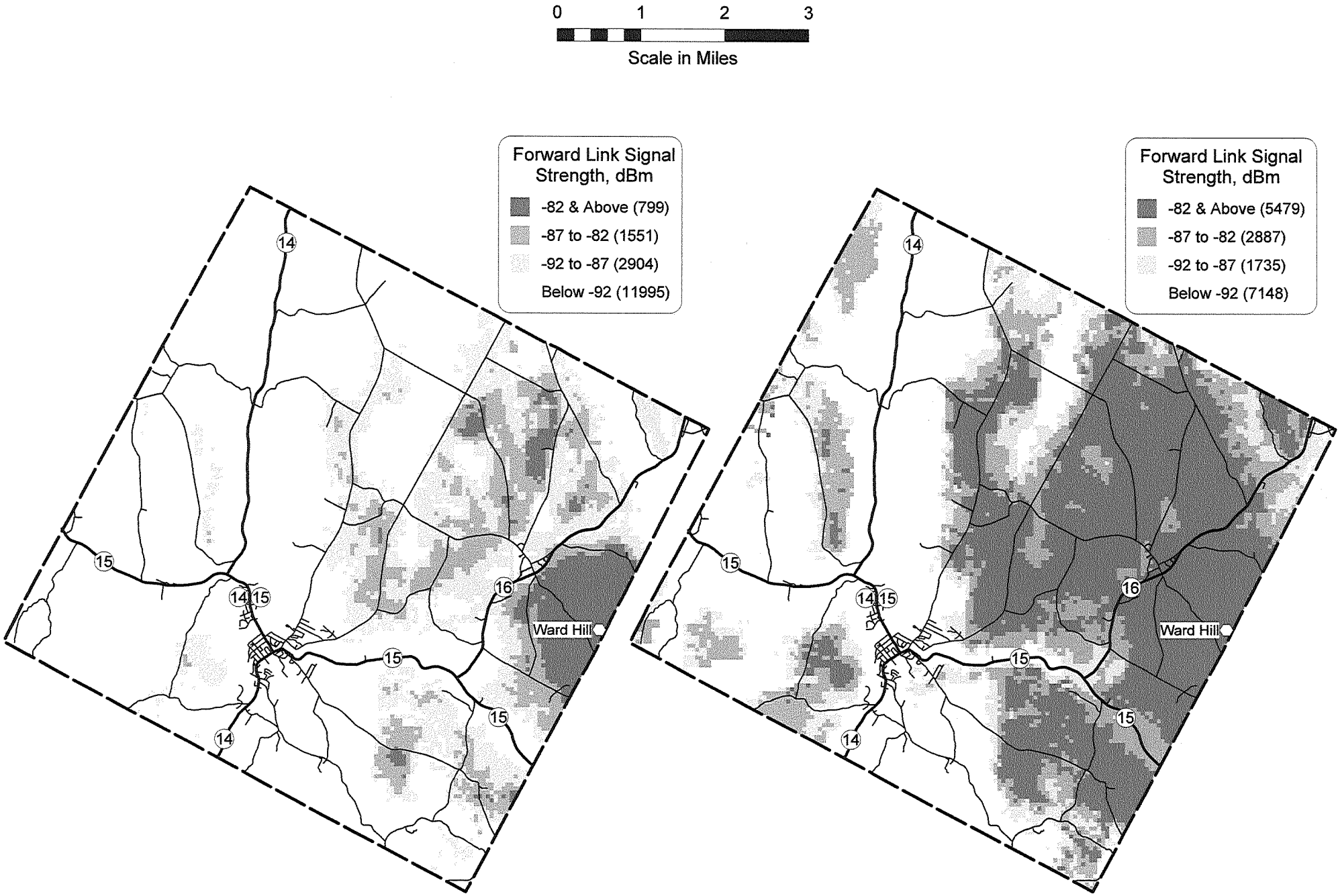

FIGURE 29 - Ward Hill @ 97' C/L - PCS

FIGURE 30 - Ward Hill @ 97' C/L - Cellular

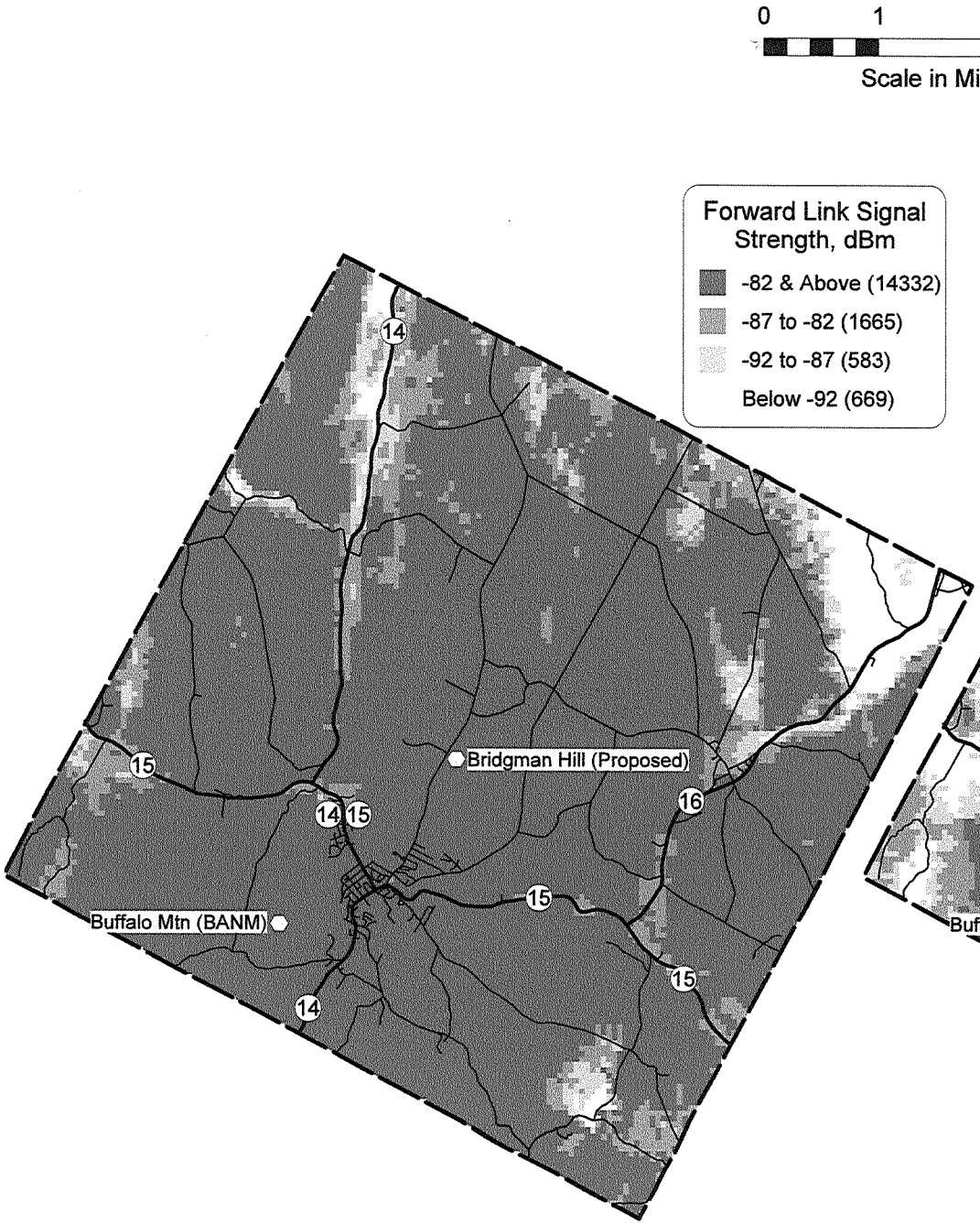

FIGURE 31 - Aggregate Cellular: Bridgman Hill @ 172' C/L & Buffalo Mtn (BANM) @ 147' C/L

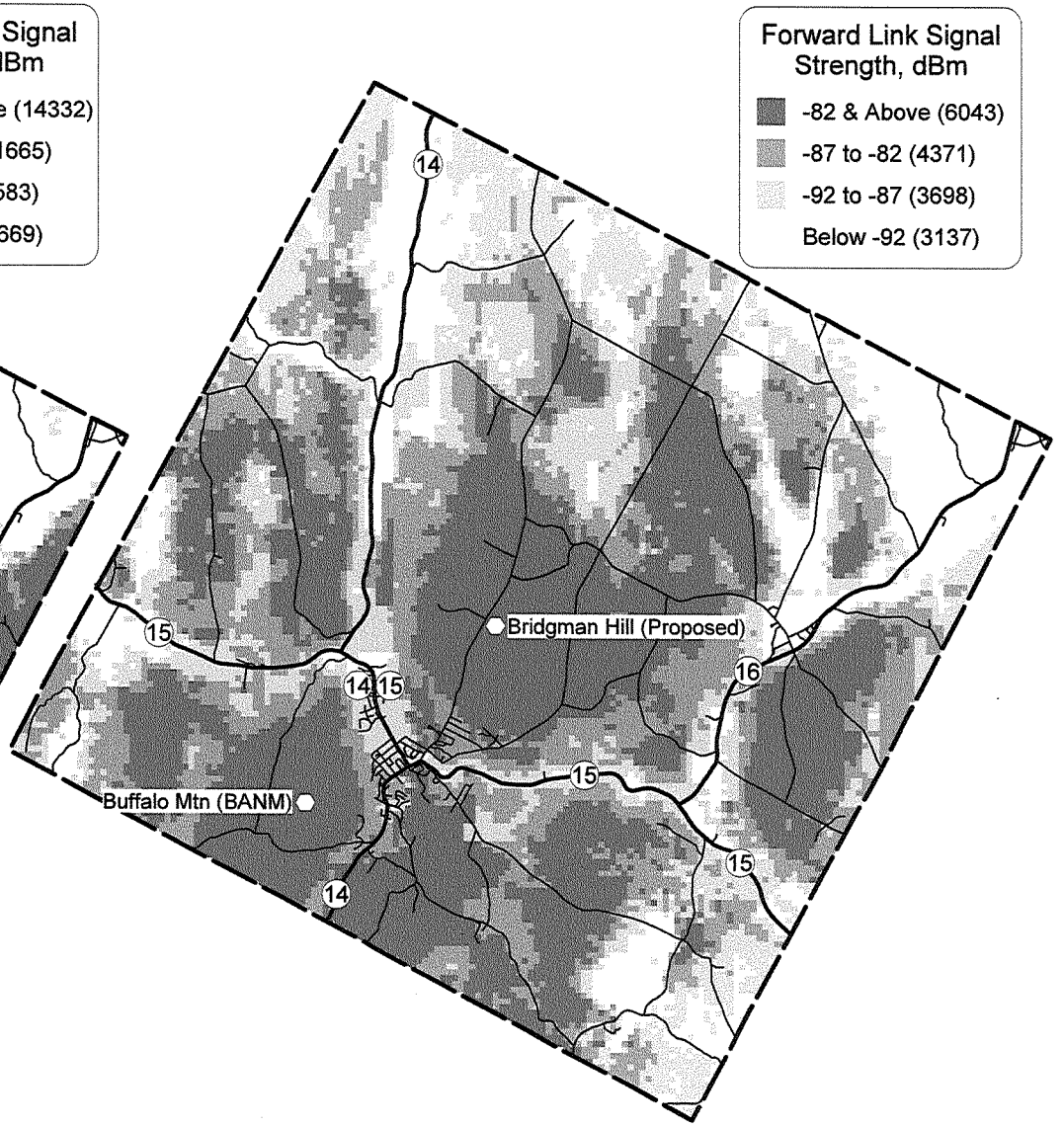

FIGURE 32 - Aggregate PCS: Bridgman Hill @ 172' C/L & Buffalo Mtn (BANM) @ 97' C/L

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Table 1 – Antenna Locations & Coverage Results

Facility Location	Antenna C/L*	Percentage Adequate**	-92 to -87dBm (Adequate)***	-87 to -82dBm (Good)***	-82dBm & Over (Better)***
Buffalo Mtn: Davis - PCS	97	49.0	2706	1970	3791
Buffalo Mtn: Davis - cellular	97	76.6	2074	2519	8614
Buffalo Mtn: Town - PCS	97	18.3	930	845	1387
Buffalo Mtn: BANM - PCS	97	57.9	3699	3157	3136
Buffalo Mtn: BANM - cellular	97	83.6	1742	2791	9881
Buffalo Mtn: BANM - cellular	147	85.4	1547	2636	10556
Buffalo Mtn: BANM - UHF	97	92.1	1100	1523	13270
Buffalo Mtn: BANM - VHF	97	99.5	310	789	16063
Woodbury Mtn. - cellular	97	41.7	5512	1440	249
Round Knoll - cellular	97	63.1	3580	4277	3019
Bridgman Hill - PCS	97	59.2	3968	3356	2896
Bridgman Hill - cellular	97	86.5	1663	2811	10440
Bridgman Hill - PCS	122	62.1	3882	3404	3431
Bridgman Hill - PCS	147	65.0	3759	3515	3932
Bridgman Hill - PCS	172	68.1	3630	3708	4408
Bridgman Hill - cellular	172	90.0	1256	2338	11934
KDS417 (existing Rinker) - PCS	97	45.8	3183	2206	2504
Memorial Building - PCS	72	24.2	1043	875	2264
Proposed FM site - PCS	97	25.7	1806	1289	1331
Proposed FM site - PCS	172	59.1	2712	2390	5095
West Hill - PCS	97	50.0	2884	2416	3333
West Hill - cellular	97	78.8	2014	2898	8673
Cook Hill - PCS	97	17.2	1511	699	756
Cook Hill - cellular	97	46.5	2638	2353	3022
Hopkins Hill - PCS	97	42.6	3657	1874	1822
Hopkins Hill - cellular	97	74.2	1782	3382	7638
Ward Hill - PCS	97	30.5	2904	1551	799
Ward Hill - cellular	97	58.6	1735	2887	5479
Aggregate cellular: BANM / Bridgman	147 / 172	96.1	583	1665	14332
Aggregate PCS: BANM / Bridgman	97 / 172	81.8	3698	4371	6043

*Antenna Center Line (height above ground level, feet)

**Percentage of 17,249 calculation points (identical point locations for each propagation study) meeting at least -92dBm threshold.

***Number of calculation points that meet the indicated signal strength threshold.

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APPENDIX 1

Section 704 of Telecommunications Act of 1996: Text from 47 U.S.C. § 332(c)(7)

(7) PRESERVATION OF LOCAL ZONING AUTHORITY.

(A) GENERAL AUTHORITY. Except as provided in this paragraph, nothing in this Act shall limit or affect the authority of a State or local government or instrumentality thereof over decisions regarding the placement, construction, and modification of personal wireless service facilities.

(B) LIMITATIONS

(i) The regulation of the placement, construction, and modification of personal wireless service facilities by any State or local government or instrumentality thereof

(I) shall not unreasonably discriminate among providers of functionally equivalent services; and

(II) shall not prohibit or have the effect of prohibiting the provision of personal wireless services.

(ii) A State or local government or instrumentality thereof shall act on any request for authorization to place, construct, or modify personal wireless service facilities within a reasonable period of time after the request is duly filed with such government or instrumentality, taking into account the nature and scope of such request.

(iii) Any decision by a State or local government or instrumentality thereof to deny a request to place, construct, or modify personal wireless service facilities shall be in writing and supported by substantial evidence contained in a written record.

(iv) No State or local government or instrumentality thereof may regulate the placement, construction, and modification of personal wireless service facilities on the basis of the environmental effects of radio frequency emissions to the extent that such facilities comply with the Commission's regulations concerning such emissions.

(v) Any person adversely affected by any final action or failure to act by a State or local government or any instrumentality thereof that is inconsistent with this subparagraph may, within 30 days after such action or failure to act, commence an action in any court of competent jurisdiction. The court shall hear and decide such action on an expedited basis. Any person adversely affected by an act or failure to act by a State or local government or any instrumentality thereof that is inconsistent with clause (iv) may petition the Commission for relief.

(C) DEFINITIONS.-- For purposes of this paragraph

(i) the term "personal wireless services" means commercial mobile services, unlicensed wireless services, and common carrier wireless exchange access services;

(ii) the term "personal wireless service facilities" means facilities for the provision of personal wireless services; and

(iii) the term "unlicensed wireless service" means the offering of telecommunications services using duly authorized devices which do not require individual licenses, but does not mean the provision of direct-to-home satellite services (as defined in section 303(v)).

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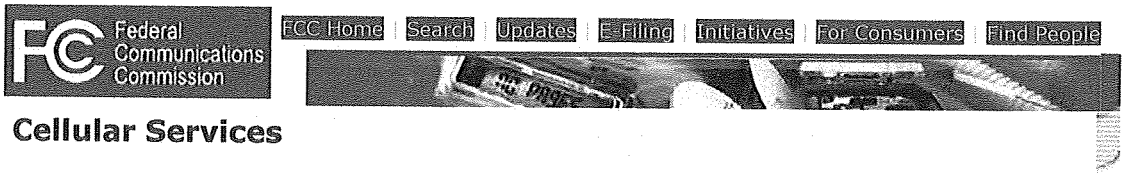

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Filing a Complaint

Spectrum Cap

ULS
Universal Licensing System

Operations

A cellular radiotelephone system is an automated, high-capacity system of one or more multichannel base stations designed to provide radio telecommunications services to users over a wide area in a spectrally efficient manner. A cellular system operates by dividing a large geographical service area into cells and assigning the same channels to multiple, nonadjacent cells. This allows channels to be reused, increasing spectrum efficiency. As a subscriber travels across the service area the call is transferred (handed-off) from one cell to another without noticeable interruption.

All the cells in a cellular system are connected to a Mobile Telephone Switching Office (MTSO) by landline or microwave links. The MTSO controls the switching between the Public Switched Telephone Network (PSTN) and the cell site for all wireline-to-mobile and mobile-to-wireline calls. The MTSO also processes mobile unit status data received from the cell-site controllers, switches calls to other cells, processes diagnostic information, and compiles billing statistics. Cellular systems may also employ digital techniques such as voice encoding and decoding, data compression, error correction, and time or code division multiple access in order to increase system capacity.

Each cell is served by its own radio telephone and control equipment. Each cell is allocated a set of voice channels and a control channel with adjacent cells assigned different channels to avoid interference. The control channel transmits data to and from the mobile/portable units. This control data tell the mobile/portable unit that a call is coming from the MTSO or, conversely, tells the controller that the mobile/portable unit wishes to place a call. The MTSO also uses the control channel to tell the mobile/portable unit which voice channel has been assigned to the call. The 25 MHz assigned to each cellular system presently consists of 395 voice channels and 21 control channels.

Low powered transmitters are an inherent characteristic of cellular radio systems. As a cellular system matures, the effective radiated power of the cell site transmitters is reduced so channels can be reused at closer intervals, thereby increasing subscriber capacity.

There are a number of issues related to operations using cellular spectrum. You can read more about Blocking & Jamming, Spectrum Cap, Tower Siting, and Resale.

Differences Between Broadband PCS and Cellular

Although broadband PCS licensees have generally opted to provide voice service similar to that found in the cellular service, PCS licensees have greater leeway to choose the types of technologies and services they may provide than do cellular carriers. Other than broadcast, PCS licensees may provide any mobile communications service on their assigned frequencies, and may also provide wireless fixed services on a co-primary basis with mobile operations. Although cellular licensees may also provide alternative technologies as well as wireless fixed services, cellular carriers must comply with more detailed technical and operational requirements, such as rules regarding mandatory provision of analog service, licensing, and interference criteria, that PCS licensees are not subject to.

Analog Service
The Commission's rules require that all cellular carriers provide analog service that is compatible with the Advanced Mobile Phone Service (AMPS) standard.

This requirement is scheduled to sunset in 2008. In contrast, other mobile telephony carriers are not required to provide analog service.

Licensing Differences
Cellular is not licensed in the same manner as other market-based services. Market-based licensees may operate anywhere within their entire geographic markets. In contrast, the initial cellular carriers of Metropolitan Statistical Areas (MSA) and Rural Service Areas (RSA) are only permitted to build out their markets for a five-year period (see 47 C.F.R. 22.947). At the end of this period, only areas that are actually being served are considered to be part of the provider's license area, or Cellular Geographic Service Area (CGSA) (see 47 C.F.R. 22.911). Portions of the MSA or RSA that are not served by the licensee at the end of the five-year period is considered unserved area, and is subject to licensing pursuant to the Commission's two-phase cellular unserved area licensing process, set forth in 47 C.F.R. 22.949. As long as they comply with applicable construction requirements, other market-based services licensees do not similarly lose the areas within their market that they are not serving.

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Last reviewed/updated on 11/19/2002.

For all questions relating to Cellular licensing, contact Keith Harper at (202) 418-2759. For all other Cellular issues, contact the Commercial Wireless Division at (202) 418-0620.

Federal Communications Commission
445 12th Street SW
Washington, DC 20554
More FCC Contact Information...

Phone: 1-888-CALL-FCC
(1-888-225-5322)
TTY: 1-888-TELL-FCC
(1-888-835-5322)
Fax: 202-418-0710
E-Mail: fccinfo@fcc.gov

Broadband PCS

Licensees use broadband Personal Communications Service (PCS) spectrum for a variety of mobile and fixed radio services, also called wireless services. Mobile broadband PCS services include both voice and advanced two-way data capabilities that are generally available on small, mobile multifunction devices. The Commission and other wireless industry representatives often refer to these services as "Mobile Telephone Services" and "Mobile Data Services." Many broadband PCS licensees offer these services in competition with existing cellular and SMR licensees. Examples of entities holding a significant amount of broadband PCS spectrum include AT&T Wireless and Sprint PCS. You can read more about broadband PCS including blocking & jamming and finding a service provider.

Finding a Service Provider

There are several issues to consider when searching for and selecting a mobile telephone service provider:

- Differences between cellular and broadband PCS
- Handset compatibility
- Finding a carrier in your area

Licensing

The process of broadband PCS licensing begins with spectrum auctions, after which applications are filed, final payments provided, and granted licenses are announced. Once licensed, construction requirements must be met, and various methods exist for obtaining spectrum from existing licensees and secondary markets.

- Construction Requirements
- Obtaining Spectrum

Service At A Glance

Broadband PCS

Broadband PCS is primarily used to provide a variety of services, such as digital mobile phones and wireless internet access. These services are also called mobile telephone services and mobile data services.

Established	1994
Service Rules	C.F.R., Part 24

Related Services

Cellular
Narrowband PCS

Bandplan

Band	1850-1990 MHz
Blocks	A-F, C1-C5
Block Size	10 to 30 MHz
Market Areas	MTAs, BTAs

Licensing

System	ULS

ULS Radio Service Codes

CW - PCS Broadband

Auctions

#4 - A & B Block PCS
12/5/1994-3/13/1995
Winning Bidders PN

#5 - C Block PCS
12/18/1995-5/6/1996
Winning Bidders PN

#10 - C Block PCS Reauction
7/3/1996-7/16/1996
Winning Bidders PN

#11 - D, E, & F Block PCS
8/26/1996-1/14/1997
Winning Bidders PN

#22 - C, D, E, & F Block PCS
3/23/1999-4/15/1999
Winning Bidders PN

#35 - C & F Block PCS
12/12/2000-1/26/2001
Winning Bidders PN

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Last reviewed/updated on 6/18/2002.

Appendix 2-2 FCC Information Regarding Broadband PCS

Technical Support Issues
- Call (202) 414-1250 (TTY: (202) 414-1255)
- E-mail ulscomm@fcc.gov

Licensing Support and Form Issues
- Call (888) 225-5322 and select option 2
- Call (717) 338-2888 (TTY: (202) 414-1255)
- E-mail ulshelp@fcc.gov

Inquiries Related to Broadband PCS
- Contact Melvin Spann at (202) 418-1333 or mspann@fcc.gov

Federal Communications Commission
445 12th Street SW
Washington, DC 20554
More FCC Contact Information...

Phone: 1-888-CALL-FCC (1-888-225-5322)
TTY: 1-888-TELL-FCC (1-888-835-5322)
Fax: 1-866-418-0232
E-Mail: fccinfo@fcc.gov

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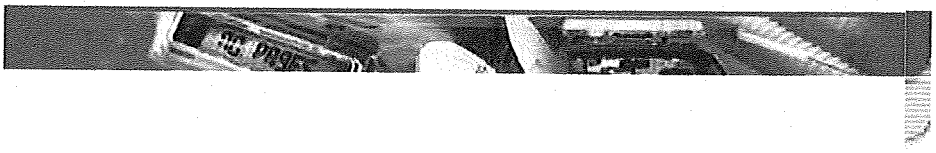
- Freedom of Information Act



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Releases

Related Sites

Auctions

Filing a Complaint

Tower Siting
Tower & Antenna Siting Issues

ULS
Universal Licensing System

Narrowband PCS

Personal Communications Service (PCS) encompasses a wide variety of mobile, portable and ancillary communications services to individuals and businesses. The Commission broadly defined PCS as mobile and fixed communications offerings that serve individuals and businesses, and can be integrated with a variety of competing networks. The spectrum allocated to PCS is divided into three major categories: (1) broadband, (2) narrowband, and (3) unlicensed.

Narrowband PCS uses a smaller portion of the spectrum than broadband PCS. Narrowband PCS licenses are used to provide such services as two-way paging and other text-based services. For example, licensees offer services using devices that come equipped with a small keyboard allowing a subscriber to both retrieve and send complete messages through microwave signals (e.g. wireless e-mail). Licensees also use the spectrum to offer wireless telemetry which is the monitoring of mobile or fixed equipment in a remote location. For example, a licensee may remotely monitor utility meters of energy companies (this is called automatic meter reading or "AMR").

Narrowband PCS operates in the 901-902 MHz, 930-931 MHz, and 940-941 MHz bands and is licensed based on nationwide, regional, and MTA market designations. The rules governing narrowband PCS are found in the Code of Federal Regulations, Volume 47, Part 24.

Service At A Glance

Narrowband PCS

Narrowband PCS licenses are used to provide such services as two-way paging and other text-based services. Licensees also use the spectrum to offer wireless telemetry which is the monitoring of mobile or fixed equipment in a remote location.

Also Known As	NPCS
Established	1993
Service Rules	CFR, Part 24

Related Services

Broadband PCS
Paging

Bandplan

Band	901-902 MHz 930-931 MHz 940-941 MHz
Channels	32
Channel Size	12.5 kHz - 150 kHz
Market Areas	Nationwide, Regional, MTAs

Licensing

System	ULS

ULS Radio Service Codes

CN - PCS Narrowband

Auctions

#1 - Nationwide Narrowband PCS
7/25/1994-7/29/1994
Winning Bidders PN

#3 - Regional Narrowband PCS
10/26/1994-11/8/1994
Winning Bidders PN

#41 - Narrowband PCS
10/3/2001-10/16/2001
Winning Bidders PN

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Last reviewed/updated on 8/21/2002.

Technical Support Issues
- Call (202) 414-1250 (TTY: (202) 414-1255)
- E-mail ulscomm@fcc.gov

Licensing Support and Form Issues
- Call (888) 225-5322 and select option 2
- Call (717) 338-2888 (TTY: (202) 414-1255)
- E-mail ulshelp@fcc.gov

Inquiries Related to Narrowband PCS
- Contact Melvin Spann at (202) 418-1333 or mspann@fcc.gov

Federal Communications Commission
445 12th Street SW
Washington, DC 20554
More FCC Contact Information...

Phone: 1-888-CALL-FCC (1-888-225-5322)
TTY: 1-888-TELL-FCC (1-888-835-5322)
Fax: 1-866-418-0232
E-Mail: fccinfo@fcc.gov

Specialized Mobile Radio Service

Search:
GO
Help - Advanced

SMRS Home

Services
900 MHz SMR
800 MHz SMR

Basic Economic Areas (BEA)
By County
By Name of BEA
By BEA Number

Related Sites

Auctions
Auctions Web Site

Rules
SMRS Rules & Regulations

Search
MTA / BTA / County Cross Reference Search

U L S
Universal Licensing System

WTB
Wireless Telecommunications Bureau

Specialized Mobile Radio Service

The Specialized Mobile Radio (SMR) service was first established by the Commission in 1979 to provide land mobile communications on a commercial (i.e., for profit) basis. A traditional SMR system consists of one or more base station transmitters, one or more antennas, and end user radio equipment that usually consists of a mobile radio unit either provided by the end user or obtained from the SMR operator for a fee. SMR end users may operate in either an "interconnected" mode or a "dispatch" mode. Interconnected mode interconnects mobile radio units with the public switched telephone network (PSTN). An end user may thus transmit a message with its mobile radio unit to the SMR base station. The call will then be routed to the local PSTN. This allows the mobile radio unit to function as a mobile telephone. Dispatch mode allows two-way, over the air, voice communications between two or more mobile units (e.g., between a car and a truck) or between mobile units and fixed units (e.g., between the end user's office and a truck). Typical SMR customers using dispatch communications include construction companies with several trucks at different jobs or on the road, with a dispatch operation in a central office.

SMR systems consist of two distinct types: conventional and trunked systems. A conventional system allows an end user the use of only one channel. If someone else is already using that end user's assigned channel, the end user must wait until the channel is available. In contrast, a trunked system combines channels and contains microprocessing capabilities that automatically search for an open channel. This search capability allows more users to be served at any one time. A majority of the current SMR systems are trunked systems.

Although SMRs are primarily used for voice communications, systems are also being developed for data and facsimile services. Additionally, the development of a digital, rather than analog, SMR marketplace is allowing new features and services, such as

SMRS Information

Services
900 MHz SMR
800 MHz SMR

Basic Economic Areas (BEA's)
By County
By Name of BEA
By BEA number

Relocation 800 MHz Licensees
Relocation Public Notice 98-2434
December 4, 1998 (pdf)

47 C.F.R. § 90.699

two-way acknowledgment paging and inventory tracking, credit card authorization, automatic vehicle location, fleet management, inventory tracking, remote database access, and voicemail. The growth of SMRs has been significant due to these new developments. For example, at the end of 1994, approximately 1.8 million vehicles and portable units were served by SMR systems.

Regulation of this service currently resides in Part 90 of the Code of Federal Regulations (CFR), Subtitle 47, on Telecommunications and may be researched or ordered through the Government Printing Office or by calling 202-512-1800.

For forms and fee information, see Forms & Fees.

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Last Reviewed/Updated on 10/15/2002

Technical Support Issues
- Call (202) 414-1250 (TTY: (202) 414-1255)
- E-mail ulscomm@fcc.gov

Licensing Support and Form Issues
- Call (888) 225-5322 and select option 2
- Call (717) 338-2888 (TTY: (202) 414-1255)
- E-mail ulshelp@fcc.gov

Inquiries Related to Specialized Mobile
- Contact Donald Johnson at (202) 418-7240 or dajohnso@fcc.gov

Federal Communications Commission
445 12th Street SW
Washington, DC 20554
More FCC Contact Information...

Phone: 1-888-CALL-FCC
(1-888-225-5322)
TTY: 1-888-TELL-FCC
(1-888-835-5322)
Fax: 1-866-418-0232
E-Mail: fccinfo@fcc.gov

Section 4.15 Telecommunications Facility

(A) **Purpose**. The purpose of these regulations is to protect the public health, safety, general welfare and scenic character of the Town of Hardwick, while accommodating the communication needs of residents and businesses. The intent of these regulations is to:

(1) preserve the character and appearance of the town while allowing adequate services and coverage to be developed;.
(2) protect the scenic, historic, environmental and natural resources of the town;
(3) provide standards as requirements for the siting, design, appearance, construction, operation, and removal of telecommunications facilities;
(4) minimize tower and antenna proliferation by requiring the co-location and sharing of existing telecommunications facilities wherever feasible and appropriate; and
(5) facilitate the provision of telecommunications services to residents and businesses in town.

(B) **Federal Limitations**. In accordance with federal law, these regulations shall not have the effect of prohibiting personal wireless services, unreasonably discriminating among providers of functionally equivalent services, nor regulating wireless telecommunications facilities based on emissions which are subject to and in compliance with Federal Communications Commission (FCC) regulations.

(C) **Applicability.** Wireless telecommunications facilities shall include all facilities subject to licensing or regulation by the FCC, including towers, associated accessory structures, buildings and/or equipment, except as specifically exempted under subsection (D). New, modified or expanded wireless telecommunication facilities, except as specified for small scale facilities under subsection (G), may be allowed in designated zoning districts as conditional uses subject to review under Section 5.2 and the requirements of this section. However:

(D) **Exemptions**. The following are specifically exempted from the provisions of this Section:

(1) A single ground or building mounted radio or television antenna or satellite dish not exceeding 36 inches in diameter which is intended solely for residential use, and does not, as mounted, exceed 35 feet in height above the lowest grade at ground level.

(2) Citizens band radio antennas operated by federally licensed amateur radio operators which do not exceed a height of 50 feet above the grade level, whether free standing or mounted, and which meet all setback requirements for the district in which they are located.

(3) Replacement of telecommunications facilities operated by public (municipal, state or federal) or not-for-profit emergency service providers (e.g., police, fire, ambulance) in association with their duties.

(E) **Application Requirements**. In addition to application requirements under Section 5.2, applications for new towers shall also include the following:

(1) The applicant's legal name, address and telephone number. If the applicant is not a natural person, the applicant shall provide the state in which it is incorporated and the name and address of its resident agent.

(2) The name, title, address and telephone number of the persons to whom correspondence concerning the application should be sent.

(3) The name, address, and telephone number of the owner or lessee of the property on which the Wireless Telecommunication Facility will be located.

(4) The names and addresses of all adjoining property owners. Adjoining property owners shall be determined without regard to any public right-of-way.

(5) A vicinity map showing the entire vicinity within a 1,000 foot radius of the Facility, including the location of any tower, topography, public and private roads and driveways, buildings and structures, utilities, water bodies, wetlands, landscape features, historic sites and necessary wildlife habitats. It shall indicate the property lines of the proposed Facility site parcel and all easements or rights of way needed for access from a public way to the Facility.

(6) The location of the Facility on a USGS Topographic Map or a GIS-generated map compatible with Vermont Center for Geographic Information (VCGI) standards and encompassing the area within at least a two-mile radius of the proposed tower site.

(7) Elevations and proposed site plans of the Facility showing all facades and indicating all exterior materials and colors of towers, buildings and equipment, as well as all landscaping, utility wires, guy wires and screening. (All plans shall be drawn at a minimum scale of 1 inch = 50 feet).

(8) In the case of a site that is forested, the approximate average elevation of the existing vegetation within 50 feet of any tower base.

(9) Construction sequence and time schedule for completion of each phase of the entire project.

(10) A report from a qualified engineer that:

(a) Describes any tower's design and elevation,
(b) Documents the elevation above grade for all proposed mounting positions for antennas to be collocated on a tower and the minimum distances between antennas,
(c) Describes a tower's capacity, including the number, elevation and types of antennas that the tower is proposed to accommodate.
(d) In the case of new Facilities, demonstrates that existing towers and structures within 5 miles of the site cannot reasonably be modified to provide adequate coverage and adequate capacity to the community.
(e) Describes potential changes or additions to existing structures or towers that would enable them to provide adequate coverage.
(f) Describes the output frequency, number of channels and the power output per channel for each antenna. In the alternative, a coverage map may be provided.
(g) Demonstrates the Facility's compliance with the standards set forth in this bylaw or other applicable standards.
(h) Provides proof that at the proposed Facility site the applicant will be in compliance with all FCC regulations, standards and requirements, and includes a statement that the applicant commits to continue to maintain compliance with all FCC regulations, standards and requirements for radio frequency radiation (RFR).
(i) Includes such other information as determined by the Board of Adjustment to evaluate the application.

(11) A letter of intent committing the Facility owner and its successors to permit shared use of any tower if the additional users agree to meet reasonable terms and conditions for shared use, including compliance with all applicable FCC regulations, standards and requirements and the provisions of this Bylaw and all other applicable laws.

(12) In the case of an application for additional antennas or other equipment to be installed on an existing Facility, a copy of the executed contract with the owner of the existing structure.

(13) To the extent required by the National Environmental Policy ACT (NEPA) and as administered by the FCC, a complete Environmental Assessment (EA) draft or final report describing the probable impacts of the Facility, or a written statement by the applicant that an EA is not required for the facility.

(F) **Independent Consultants** Upon submission of an application for a Telecommunication Facility permit, the Board of Adjustment may retain independent consultants whose services shall be paid for by the applicant. These consultants shall be qualified professionals in telecommunications engineering, structural engineering, monitoring of electromagnetic fields and such other fields as determined by the Board of Adjustment. The consultant(s) shall work at the Board of Adjustment's direction and shall

provide the Board of Adjustment such reports and assistance as the Board of Adjustment deems necessary to review an application.

(G) **Balloon Test** The Board of Adjustment may require the applicant to fly a four-foot diameter brightly colored balloon at the location and maximum elevation of any proposed tower. If a balloon test is required, the applicant shall advertise the date, time, and location of this balloon test at least 7 days in advance of the test in a newspaper with a general circulation in the Town. The applicant shall also inform the Board of Adjustment, in writing of the date, time and location of the test at least 15 days in advance of the test.

The balloon shall be flown for at least eight consecutive daylight hours on two days. If visibility and weather conditions are inadequate for observers to be able to clearly see the balloon test, further tests may be required by the Board of Adjustment.

(H) **Criteria for Approval and Conditions** An application for a Telecommunication Facility permit shall be approved after a hearing when the Board of Adjustment finds all the following criteria have been met:

(1) The Facility will not be built on speculation. If the applicant is not a Telecommunication Service Provider, the Board of Adjustment may require the applicant to provide a copy of a contract or letter of intent showing that a Wireless Telecommunication Service Provider is legally obligated to locate a Telecommunication Facility on lands owned or leased by the applicant.

(2) The Facility will not project more than 20 feet above the average elevation of the tree line measured within 50 feet of the highest vertical element of the Telecommunication Facility, unless the proposed elevation is reasonably necessary to provide adequate Wireless Telecommunication Service capacity or coverage or to facilitate collocation of facilities.

(3) No wireless telecommunication facility shall be located within 500 feet of an existing residence.

(4) The minimum distance from the base of any tower to any property line is not less than 100% of the total elevation of the tower, including antenna or equipment, unless otherwise permitted by the Board of Adjustment in accordance with one of the following:

(a) if tower design and construction guarantees that, if it collapses, it will collapse inwardly upon itself, and that no liability or risk to adjoining private or public property shall be assumed by the municipality; or
(b) to allow for the integration of a tower into an existing or proposed structure such as a church steeple, light standard, utility pole, or similar structure, to the extent that no hazard to public health, safety or welfare results.

(5) The tower including attached antennas does not exceed a height of 180 feet.

(6) The Facility will not be illuminated by artificial means and will not display any lights or signs except for such lights and signs as required by Federal Aviation Administration, federal or state law, this bylaw, or as needed for the safe operation of the facility.

(7) The applicant will remove the Facility, should the Facility be abandoned or cease to operate. The Board of Adjustment may require the applicant to provide a bond, or other form of financial guarantee acceptable to the Board of Adjustment to cover the cost of removal of the Facility, should the Facility be abandoned or cease to operate.

(8) The applicant demonstrates that the facility will be in compliance with all FCC standards and requirements regarding radio frequency radiation.

(9) The applicant will maintain adequate insurance on the Facility.

(10) The Facility will be properly identified with appropriate warnings indicating the presence of radio frequency radiation. The Board of Adjustment may condition a permit on the provision of appropriate fencing.

(11) The proposed equipment cannot be reasonably collocated at an existing Telecommunication Facility. In determining whether the proposed equipment cannot be reasonably collocated at an existing facility, the Board of Adjustment shall consider the following factors:

(a) The proposed equipment would exceed the structural or spatial capacity of the existing facility and the existing facility cannot be reinforced, modified or replaced to accommodate planned equipment at a reasonable cost.
(b) The proposed equipment would materially impact the usefulness of other equipment at the existing facility and such impact cannot be mitigated or prevented at a reasonable cost.
(c) The proposed equipment, alone or together with existing equipment, would create radio frequency interference and/or radio frequency radiation in violation of federal standards.
(d) Existing towers and structures cannot accommodate the proposed equipment at an elevation necessary to function reasonably or are too far from the area of needed coverage to function adequately.
(e) Collocation of the equipment upon existing tower would cause an undue aesthetic impact.

(12) The Facility provides reasonable opportunity for collocation of other equipment.

(13) The Facility will not unreasonably interfere with the view from any public park, natural scenic vista, historic building or district, or major view corridor.

(14) The Facility will not have an undue adverse aesthetic impact. In determining whether a facility has an undue adverse aesthetic impact, the Board of Adjustment shall consider the following factors:

(a) The results of the balloon test, if conducted.
(b) The extent to which the proposed towers and equipment have been designed to blend into the surrounding environment through the use of screening, camouflage, architectural design, and/or imitation of natural features.
(c) The extent to which access roads have been designed to follow the contour of the land and will be constructed within forest or forest fringe areas and not open fields.
(d) The duration and frequency with which the Facility will be viewed on a public highway or from public property.
(e) The degree to which the Facility will be screened by existing vegetation, topography, or existing structures.
(f) Background features in the line of sight to the Facility that obscure or make the Facility more conspicuous.
(g) The distance of the Facility from the point of view and the proportion of the facility that is above the skyline.
(h) The sensitivity or unique value of a particular view affected by the Facility.

(i) Any significant disruption of a viewshed that provides context to an important historic or scenic resource.

(15) The Facility will not destroy or significantly imperil necessary wildlife habitat or that all reasonable means of minimizing the destruction or imperilment of such habitat or species will be utilized.

(16) The Facility will not generate undue noise.

(17) The extent to which utility lines (e.g. power) serving telecommunications facilities follow access roads and does not involve extensive clearing; the Board of Adjustment may require that such utilities be buried where they are likely to otherwise have an adverse visual impact.

(I) **Small Scale and Temporary Facilities**. Notwithstanding the requirements of Article 2, the following may be permitted in any zoning district by the Administrative Officer without conditional use approval:

(1) Small scale wireless telecommunications equipment, including antennas, microcells or repeaters, which are to be installed on existing towers, utility poles, or other structures; or the installation of ground facilities less than 20 feet in height, provided that:

(a) no such device is located within 50 feet of an existing residence;
(b) no changes are made to the height or appearance of such structure except as required for mounting;
(c) the height of the facility as mounted does not extend the total height of the structure by more than 10 feet;
(d) no panel antenna shall exceed 72 inches in height or 24 inches in width;
(e) no dish antenna shall exceed 3 feet in diameter; and
(f) any accompanying equipment shall be screened from view.

(2) Wireless communications facilities designed for temporary use, provided that:

(a) the temporary facility is permitted for the duration of the intended use or event, as specified in the permit, which shall not exceed 60 days, and is removed immediately upon the expiration of the permit,
(b) the height of the facility does not exceed 50 feet from grade, and
(c) the facility complies with all other applicable provisions of these regulations.

(J) **Continuing Obligations for Wireless Telecommunication Facilities** The owner of a Telecommunication Facility shall, at such times as requested by the Board of Adjustment, file a certificate showing that it is in compliance with all FCC standards and requirements regarding radio frequency radiation, and that adequate insurance has been obtained for the Facility. Failure to file a certificate within the timeframe requested by the Board of Adjustment, shall mean that the Facility has been abandoned.

(K) **Removal of Abandoned or Unused Facilities** Unless otherwise approved by the Board of Adjustment, an abandoned or unused Telecommunication Facility shall be removed within 90 days of abandonment or cessation of use. If the Facility is not removed within 90 days of abandonment or cessation of use, the Board of Adjustment may cause the Facility to be removed. The costs of removal shall be assessed against the Facility owner.

Unused portions of a Telecommunication Facility shall be removed within 180 days of the time that such portion is no longer used. Replacement of portions of a Facility previously removed shall require a new permit.

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APPENDIX 4-1 FCC License Database

Frequency: 460.1500 Mhz Callsign: KSU589

DBA Name:	HARDWICK, VILLAGE OF	**Appl Phone:**	8022448786
Licensee:	HARDWICK, VILLAGE OF	**Control Phone:**	8022448786
Address:	103 S MAIN ST	**PO Box:**	
City:	WATERBURY	**State:** VT	**Zip:** 05676
Issue Date:	20040511	**Expiration Date:**	20140724
Freq High:	0.0000 Mhz		
Contact:			
Attention:	PUBLIC SAFETY DEPT		
RS Code:	PW	**CS Code:** FB	
Latitude:	443017 N	**Longitude:**	0722208 W
Transmitter Address:	MEMORIAL BLDG CHURCH ST HARDWICK CALEDONIA VT		

File Number:			**Vehicles:**	0	
Begin Time:			**Portables:**	0	
End Time:			**Air:**	0	
Elevation:	262.0	Meters	**Marine:**	0	
Height:	20.0	Meters	**Pager:**	0	
HAAT:	0.0	Meters	**# Units:**	1	
Eff. Height:	0.0	Meters	**# Trunked:**	0	
Stru Height:	0.0	Meters	**Type Appl:**	G	
Area Oper:			**Type LC:**	A	
Radius Oper:	0.0	Kilometers	**Date LC:**	20040511	
Elev Angle:	0.000	Degrees	**Metric Ind:**	M	
Azimuth:	0.000	Degrees	**DB ID:**	L_LMPRI	
Polarization:			**Auth Type:**	A	
Gain:	0.0		**CP Auth:**		
Path Length:		Kilometers	**FAA ID:**		
Beam Width:	0.000		**Tower ID:**		
ERP:	0.000	Watts	**Antenna Type:**		
Power Out:	35.000	Watts	**Line Loss:**	0.0	
Tolerance:	0.000				
Emissions:	20K0F3E				

Control: MEMORIAL BLDG CHURCH ST HARDWICK VT

Receiver: No Receiver Data

PL Specs: No Paint and Lighting Specs

Spec Cond: No Special Conditions

AO Desc: No Area of Operation Data

Assoc Calls: No Assc Callsign Data

SMR Calls: No SMRCallsign Data

Receiver Calls: No Receiver Callsign Data

APPENDIX 4-2 FCC License Database

Frequency: 460.3000 Mhz Callsign: KSU589

DBA Name:	HARDWICK, VILLAGE OF	**Appl Phone:**	8022448786
Licensee:	HARDWICK, VILLAGE OF	**Control Phone:**	8022448786
Address:	103 S MAIN ST	**PO Box:**	
City:	WATERBURY	**State:** VT	**Zip:** 05676
Issue Date:	20040511	**Expiration Date:**	20140724
Freq High:	0.0000 Mhz		
Contact:			
Attention:	PUBLIC SAFETY DEPT		
RS Code:	PW	**CS Code:**	FB
Latitude:	443017 N	**Longitude:**	0722208 W
Transmitter Address:	MEMORIAL BLDG CHURCH ST HARDWICK CALEDONIA VT		

File Number:			**Vehicles:**	0	
Begin Time:			**Portables:**	0	
End Time:			**Air:**	0	
Elevation:	262.0	Meters	**Marine:**	0	
Height:	20.0	Meters	**Pager:**	0	
HAAT:	0.0	Meters	**# Units:**	1	
Eff. Height:	0.0	Meters	**# Trunked:**	0	
Stru Height:	0.0	Meters	**Type Appl:**	G	
Area Oper:			**Type LC:**	A	
Radius Oper:	0.0	Kilometers	**Date LC:**	20040511	
Elev Angle:	0.000	Degrees	**Metric Ind:**	M	
Azimuth:	0.000	Degrees	**DB ID:**	L_LMPRI	
Polarization:			**Auth Type:**	A	
Gain:	0.0		**CP Auth:**		
Path Length:		Kilometers	**FAA ID:**		
Beam Width:	0.000		**Tower ID:**		
ERP:	0.000	Watts	**Antenna Type:**		
Power Out:	35.000	Watts	**Line Loss:**	0.0	
Tolerance:	0.000				
Emissions:	20K0F3E				

Control:	MEMORIAL BLDG CHURCH ST HARDWICK VT	**Receiver:**	No Receiver Data
PL Specs:	No Paint and Lighting Specs		
Spec Cond:	No Special Conditions		
AO Desc:	No Area of Operation Data		
Assoc Calls:	No Assc Callsign Data		
SMR Calls:	No SMRCallsign Data	**Receiver Calls:**	No Receiver Callsign Data

APPENDIX 4-3 FCC License Database

Frequency: 460.5000 Mhz Callsign: KSU589

DBA Name: HARDWICK, VILLAGE OF
Licensee: HARDWICK, VILLAGE OF
Appl Phone: 8022448786
Control Phone: 8022448786
Address: 103 S MAIN ST
PO Box:
City: WATERBURY
State: VT
Zip: 05676
Issue Date: 20040511
Expiration Date: 20140724
Freq High: 0.0000 Mhz

Contact:
Attention: PUBLIC SAFETY DEPT
RS Code: PW
CS Code: FB

Latitude: 443017 N
Longitude: 0722208 W

Transmitter Address: MEMORIAL BLDG CHURCH ST HARDWICK CALEDONIA VT

File Number:			**Vehicles:**	0
Begin Time:			**Portables:**	0
End Time:			**Air:**	0
Elevation:	262.0	Meters	**Marine:**	0
Height:	20.0	Meters	**Pager:**	0
HAAT:	0.0	Meters	**# Units:**	1
Eff. Height:	0.0	Meters	**# Trunked:**	0
Stru Height:	0.0	Meters	**Type Appl:**	G
Area Oper:			**Type LC:**	A
Radius Oper:	0.0	Kilometers	**Date LC:**	20040511
Elev Angle:	0.000	Degrees	**Metric Ind:**	M
Azimuth:	0.000	Degrees	**DB ID:**	L_LMPRI
Polarization:			**Auth Type:**	A
Gain:	0.0		**CP Auth:**	
Path Length:		Kilometers	**FAA ID:**	
Beam Width:	0.000		**Tower ID:**	
ERP:	0.000	Watts	**Antenna Type:**	
Power Out:	35.000	Watts	**Line Loss:**	0.0
Tolerance:	0.000			
Emissions:	20K0F3E			

Control: MEMORIAL BLDG CHURCH ST HARDWICK VT
Receiver: No Receiver Data

PL Specs: No Paint and Lighting Specs

Spec Cond: No Special Conditions

AO Desc: No Area of Operation Data

Assoc Calls: No Assc Callsign Data
SMR Calls: No SMRCallsign Data
Receiver Calls: No Receiver Callsign Data

APPENDIX 4-4 FCC License Database

Frequency: 465.0250 Mhz Callsign: WAN503

DBA Name:	HARDWICK, VILLAGE OF	**Appl Phone:**	8022448786
Licensee:	HARDWICK, VILLAGE OF	**Control Phone:**	8022448786
Address:	103 S MAIN ST	**PO Box:**	
City:	WATERBURY	**State:** VT	**Zip:** 05676
Issue Date:	20040511	**Expiration Date:**	20140724
Freq High:	0.0000 Mhz		
Contact:			
Attention:	PUBLIC SAFETY DEPT		
RS Code:	PW	**CS Code:**	FX1
Latitude:	442917 N	**Longitude:**	0722208 W
Transmitter Address:	MACKVILLE RD HARDWICK	CALEDONIA	VT

File Number:		**Vehicles:**	0
Begin Time:		**Portables:**	0
End Time:		**Air:**	0
Elevation:	293.0 Meters	**Marine:**	0
Height:	14.0 Meters	**Pager:**	0
HAAT:	0.0 Meters	**# Units:**	1
Eff. Height:	0.0 Meters	**# Trunked:**	0
Stru Height:	0.0 Meters	**Type Appl:**	G
Area Oper:		**Type LC:**	A
Radius Oper:	0.0 Kilometers	**Date LC:**	20040511
Elev Angle:	0.000 Degrees	**Metric Ind:**	M
Azimuth:	0.000 Degrees	**DB ID:**	L_LMPRI
Polarization:		**Auth Type:**	A
Gain:	0.0	**CP Auth:**	
Path Length:	Kilometers	**FAA ID:**	
Beam Width:	0.000	**Tower ID:**	
ERP:	0.000 Watts	**Antenna Type:**	
Power Out:	35.000 Watts	**Line Loss:**	0.0
Tolerance:	0.000		
Emissions:	20K0F3E 20K0F3E 20K0F3E 20K0F3E 20K		

Control:	MACKVILLE RD HARDWICK VT	**Receiver:**	No Receiver Data

PL Specs: No Paint and Lighting Specs

Spec Cond: No Special Conditions

AO Desc: No Area of Operation Data

Assoc Calls: No Assc Callsign Data

SMR Calls: No SMRCallsign Data

Receiver Calls: No Receiver Callsign Data

APPENDIX 4-5 FCC License Database

Frequency: 155.2050 Mhz Callsign: KSJ200

DBA Name: HARDWICK EMERGENCY RESCUE SQUAD INC **Appl Phone:** 8024725936
Licensee: HARDWICK EMERGENCY RESCUE SQUAD INC **Control Phone:** 8024725936
Address: **PO Box:** 837
City: HARDWICK **State:** VT **Zip:** 05843
Issue Date: 20030612 **Expiration Date:** 20130726
Freq High: 0.0000 Mhz

Contact:
Attention:
RS Code: PW **CS Code:** FB

Latitude: 443400 N **Longitude:** 0721758 W

Transmitter Address: D BROCHU SR RES HARDWICK ST HARDWICK CALEDONIA VT

File Number:			**Vehicles:**	0
Begin Time:			**Portables:**	0
End Time:			**Air:**	0
Elevation:	446.0	Meters	**Marine:**	0
Height:	12.0	Meters	**Pager:**	30
HAAT:	0.0	Meters	**# Units:**	1
Eff. Height:	0.0	Meters	**# Trunked:**	0
Stru Height:	0.0	Meters	**Type Appl:**	C
Area Oper:			**Type LC:**	A
Radius Oper:	0.0	Kilometers	**Date LC:**	20030612
Elev Angle:	0.000	Degrees	**Metric Ind:**	M
Azimuth:	0.000	Degrees	**DB ID:**	L_LMPRI
Polarization:			**Auth Type:**	A
Gain:	0.0		**CP Auth:**	
Path Length:		Kilometers	**FAA ID:**	
Beam Width:	0.000		**Tower ID:**	
ERP:	6.000	Watts	**Antenna Type:**	
Power Out:	50.000	Watts	**Line Loss:**	0.0
Tolerance:	0.000			
Emissions:	20K0F3E			

Control: 17 HIGHLAND AVE HARDWICK VT **Receiver:** No Receiver Data

PL Specs: No Paint and Lighting Specs

Spec Cond: No Special Conditions

AO Desc: No Area of Operation Data

Assoc Calls: No Assc Callsign Data
SMR Calls: No SMRCallsign Data **Receiver Calls:** No Receiver Callsign Data

APPENDIX 4-6 FCC License Database

Frequency: 154.1900 Mhz Callsign: KKV518

DBA Name:	HARDWICK, TOWN OF	**Appl Phone:**	8024725936
Licensee:	HARDWICK, TOWN OF	**Control Phone:**	8024725936
Address:	**PO Box:** 142		
City:	HARDWICK	**State:** VT	**Zip:** 05843
Issue Date:	20001121	**Expiration Date:**	20070903
Freq High:	0.0000 Mhz		
Contact:	SANDERS RADIO		
Attention:	FIRE DEPT SHARLEEN		
RS Code:	PW	**CS Code:**	FB
Latitude:	443000 N	**Longitude:**	0722158 W
Transmitter Address:	WOLCOTT ST US RT 15 FIRE STA HARDWICK CALEDONIA VT		

File Number:		**Vehicles:**	0
Begin Time:		**Portables:**	0
End Time:		**Air:**	0
Elevation:	262.0 Meters	**Marine:**	0
Height:	15.0 Meters	**Pager:**	0
HAAT:	-135.0 Meters	**# Units:**	1
Eff. Height:	0.0 Meters	**# Trunked:**	0
Stru Height:	10.0 Meters	**Type Appl:**	G
Area Oper:		**Type LC:**	A
Radius Oper:	0.0 Kilometers	**Date LC:**	20001121
Elev Angle:	0.000 Degrees	**Metric Ind:**	M
Azimuth:	0.000 Degrees	**DB ID:**	L_LMPRI
Polarization:		**Auth Type:**	A
Gain:	0.0	**CP Auth:**	
Path Length:	Kilometers	**FAA ID:**	
Beam Width:	0.000	**Tower ID:**	N/A
ERP:	225.000 Watts	**Antenna Type:**	
Power Out:	75.000 Watts	**Line Loss:**	0.0
Tolerance:	0.000		
Emissions:	20K0F3E		

Control: 98 HIGHLAND AVE HARDWICK VT **Receiver:** No Receiver Data

PL Specs: No Paint and Lighting Specs

Spec Cond: No Special Conditions

AO Desc: No Area of Operation Data

Assoc Calls: No Assc Callsign Data
SMR Calls: No SMRCallsign Data **Receiver Calls:** No Receiver Callsign Data

APPENDIX 4-7 FCC License Database

Frequency: 154.1900 Mhz Callsign: KKV518

DBA Name:	HARDWICK, TOWN OF	**Appl Phone:**	8024725936
Licensee:	HARDWICK, TOWN OF	**Control Phone:**	8024725936
Address:		**PO Box:**	142
City:	HARDWICK	**State:**	VT
		Zip:	05843
Issue Date:	20001121	**Expiration Date:**	20070903
Freq High:	0.0000 Mhz		
Contact:	SANDERS RADIO		
Attention:	FIRE DEPT SHARLEEN		
RS Code:	PW	**CS Code:**	FB
Latitude:	442926 N	**Longitude:**	0722058 W
Transmitter Address:	98 HIGHLAND AVE HARDWICK	CALEDONIA	VT

File Number:			**Vehicles:**	0	
Begin Time:			**Portables:**	0	
End Time:			**Air:**	0	
Elevation:	280.0	Meters	**Marine:**	0	
Height:	14.0	Meters	**Pager:**	0	
HAAT:	-131.0	Meters	**# Units:**	1	
Eff. Height:	0.0	Meters	**# Trunked:**	0	
Stru Height:	9.0	Meters	**Type Appl:**	G	
Area Oper:			**Type LC:**	A	
Radius Oper:	0.0	Kilometers	**Date LC:**	20001121	
Elev Angle:	0.000	Degrees	**Metric Ind:**	M	
Azimuth:	0.000	Degrees	**DB ID:**	L_LMPRI	
Polarization:			**Auth Type:**	A	
Gain:	0.0		**CP Auth:**		
Path Length:		Kilometers	**FAA ID:**		
Beam Width:	0.000		**Tower ID:**	N/A	
ERP:	50.000	Watts	**Antenna Type:**		
Power Out:	25.000	Watts	**Line Loss:**	0.0	
Tolerance:	0.000				
Emissions:	20K0F3E				

Control: 98 HIGHLAND AVE HARDWICK VT **Receiver:** No Receiver Data

PL Specs: No Paint and Lighting Specs

Spec Cond: No Special Conditions

AO Desc: No Area of Operation Data

Assoc Calls: No Assc Callsign Data

SMR Calls: No SMRCallsign Data **Receiver Calls:** No Receiver Callsign Data

APPENDIX 4-8 FCC License Database

Frequency: 155.2050 Mhz Callsign: KSJ200

DBA Name:	HARDWICK EMERGENCY RESCUE SQUAD INC	**Appl Phone:**	8024725936
Licensee:	HARDWICK EMERGENCY RESCUE SQUAD INC	**Control Phone:**	8024725936
Address:	**PO Box:** 837		
City:	HARDWICK **State:** VT	**Zip:**	05843
Issue Date:	20030612 **Expiration Date:** 20130726		
Freq High:	0.0000 Mhz		
Contact:			
Attention:			
RS Code:	PW **CS Code:** FB		
Latitude:	443000 N **Longitude:** 0722158 W		
Transmitter Address:	17 HIGHLAND AVE HARDWICK CALEDONIA VT		

File Number:			**Vehicles:**	0	
Begin Time:			**Portables:**	0	
End Time:			**Air:**	0	
Elevation:	267.0	Meters	**Marine:**	0	
Height:	14.0	Meters	**Pager:**	30	
HAAT:	0.0	Meters	**# Units:**	1	
Eff. Height:	0.0	Meters	**# Trunked:**	0	
Stru Height:	0.0	Meters	**Type Appl:**	C	
Area Oper:			**Type LC:**	A	
Radius Oper:	0.0	Kilometers	**Date LC:**	20030612	
Elev Angle:	0.000	Degrees	**Metric Ind:**	M	
Azimuth:	0.000	Degrees	**DB ID:**	L_LMPRI	
Polarization:			**Auth Type:**	A	
Gain:	0.0		**CP Auth:**		
Path Length:		Kilometers	**FAA ID:**		
Beam Width:	0.000		**Tower ID:**		
ERP:	4.500	Watts	**Antenna Type:**		
Power Out:	50.000	Watts	**Line Loss:**	0.0	
Tolerance:	0.000				
Emissions:	20K0F3E				

Control: 17 HIGHLAND AVE HARDWICK VT **Receiver:** No Receiver Data

PL Specs: No Paint and Lighting Specs

Spec Cond: No Special Conditions

AO Desc: No Area of Operation Data

Assoc Calls: No Assc Callsign Data
SMR Calls: No SMRCallsign Data **Receiver Calls:** No Receiver Callsign Data

APPENDIX 4-9 FCC License Database

Frequency: 153.7850 Mhz Callsign: WPEC653

DBA Name:	HARDWICK, TOWN OF ELECTRIC DEPARTMENT	**Appl Phone:**	8024725201
Licensee:	HARDWICK, TOWN OF ELECTRIC DEPARTMENT	**Control Phone:**	8024725201
Address:	**PO Box:** 516		
City:	HARDWICK **State:** VT	**Zip:**	05843
Issue Date:	20040512 **Expiration Date:** 20140202		
Freq High:	0.0000 Mhz		
Contact:	TOWN OF HARDWICK		
Attention:	ERIC WERNER		
RS Code:	PW **CS Code:** FB		
Latitude:	443149 N **Longitude:** 0722310 W		
Transmitter Address:	WEST HILL HARDWICK CALEDONIA		VT

File Number:	0001586908		**Vehicles:**	0	
Begin Time:			**Portables:**	0	
End Time:			**Air:**	0	
Elevation:	401.0	Meters	**Marine:**	0	
Height:	9.0	Meters	**Pager:**	0	
HAAT:	0.0	Meters	**# Units:**	1	
Eff. Height:	0.0	Meters	**# Trunked:**	0	
Stru Height:	8.0	Meters	**Type Appl:**	G	
Area Oper:			**Type LC:**	A	
Radius Oper:	0.0	Kilometers	**Date LC:**	20040512	
Elev Angle:	0.000	Degrees	**Metric Ind:**	M	
Azimuth:	0.000	Degrees	**DB ID:**	L_LMPRI	
Polarization:			**Auth Type:**	A	
Gain:	0.0		**CP Auth:**		
Path Length:		Kilometers	**FAA ID:**		
Beam Width:	0.000		**Tower ID:**		
ERP:	100.000	Watts	**Antenna Type:**		
Power Out:	50.000	Watts	**Line Loss:**	0.0	
Tolerance:	0.000				
Emissions:	20K0F3E				

Control: AT VLG LIGHT DEPT OFC ON CHURCH ST HARDWICK VT

Receiver: No Receiver Data

PL Specs: No Paint and Lighting Specs

Spec Cond: No Special Conditions

AO Desc: No Area of Operation Data

Assoc Calls: No Assc Callsign Data

SMR Calls: No SMRCallsign Data

Receiver Calls: No Receiver Callsign Data

APPENDIX 4-10 FCC License Database

Frequency: 152.0300 Mhz Callsign: KDS417

DBA Name:	RINKER, KARL A	**Appl Phone:**	8024790121
Licensee:	RINKER, KARL A	**Control Phone:**	8024790121
Address:	103 SOUTH MAIN STREET	**PO Box:**	
City:	BARRE	**State:** VT	**Zip:** 05641
Issue Date:	19990427	**Expiration Date:**	20090401
Freq High:	0.0000 Mhz		
Contact:	LAW OFFICES OF HILL &		
Attention:	DBA RINKERS		
RS Code:	CD	**CS Code:**	
Latitude:	443104 N	**Longitude:**	0722134 W
Transmitter Address:	300 WEST OF BIDGEMAN HILL ROAD HARDWICK CALEDONIA VT		

File Number:		**Vehicles:**	0
Begin Time:		**Portables:**	0
End Time:		**Air:**	0
Elevation:	360.3 Meters	**Marine:**	0
Height:	21.3 Meters	**Pager:**	0
HAAT:	0.0 Meters	**# Units:**	0
Eff. Height:	0.0 Meters	**# Trunked:**	0
Stru Height:	21.3 Meters	**Type Appl:**	I
Area Oper:		**Type LC:**	A
Radius Oper:	Kilometers	**Date LC:**	20050215
Elev Angle:	0.000 Degrees	**Metric Ind:**	M
Azimuth:	0.360 Degrees	**DB ID:**	L_PAGIN
Polarization:		**Auth Type:**	A
Gain:	6.0	**CP Auth:**	
Path Length:	Kilometers	**FAA ID:**	
Beam Width:	0.360	**Tower ID:**	
ERP:	379.400 Watts	**Antenna Type:**	
Power Out:	110.000 Watts	**Line Loss:**	0.0
Tolerance:	0.000		
Emissions:			

Control: 103 SOUTH MAIN STREET BARRE VT **Receiver:** No Receiver Data

PL Specs: No Paint and Lighting Specs

Spec Cond: No Special Conditions

AO Desc: No Area of Operation Data

Assoc Calls: No Assc Callsign Data
SMR Calls: No SMRCallsign Data **Receiver Calls:** No Receiver Callsign Data

APPENDIX 4-11 FCC License Database

Frequency: 466.8000 Mhz Callsign: WPGK985

DBA Name: HARDWICK BUILDING SUPPLY
Licensee: HARDWICK BUILDING SUPPLY
Appl Phone: 8024725981
Control Phone: 8024725981
Address: **PO Box:** 577
City: HARDWICK **State:** VT **Zip:** 05843
Issue Date: 20050125 **Expiration Date:** 20150203
Freq High: 0.0000 Mhz

Contact:
Attention: KELLY JEROME
RS Code: IG **CS Code:** FX1

Latitude: 443000 N **Longitude:** 0722158 W

Transmitter Address: 4 KM E RT 16 RT 15 E HARDWICK CALEDONIA VT

File Number:			**Vehicles:**	0
Begin Time:			**Portables:**	0
End Time:			**Air:**	0
Elevation:	262.0	Meters	**Marine:**	0
Height:	15.0	Meters	**Pager:**	0
HAAT:	0.0	Meters	**# Units:**	1
Eff. Height:	0.0	Meters	**# Trunked:**	0
Stru Height:	6.0	Meters	**Type Appl:**	C
Area Oper:			**Type LC:**	A
Radius Oper:	0.0	Kilometers	**Date LC:**	20050125
Elev Angle:	0.000	Degrees	**Metric Ind:**	M
Azimuth:	0.000	Degrees	**DB ID:**	L_LMPRI
Polarization:			**Auth Type:**	A
Gain:	0.0		**CP Auth:**	
Path Length:		Kilometers	**FAA ID:**	
Beam Width:	0.000		**Tower ID:**	N/A
ERP:	80.000	Watts	**Antenna Type:**	
Power Out:	40.000	Watts	**Line Loss:**	0.0
Tolerance:	0.000			
Emissions:	20K0F3E			

Control: ON RT 15 1 KM E OF HARDWICK VT **Receiver:** No Receiver Data

PL Specs: No Paint and Lighting Specs

Spec Cond: No Special Conditions

AO Desc: No Area of Operation Data

Assoc Calls: No Assc Callsign Data
SMR Calls: No SMRCallsign Data **Receiver Calls:** No Receiver Callsign Data

APPENDIX 4-12 FCC License Database

Frequency: 152.3600 Mhz Callsign: KNDF725

DBA Name:	WILDCAT BUSING INC	**Appl Phone:**	8024725206
Licensee:	WILDCAT BUSING INC	**Control Phone:**	8024725206
Address:	DONAS DR	**PO Box:**	
City:	HARDWICK	**State:** VT	**Zip:** 05843
Issue Date:	20030322	**Expiration Date:**	20130302
Freq High:	0.0000 Mhz		
Contact:	CARA ENTERPRISES INC		
Attention:	DOUG THOMPSON		
RS Code:	IG	**CS Code:**	FB
Latitude:	443000 N	**Longitude:**	0722158 W
Transmitter Address:	BARCOMB MOTOR SALES VILLAGE RT HARDWICK CALEDONIA		VT

File Number:			**Vehicles:**	0	
Begin Time:			**Portables:**	0	
End Time:			**Air:**	0	
Elevation:	262.0	Meters	**Marine:**	0	
Height:	17.0	Meters	**Pager:**	0	
HAAT:	0.0	Meters	**# Units:**	1	
Eff. Height:	0.0	Meters	**# Trunked:**	0	
Stru Height:	0.0	Meters	**Type Appl:**	C	
Area Oper:			**Type LC:**	A	
Radius Oper:	0.0	Kilometers	**Date LC:**	20030326	
Elev Angle:	0.000	Degrees	**Metric Ind:**	M	
Azimuth:	0.000	Degrees	**DB ID:**	L_LMPRI	
Polarization:			**Auth Type:**	A	
Gain:	0.0		**CP Auth:**		
Path Length:		Kilometers	**FAA ID:**		
Beam Width:	0.000		**Tower ID:**		
ERP:	12.500	Watts	**Antenna Type:**		
Power Out:	50.000	Watts	**Line Loss:**	0.0	
Tolerance:	0.000				
Emissions:	20K0F3E				

Control: 154 Route 15 W HARDWICK VILLAGE HARDWICK VT

Receiver: No Receiver Data

PL Specs: No Paint and Lighting Specs

Spec Cond: No Special Conditions

AO Desc: No Area of Operation Data

Assoc Calls: No Assc Callsign Data

SMR Calls: No SMRCallsign Data

Receiver Calls: No Receiver Callsign Data

APPENDIX 5 - Propagation Study Assumptions & Parameters

Okumura Tile Calculations

Operating Frequencies:
154.19000 MHz (Town - Fire - VHF)
460.50000 MHz (Village - UHF)
891.00000 MHz (cellular)
1962.50000 MHz (PCS)

Transmit Parameters:

Transmit ERP:

225.00W	(VHF)
45.00W	(UHF)
54.30dBm	(cellular)
54.30dBm	(PCS)

Antenna:

PD-200	(VHF collinear omni)
BA6110-2	(UHF collinear omni)
Omni	(cellular & PCS)

Earth curvature: 1.333

Obstruction files included in calculations:
\\SURFACE\HARDWCK1

Land Use Data included in calculations:
Template: TIA TR8 (May 20 1997)

Area type:	QUASI-OPEN
Street orientation:	NO CORRECTION
Slope correction:	AVG PATH SLOPE
Land-Sea:	NO CORRECTION
Rolling hill:	ROLLING HILLS CORRECTION (999.00 mi from RX)
Hill correction:	LOCATION
Ridge correction:	ISOLATED RIDGES

Percentage of the locations in the area:
75.00%

Receive parameters:
RX height used: 5.00 ft AGL

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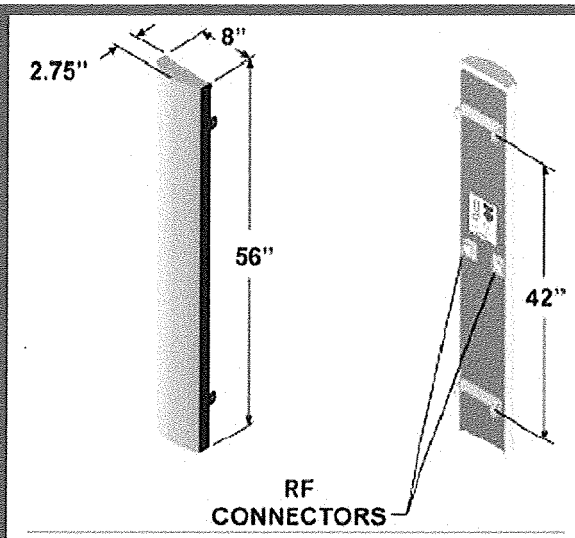
APPENDIX 6 - PCS Antenna Specifications

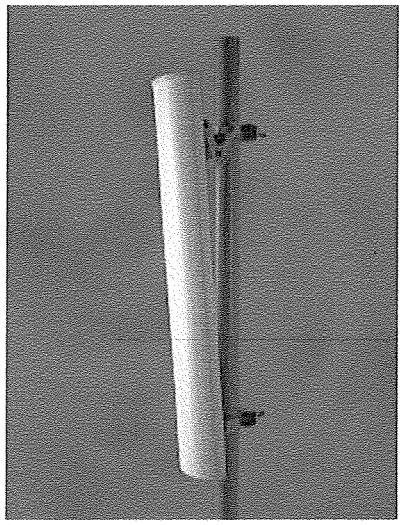
EMS WIRELESS

OptiRange™

RR90-17-XXXP

1850 MHz - 1990 MHz (P)





90° beamwidth

16.5 dBi gain

±45° DualPol™

56 inch

SPECIFICATIONS

Electrical

Azimuth Beamwidth	90°
Elevation Beamwidth	6°
Gain	16.5 dBi (14.4 dBd)
Polarization	Slant, ±45°
Port-to-Port Isolation	≥ 30 dB
Front-to-Back Ratio	≥ 25 dB (≥ 30 dB Typ.)
Electrical Downtilt Options	0°, 2°, 4°, 6°
VSWR	1.35:1 Max
Connectors	2;Type N or 7-16 DIN (female)
Power Handling	250 Watts CW
Passive Intermodulation	<-147 dBc (2 tone @ +43 dBm {20W} ea.)
Lightning Protection	Chassis Ground

Mechanical

Dimensions (L x W x D)	56in x 8in x 2.75in (142 cm x 20.3 cm x 7.0 cm)
Rated Wind Velocity	150 mph (241 km/hr)
Equivalent Flat Plate Area	3.1ft² (.29 m²)
Front Wind Load @ 100 mph (161 kph)	90 lbs (400 N)
Side Wind Load @ 100 mph (161 kph)	31 lbs (139 N)
Weight	18 lbs (8.2 kg)

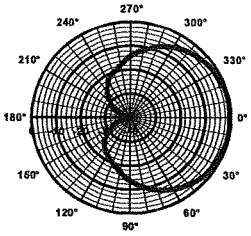
Note: Patent Pending and US Patent number 5, 757, 246.

Values and patterns are representative and variations may occur. Specifications may change without notice due to continuous product enhancements. Digitized pattern data is available from the factory or via the web site www.emswireless.com and reflect all updates.

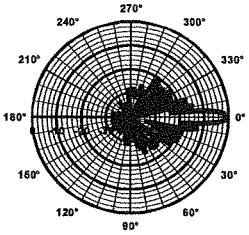
MOUNTING OPTIONS

Model Number	Description	Comments
MTG-P00-10	Standard Mount (Supplied with antenna)	Mounts to Wall or 1.5 inch to 5.0 inch O.D. Pole (3.8 cm to 12.7 cm)
MTG-S02-10	Swivel Mount	Mounting kit providing azimuth adjustment.
MTG-DXX-20*	Mechanical Downtilt Kits	0° - 10° or 0° - 15° Mechanical Downtilt
MTG-CXX-10*	Cluster Mount Kits	3 antennas 120° apart or 2 antennas 180° apart
MTG-C02-10	U-Bolt Cluster Mount Kit	3 antennas 120° apart , 4.5" O.D. pole.
MTG-TXX-10*	Steel Band Mount	Pole diameters 7.5" - 45"

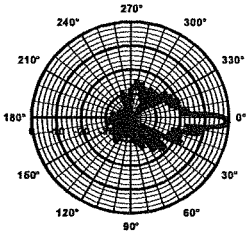
* Model number shown represents a series of products. See mounting options section for specific model number.



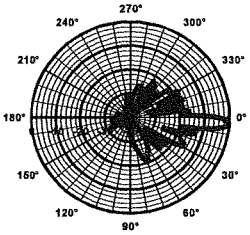
Azimuth



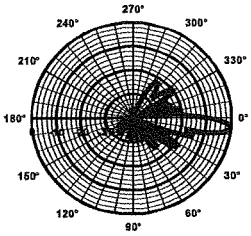
Elevation
0° Downtilt



Elevation
2° Downtilt



Elevation
4° Downtilt



Elevation
6° Downtilt

EMS *Wireless* +1(770) 582-0555 Fax +1(770) 729-0036

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APPENDIX 7 - Glossary of Abbreviations, Terms and Definitions

AGL Above Ground Level.

AMSL Above Mean Sea Level.

Cellular:
A subset of Personal Wireless Services employing both analog and digital modulation in the 800 MHz spectrum.

C/L Antenna Center Line, the center of radiation (COR).

Collocation:
Installation of an antenna on an existing tower, building or structure; generally with one or more other users or providers.

COR Antenna Center-of-Radiation, also known as the center line (C/L).

dB Decibel, a logarithmic unit used to characterize a ratio (difference). In the case of radiofrequency power, if the second level is twice as much power as the first, it is 3dB higher; if the second level is ten times that of the first, it is 10dB higher; if the second is a million times the power of the first, it is 60dB higher. As can be seen, the use of decibels enables describing very large power ratios with modestly sized numbers.

dBm A power level expressed as decibels above one milliwatt. Typically seen as a negative number when shown on propagation studies.

EiRP Equivalent Isotropic (using a theoretical antenna that radiates equally in all directions) Radiated Power.

ERP Effective Radiated Power

FCC Federal Communications Commission.

GHz Gigahertz, a unit of frequency measurement equal to one thousand million cycles per second (1,000 MHz).

Hz Hertz, a unit of frequency measurement equal to one cycle per second.

MHz Megahertz, a unit of frequency measurement equal to one million cycles per second.

MPE Maximum Permissible Exposure, as determined by guidelines contained in Federal Communications Commission OET Bulletin 65.

PCS Personal Communications Services, a subset of Personal Wireless Services, generally employing digital modulation at higher (up to 2 GHz) frequencies.

PWS Personal Wireless Services. As defined in Section 704 of the Telecommunications Act of 1996, they include "commercial mobile services, unlicensed wireless services, and common carrier wireless exchange access services."

Repeater:
A transmitter/receiver with antenna(s), operating on the same frequency as the primary base station, that extends the primary signal or fills in a coverage gap.

RF Radiofrequency.

RFR Radiofrequency Radiation.

SMR Specialized Mobile Radio, a subset of Personal Wireless Services employing 800 MHz spectrum.

Substantial increase:
"A 'substantial increase in the size of the tower' occurs under one or more of the following circumstances:

(1) The height of the tower will be increased by more than the greater of: (a) 10% of the height of the tower; or (b) the height extension needed to accommodate one additional antenna array with a separation of 20 feet from the nearest existing antenna. Thus, a 150-foot tower may be increased in height by up to 15 feet without constituting a substantial increase in size. If there is already an antenna at the top of the tower, the tower height may be increased by up to 20 feet plus the height of a new antenna to be located at the new top of the tower.
(2) More than four new equipment cabinets or more than one new equipment shelter will be added.
(3) The width of the tower will be increased by more than the greater of: (a) 20 feet in any direction from the edge of the tower; or (b) the width of the tower structure at the level of the appurtenance. For example, if the width of the tower structure at the level of the appurtenance is 40 feet, the appurtenance can protrude up to 40 feet from the edge of the tower at that point without constituting a substantial increase in the size of the tower.
(4) Excavation will occur outside the current tower site, defined as the area within the boundaries of the leased or owned property surrounding the tower at the time of the proposed collocation, and including any access or utility easements related to the site."[1]

TCA Telecommunications Act of 1996.

Telephony:
Two-way voice communication.

Tower:
"...[A]ny structure built for the sole or primary purpose of supporting antennas and their associated facilities used to provide FCC-[regulated] services. A water tower, utility tower, or other structure built primarily for a purpose other than supporting FCC-[regulated] services is not a "tower" for purposes of the [definition], but is a non-tower structure."[2]

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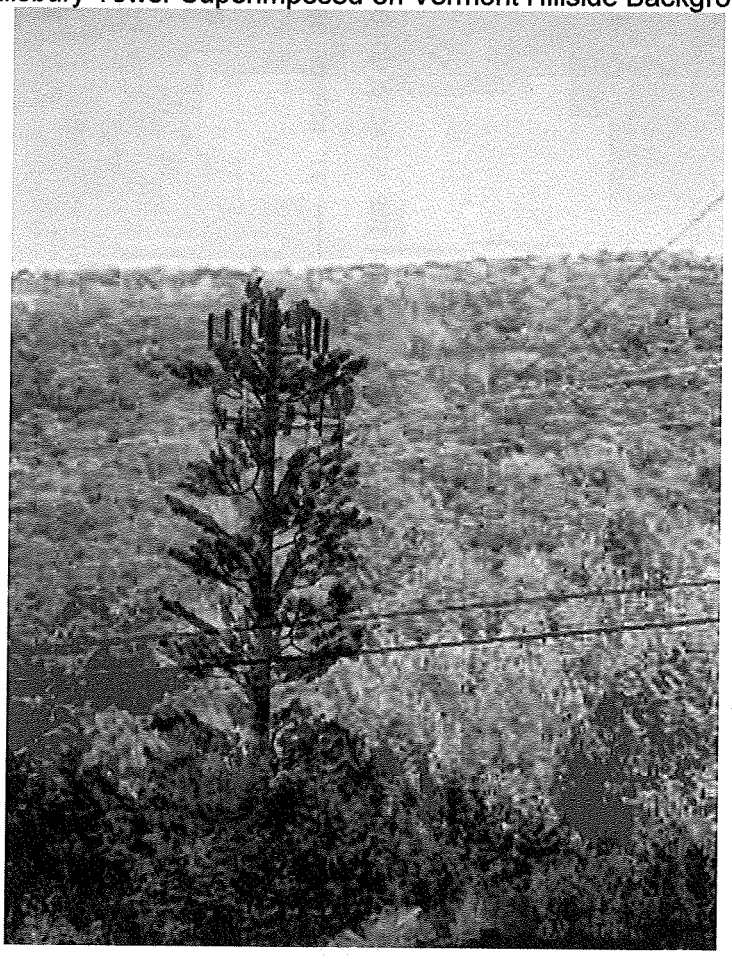
[1] Nationwide Programmatic Agreement for the Collocation of Wireless Antennas – Fact Sheet, 1/10/02. Federal Communications Commission.
[2] Ibid.

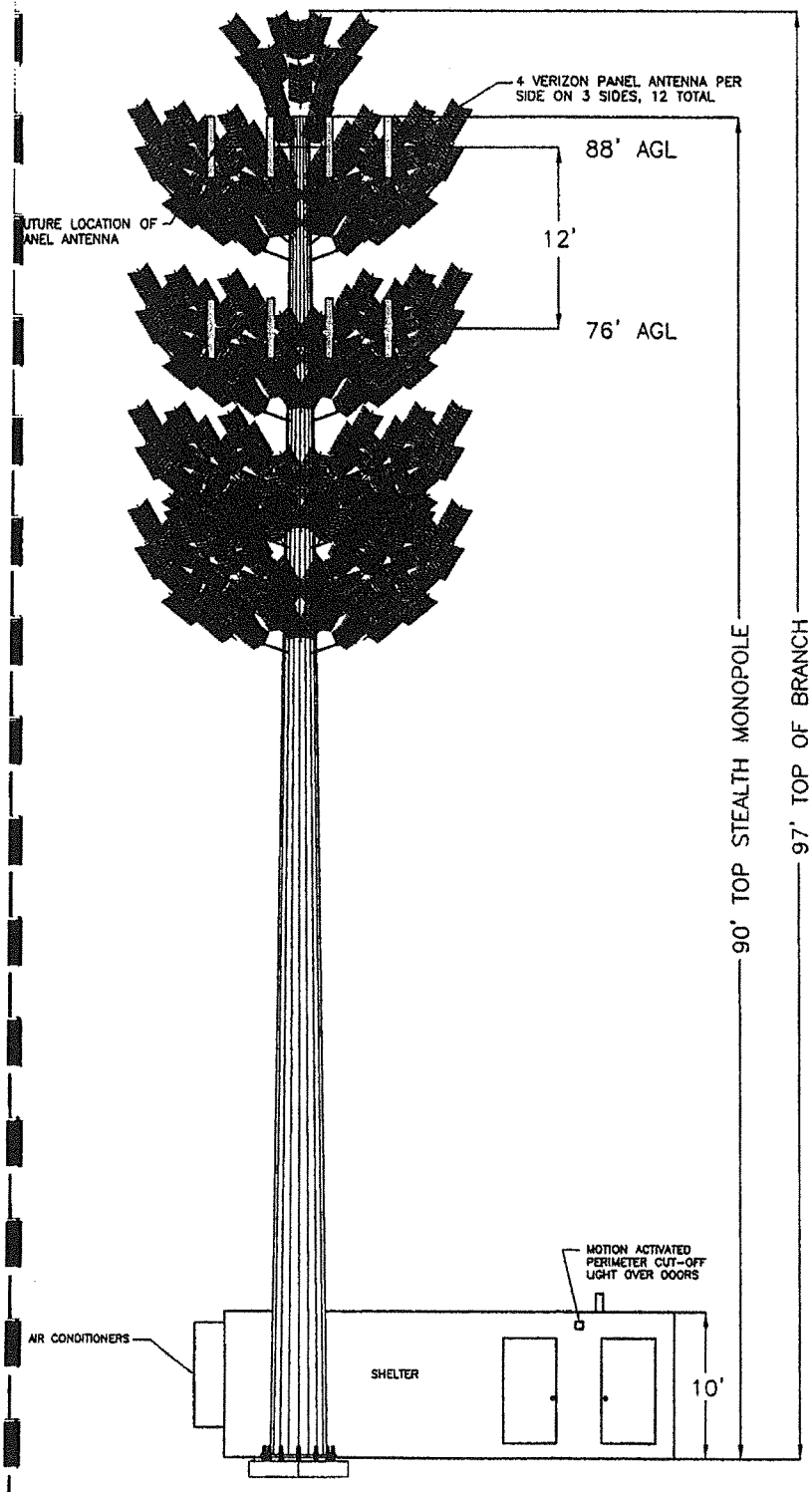
APPENDIX 8 - Stealth Facilities

6-Provider "Tree" Tower, Salisbury, MA

Salisbury Tower Superimposed on Vermont Hillside Background



Proposed C
Latitude 43
Longitude 7
Elevation 6



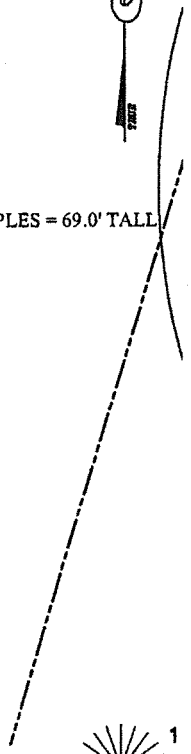
PROPOSED TREE
SCALE: 1" = 6'

REDUCED SCALE
HALF SIZE

AVERAGE TREE HEIGHT SAMPLES

1	12" EASTERN WHITE PINE	82' TALL
2	16" EASTERN WHITE PINE	66' TALL
3	18" SUGAR MAPLE	60' TALL
4	20" OAK	60' TALL
5	18" EASTERN WHITE PINE	65' TALL
6	14" EASTERN WHITE PINE	72' TALL
7	16" EASTERN WHITE PINE	73' TALL
8	20" SUGAR MAPLE	66' TALL
9	14" EASTERN WHITE PINE	87' TALL
10	10" SUGAR MAPLE	59' TALL
11	16" EASTERN WHITE PINE	69' TALL
12	12" EASTERN WHITE PINE	66' TALL
13	12" EASTERN WHITE PINE	75' TALL
14	16" EASTERN WHITE PINE	74' TALL
15	18" EASTERN WHITE PINE	75' TALL
16	20" EASTERN WHITE PINE	84' TALL
17	12" EASTERN WHITE PINE	68' TALL
18	12" EASTERN WHITE PINE	60' TALL
19	18" EASTERN WHITE PINE	72' TALL
20	14" EASTERN WHITE PINE	60' TALL
21	14" EASTERN WHITE PINE	70' TALL
22	12" EASTERN WHITE PINE	70' TALL
23	12" EASTERN WHITE PINE	70' TALL
24	20" MAPLE	65' TALL
25	18" OAK	65' TALL

AVERAGE TREE HEIGHT BASED UPON 25 SAMPLES = 69.0' TALL



TREE HEIGHT RELATIVE TO TOWER

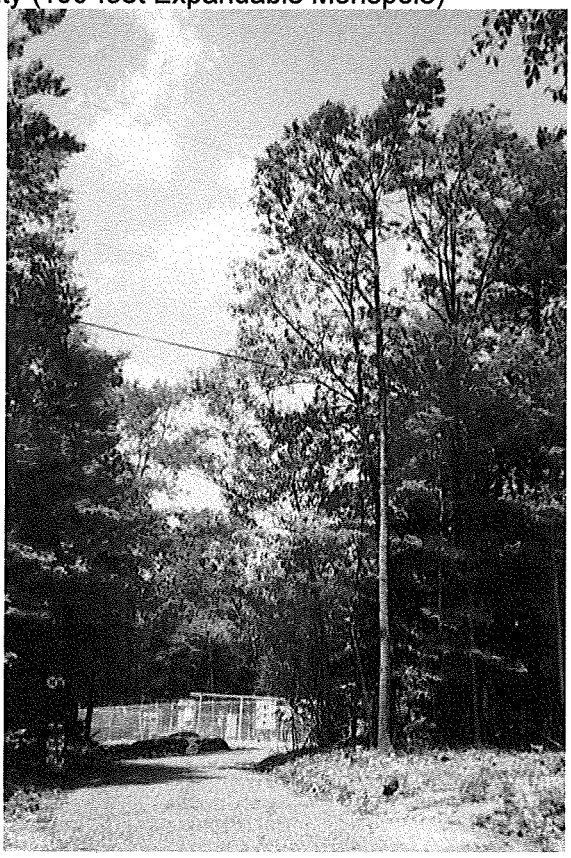
	GROUND	TOP	HEIGHT	BELOW TOWER	DESCRIPTION
5	650.9'	715.9'	65.0'	25.1'	BENCHMARK/PINE
4	652.3'	712.3'	60.0'	28.7'	20" OAK
25	648.8'	713.8'	65.0'	27.2'	18" OAK
22	643.9'	713.9'	70.0'	27.1'	12" WHITE PINE
21	640.8'	710.8'	70.0'	30.2'	14" WHITE PINE
	644.0'	741.0'	97.0'		TOWER
18	640.5'	700.5'	60.0'	40.5'	12" WHITE PINE
17	643.6'	711.6'	68.0'	29.4'	12" WHITE PINE
24	646.4'	711.4'	65.0'	29.6'	20" MAPLE
19	644.4'	716.4'	72.0'	24.6'	18" WHITE PINE
10	638.9'	697.9'	59.0'	43.1'	10" SUGAR MAPLE

verizonwireless

NO.	DATE	
3	9-25-03	SHORTE
2	8-20-03	ADDED
1	8-07-03	

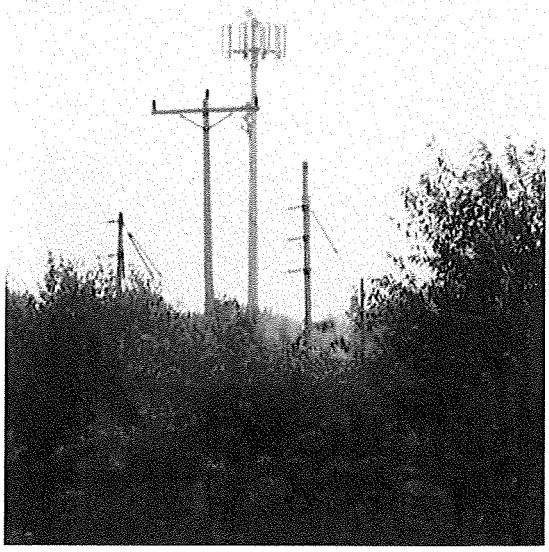
Given extensive tree cover, it may be possible to place a tower in a manner that minimizes visual impact. The photos below show a collocation facility (two levels of provider antennas) with a larger-than-normal pole diameter to allow future expansion with additional sections bolted to the top. This extra future-expansion diameter is well hidden by the trees on the driveway approach shown in the photo on the right. A tower limited to 100-feet - and not designed for expansion - would generally have a smaller diameter. Other concealment approaches could involve antennas not on arms or platforms, but snug against the pole. Some such designs contain the antennas within an RF-transparent canister that appears to be part of the pole. Moving antennas inward reduces coverage.

Westmoreland, NH Collocation Facility (100-foot Expandable Monopole)



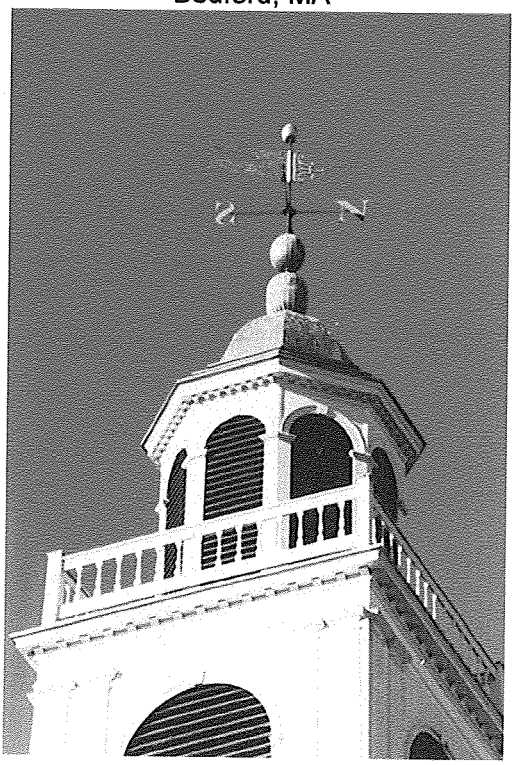
Keene, NH Athletic Field Light/Antenna Pole

Antennas can sometimes be placed on existing poles, as shown at right. This athletic field light pole has been extended to accommodate the PWS panel antennas. In the proximity of an electric utility right-of-way, the nearby clutter of the power lines may mitigate visual impact of the additional antennas.

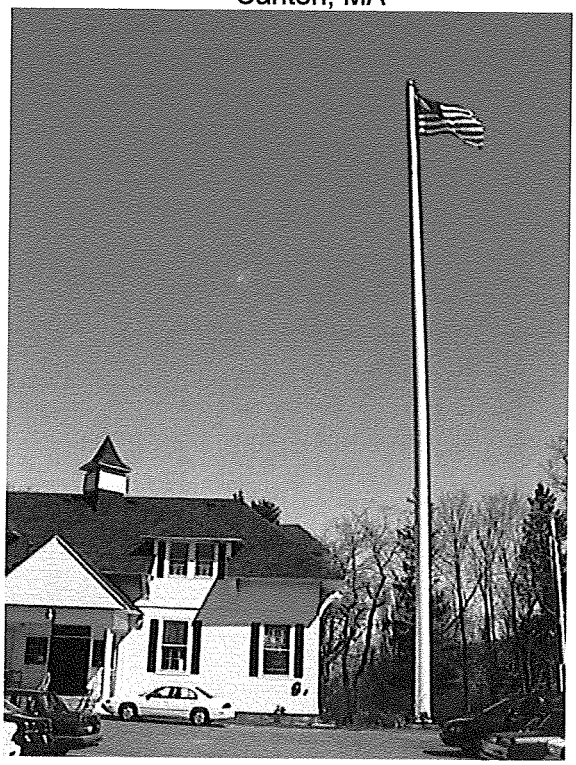


The Following Stealth Facility Photographs
Courtesy of Stealth Network Technologies, Inc.

Bedford, MA



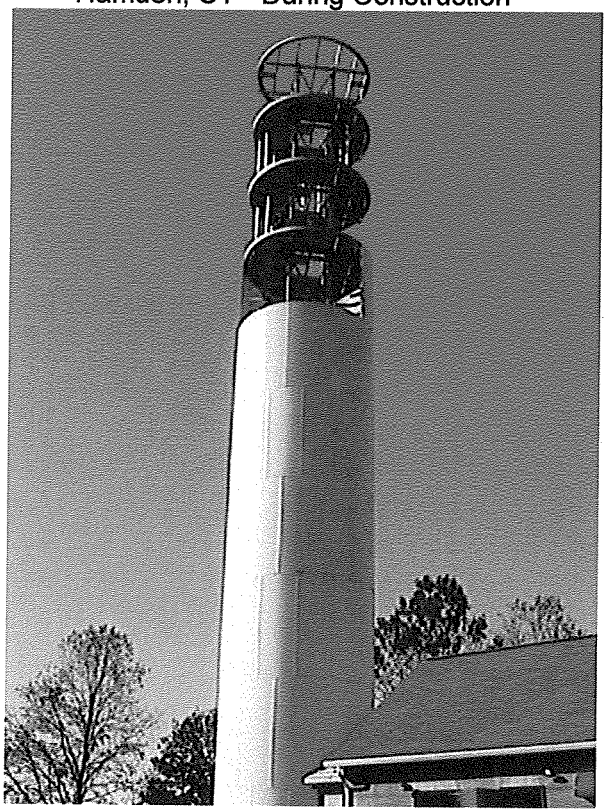
Canton, MA



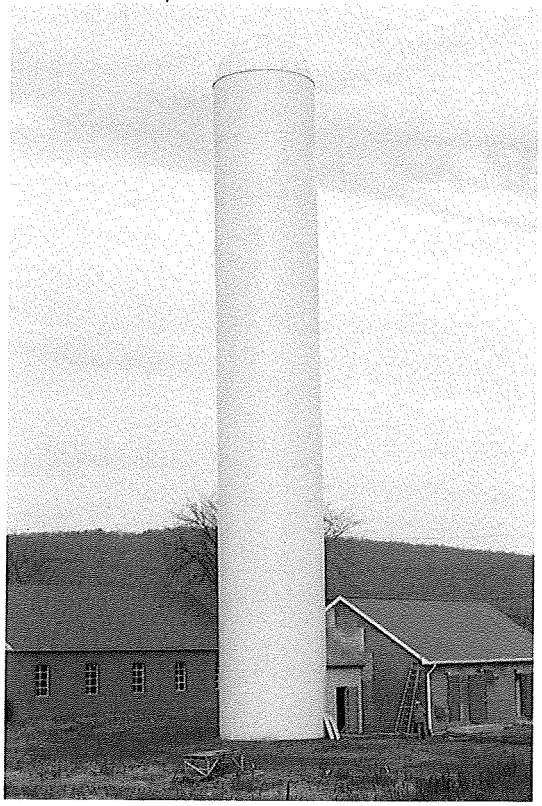
Wakefield, MA

Charlton, MA

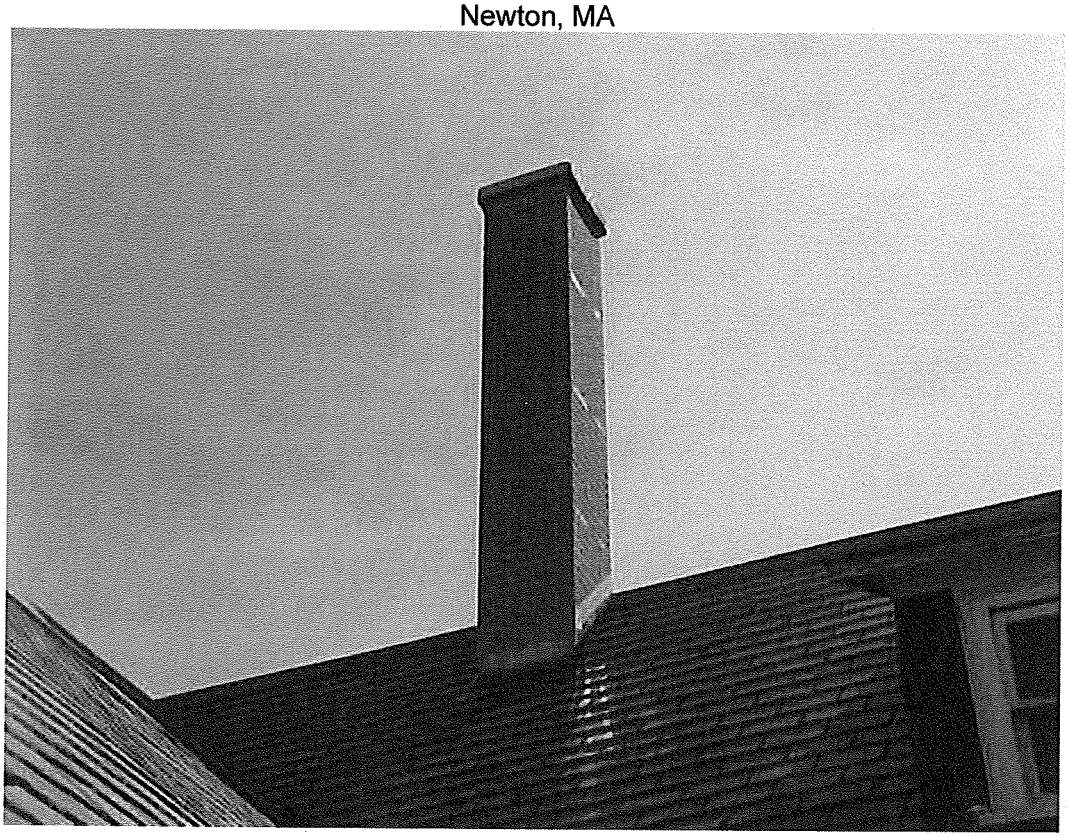
Hamden, CT - During Construction



Hamden, CT - After Construction



Newton, MA



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FINOWEN™
Fast InterNet On Wireless EtherNet

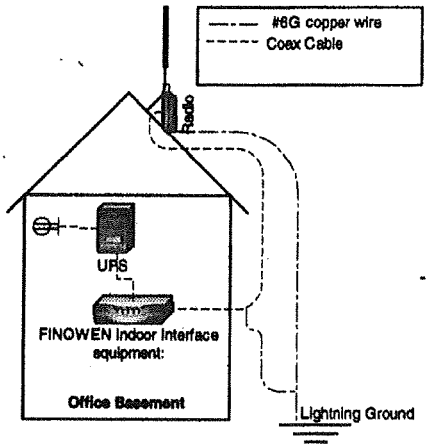
Introduction

Overview

The purpose of this document is to serve as an application for permit of installation of equipment at offices of Simpson Development Corporation located at 2458 Christian St., Hartford, VT. The purpose of the equipment is to provide broadband services to business and residences in surrounding area as dictated by the topography and not extending farther than 6 miles from the installed equipment.

General Description

The diagram to the right illustrates the intended configuration.



Starting from the outside in, a mast containing a small, dish-style, subscriber antenna is already attached to the building with sufficient mast space above the dish for more equipment. Our omni-directional service antenna will be mounted to this same mast. See the Appendix A for antenna details (approximate size: 96 inches high by 2 inches in diameter).

The antenna will be attached to an outdoor radio unit also to be mounted in an unobtrusive way to the mast (see Appendix B for radio details). From that outdoor unit, FINOWEN will run a coaxial cable from the radio to an indoor radio unit which works with the outdoor unit to complete the radio system. Indoor unit will be connected to an existing uninterruptible power supply (UPS) for power which will be plugged into a grounded power receptacle provided by Simpson Development.

Ground wire is connected to the mast and to a grounding rod placed just off the northwest corner of the building. In addition, lighting protection will be placed at the point of entry for the outdoor cable, near where another grounding rod is accessible for connection to the lightning protection.

Resulting Benefit

Up to 100 businesses and residences will have access to the Internet at broadband speeds through this single facility. Should more than 100 users request service within this coverage area, future expansion can be provisioned by adding wider but shorter antennas to this same location. At most, 6 12" square antennas could be placed at this location, each capable of serving up to 100 users.

The direct impact to businesses is increased productivity and/or lower costs, and residences will enjoy the wealth of information and entertainment at their finger tips that only broadband Internet access can provide. As an indirect bonus, over time, having broadband service available will help increase property values.

Forward

It is FINOWEN's mission to bring broadband service to underserved communities in rural and semi-rural areas of Vermont and New Hampshire. Nothing would please us more than to make Hartford one of the first towns to benefit from a long desired service such as ours. We are extremely grateful for the time and efforts that have been made so far on the part of the town and its employees, and we look forward to a long and mutually beneficial relationship via additional cooperation on both sides.

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