CELLULAR TOWER

REQUIREMENTS STUDY

FOR

TALBOT COUNTY, MARYLAND

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1. Introduction and Overview

Columbia Telecommunications Corporation (CTC) is an independent telecommunications engineering consulting firm specializing in providing support to local governments. CTC has been contracted by Talbot County, Maryland to examine the feasibility of enhancing and improving the systematic planning process for the siting of new cellular towers in the County. Cellular or wireless telephone towers typically are stand-alone facilities shared by multiple service providers that serve as access points for communicating with subscribers' handheld and mobile cellular devices.

Over the years cellular telephone usage has increased dramatically. Initially a status symbol of a privileged few, cell phones have evolved into the basic communications lifeline for all social and economic classes of our society. Many consumers no longer subscribe to traditional landline service, but rather use cell phones exclusively.

In addition to the greater number of people using cell phones, the cellular systems themselves have expanded far beyond traditional voice service. Today, cellular carriers have expanded their offerings to include a wide range of services, including text messaging, e-mail, Web browsing, and video entertainment.

Providing more services to more users will translate into a need for more cell towers. So, too, will the expanding number of commercial companies offering cell service. Siting additional towers in Talbot County will provide expanded capacity in areas where services currently exist, and will enable new services in areas that do not currently have adequate coverage.

In our feasibility study, we examined the areas of the County where cellular coverage is provided, as well as areas where service is not currently available or where service is deemed to be inadequate. This report addresses a variety of factors that need to be understood in order to provide for an intelligent and fair distribution of cellular communications towers within the County. Many of the criteria examined are technical or of an engineering nature. They relate to the physics of the system, and how the system performs. There are numerous other, equally important issues relating to zoning, the concerns of nearby residents, and land availability—all of which will need to be weighed in the process of selecting new sites for cellular antennas.

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Figure 1 is a map illustrating the County and the locations of known cellular transmission towers. The locations of the existing facilities were determined using County databases, Federal Communications Commission (FCC) records, and field surveys. The coverage circles on the map illustrate, in an idealized fashion, the anticipated primary and secondary coverage area for each of the towers. (The estimates of the coverage areas will be discussed in detail later in this report). It should be noted that there is extensive coverage along the U.S. Route 50 corridor through the County. Additionally, towers in the County provide primary service in and around the towns of Easton, Oxford, St. Michaels, and Trappe. Along the Route 33 corridor the Wades Point tower, which was earlier used for cable TV, has been converted for cellular use. And a new tower is being put in to operation on property owned by the Calhoon MEBA Engineering School (MEBA) located between Easton and St. Michaels.

Figure 1: Talbot County Cellular Phone Coverage Area

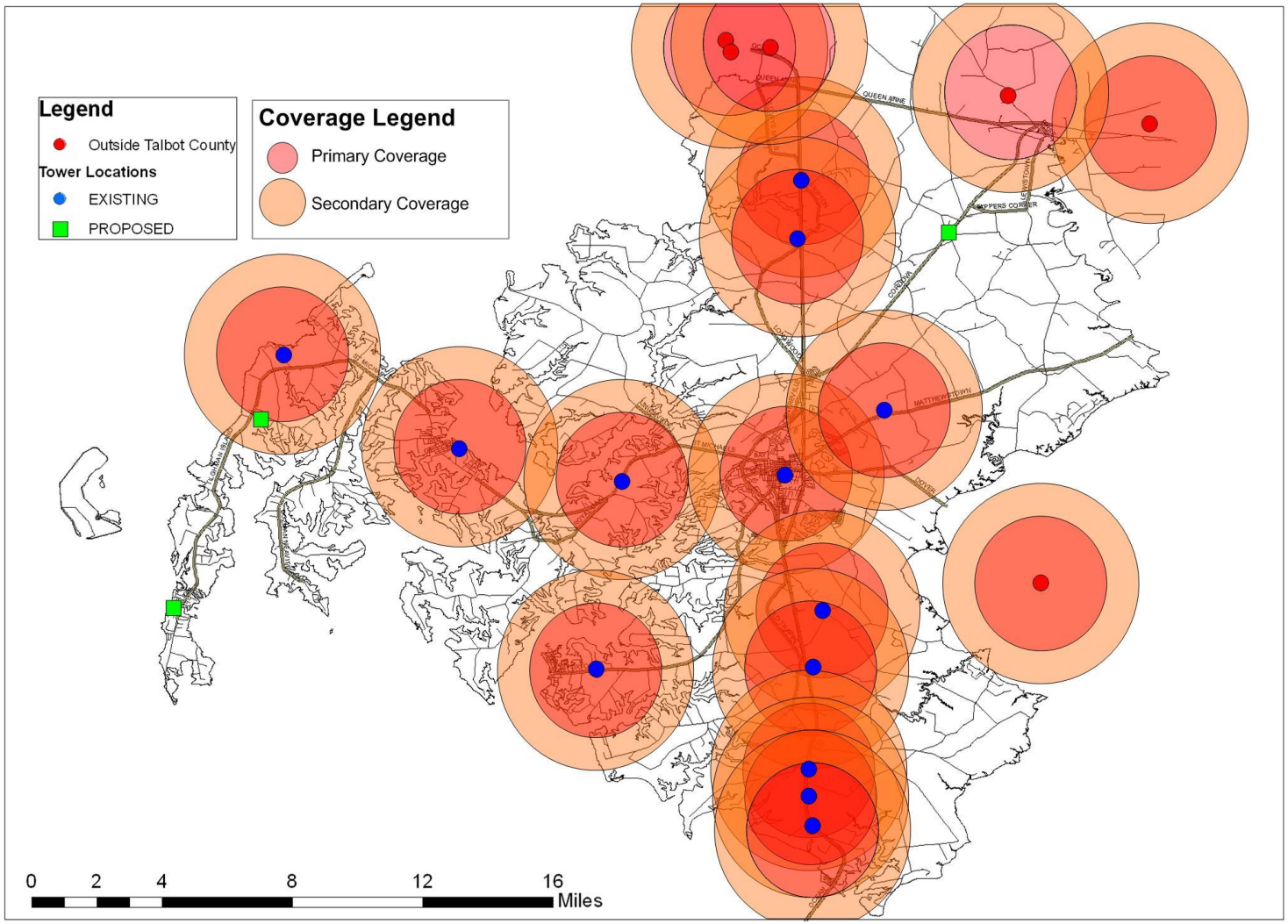

Figure 1 provides an idealized presentation of coverage areas delivered by each of the sites. The actual coverage depends on a number of factors, which will be examined in some detail in the next section of this report. The County's topography (change in elevation) is generally uniform, however, so the actual coverage of cell sites is rather consistent with this idealized representation.

In order to gain a better understanding of the existing cellular tower facilities in the County, we conducted a field inspection to observe each of the known tower installations. The existing cell towers differ in terms of structure, type, height, and supporting equipment. Each installation includes a tower, several equipment buildings, security fencing, primary and backup power sources, and interconnection links to other towers or central office-based facilities.

As an example, Figure 2 is a photograph of the Wades Point tower. Notice that there are two sets of antennas on the top of the tower, each used by a separate service provider. The tower is a lattice tower supported with the aid of guy wires. This type of installation typically requires several acres of land to accommodate the tower and the placement of guy wires, and to address easement requirements.

Figure 3 is a photograph of a recently installed tower at MEBA. The MEBA tower is a self-supporting tower that requires no guy wires. This tower is typical of the new types of structures that are being installed throughout the country.

Figure 4 is a photograph of one of the two equipment buildings at the base of the MEBA tower. These buildings house the transiting, receiving, and controlling equipment needed to provide cellular service.

Many of the towers built to support cellular service are not owned by the cellular service providers. Rather, they are installed by third-party firms—often funded by outside investors—and leased to individual cellular carriers under long-term agreements. Looking at cellular tower construction nationwide, new structures are typically constructed on the premise that there will be at least three cellular carriers leasing space on them—though this has not been the case in Talbot to date.

Figure 2: Photograph of Wades Point Tower

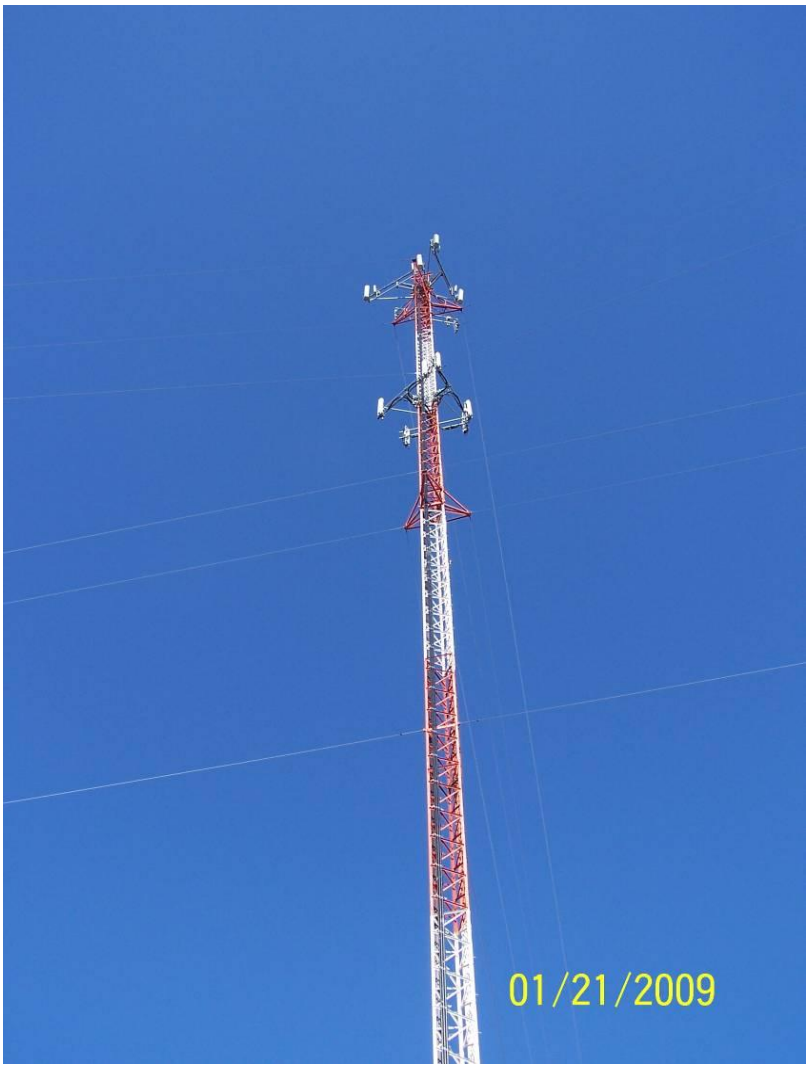

Figure 3: Photograph of MEBA Tower

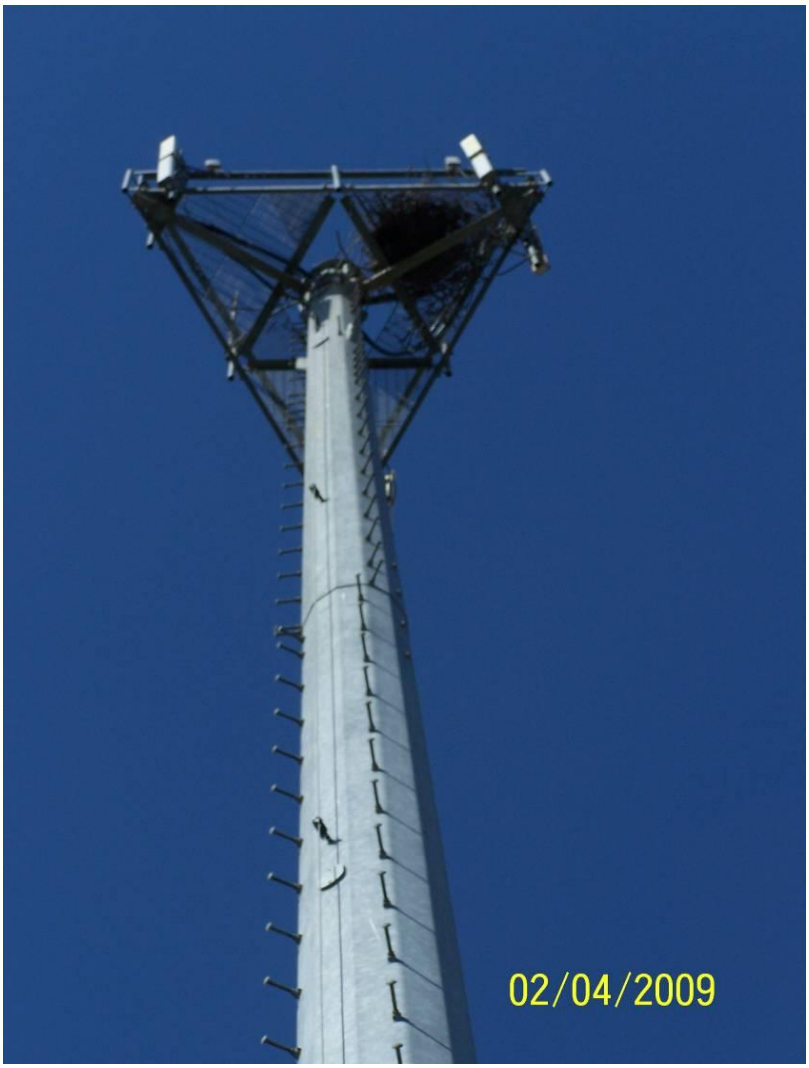

Figure 4: Photograph of Base of MEBA Tower and Equipment Shelter

2. Technical Factors Impacting Coverage Range of a Cellular Tower

Cell towers are designed to provide a reliable radio communications link between a carrier's central network access equipment and the cellular subscriber. Numerous factors impact the overall range of a cell tower and the number of subscribers that can be served from a given location. In this section of the report we will summarize, at a relatively high level, many of the engineering issues affecting the coverage range of cellular towers. We will also address some of the key factors or technical parameters that service providers consider when they select sites for cellular and broadband wireless applications.

2.1 Radio Frequency Band

Cellular telephones and other similar handheld wireless devices typically operate in a wide range of radio frequency bands from 700 MHz to 2.5 GHz. The specific bands are allocated, often through public auction, and competing operators (including Verizon, AT&T, Sprint, and CellularOne, just to name a few) construct antennas and transmission systems (often co-locating, or sharing a tower with other carriers) to operate the radio band on which they are authorized.

The transmission range, or reliable coverage distance, from the tower is determined by how the radio signal acts (its "propagation" characteristics), which varies as a function of the radio frequency as measured in Hertz (Hz). In general, given an antenna's height and power, systems that operate at a lower frequency range (i.e., 700 MHz) typically have the greatest service or distance range. As the transmission frequency increases to 2.5 GHz, the coverage area provided by a given installation is reduced. The higher frequencies are also affected by losses due to foliage and other vegetation, as well as moisture from rain and fog. Yet those higher frequencies are attractive to carriers because they often support a wider transmission bandwidth, which allows the service provider to offer high-speed services such as Internet access and data transmission.

2.2 Terrain Characteristics

Within any radio frequency band (frequency range) there is a difference in the transmission characteristics or signal loss associated with various nearby terrain or environmental conditions. In open fields or on water, for example, radio signals propagate the greatest distances with minimal signal losses. In towns and more urban areas, or where combinations of structures reflect or absorb radio signals, the coverage area is often reduced.

2.3 Antenna Height Above Service Area

The height of a carrier's antenna is the key parameter that controls the maximum range of coverage for all frequency bands. In urban areas, raising the antenna too high above ground can be detrimental: Doing so can create cell coverage areas that are much larger than desired for a

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single transmission facility. If the cell size is too large, too many subscribers will be trying to access the same facility—which will create busy signals. In lower-density areas such as Talbot County, on the other hand, larger service areas are desirable because they increase the coverage provided by a single tower. The town of Easton and the Route 50 corridor clearly have the highest population density and greatest traffic volume in the County, and thus need the most coverage.

2.4 Radio Equipment and Subscriber Devices

Subscribers' mobile devices and phones are another factor that affects the overall range of the cellular system. The limiting factor is the power or radiation capability of the handheld telephone or subscriber unit.

At the time of their introduction in the early 1980s, cell phones were large and bulky. Many were installed as fixed units in vehicles. These early units had a transmitting power of several watts and employed efficient rooftop-mounted antennas, so they could communicate with relatively distant cellular towers. Add to that the fact that carriers had very small subscriber bases—and there were only one or two cellular providers in a given area—and it's clear that there was limited need for mass deployment of cellular tower sites.

Today, subscribers continue to seek smaller, slimmer devices. This translates into relatively inefficient antennas and lower battery capacity. Most devices have less than one-tenth of a watt of power, which limits their range (but does have the positive effect of mitigating any potential harmful effects on users of the devices' radiofrequency radiation). Less powerful devices with less efficient antennas demand more cellular towers to maintain adequate service coverage.

2.5 Services Supported on the Network

Modern cellular phones support a wide variety of services ranging from simple paging and traditional voice phone calls to data transmission in the form of texting, Web browsing, and e-mail. New systems coming on the market will support full-motion video, which will provide an outlet for satellite and cable network programming such as ESPN, CNN, and the Weather Channel.

As these data-intensive applications develop for cell phones and mobile devices, they will require carriers to provide greater bandwidth and stronger signal strength to ensure a reliable transfer between the cell tower and the cellular subscriber. This will probably require the construction of additional cellular towers. (Accordingly, as new technologies become more widely adopted, the County should revisit this study to identify needs for new or expanded coverage areas.)

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3. Modeling Cellular Tower Coverage Area

In this section we will examine some typical radio propagation coverage models that are used in planning the siting of cellular telephone system towers. The aim here is to provide information and guidelines on the relative coverage areas provided by individual cell phone towers.

For purposes of illustration we will select a hypothetical site in the vicinity of the fire station in Cordova, Maryland. Figure 5 is a map illustrating the calculated coverage area of a hypothetical transmitting tower with a height of 120 feet at this site. We will use the Hata-Davidson model to calculate the service area for this tower. As seen in the map, the site's coverage area is divided into three grades of service. The area that corresponds to the strongest signal levels—of the type required to reliably penetrate buildings—is shown in red. The orange area corresponds to the signal level required to maintain reliable communications in a moving vehicle. Finally, the outer circle area is the area in which communications can be provided to individuals in the open.

Most cell phone users are familiar with these coverage issues if only from a subjective point of view. They have, by trial and error, discovered that if they experience coverage problems in buildings, then they can usually establish a better connection by walking outside of the structure to find a nearby spot where better coverage can be established. The same is true in a moving vehicle, which goes in and out of "dead zones."

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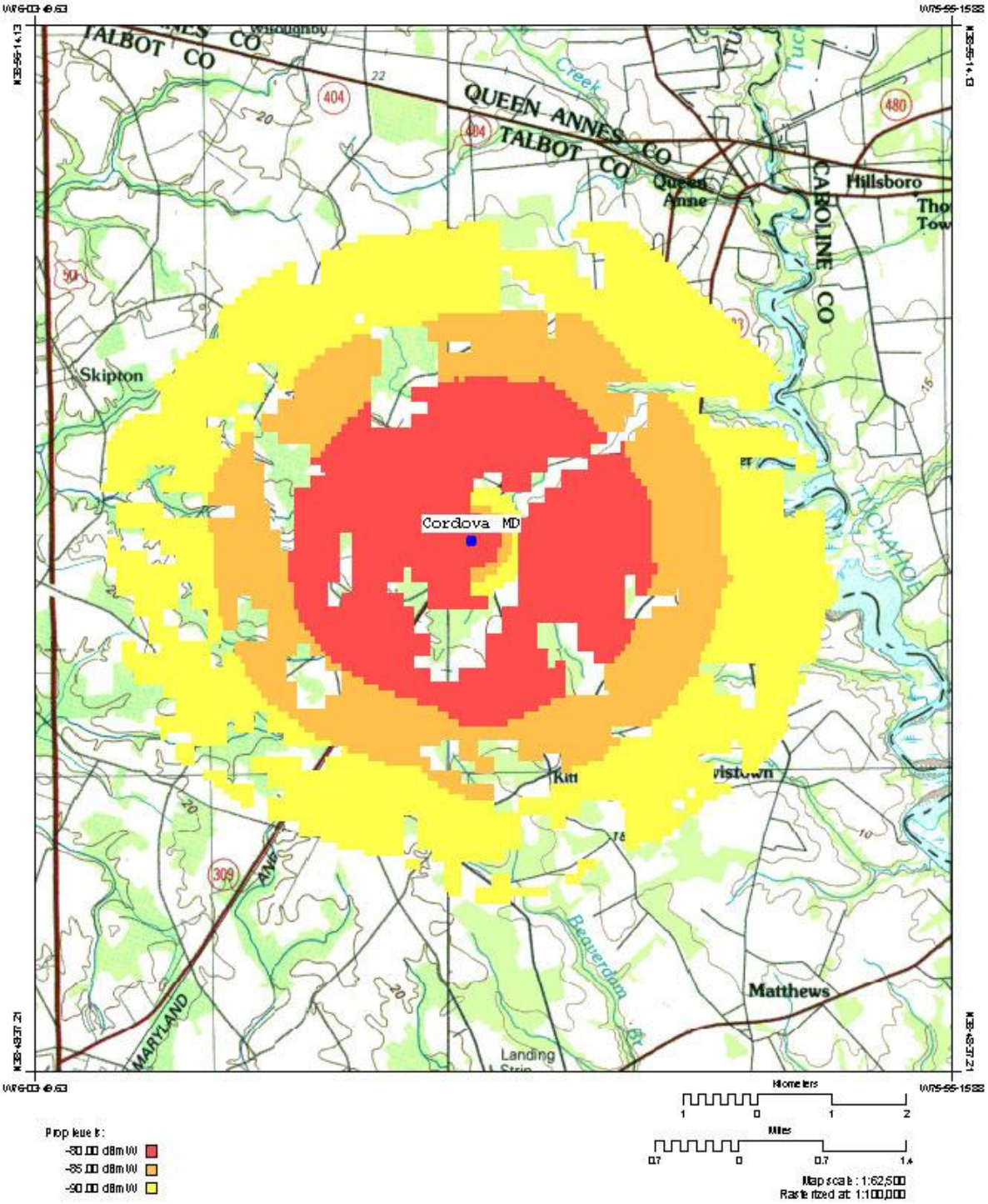
Figure 5: Calculated Service Area of a 120′ Cellular Tower



For the sake of comparison, Figure 6 and Figure 7 are coverage maps using the same model and site location, but raising and lowering the tower height to 150 feet or 90 feet, respectively. It should be noted that while increasing the tower height increases the overall range of the cell tower, it does not always address dead spots in the coverage area caused by irregularities in the terrain such as the County's creek beds and marshy areas. (The model used for creating these maps does not have the high level of resolution necessary to produce a fully accurate representation of an individual cell site's coverage; in fact, the dead zones or low-signal areas are actually smaller than illustrated, because of the granularity of the maps.)

Figure 6: Calculated Service Area of a 150′ Cellular Tower

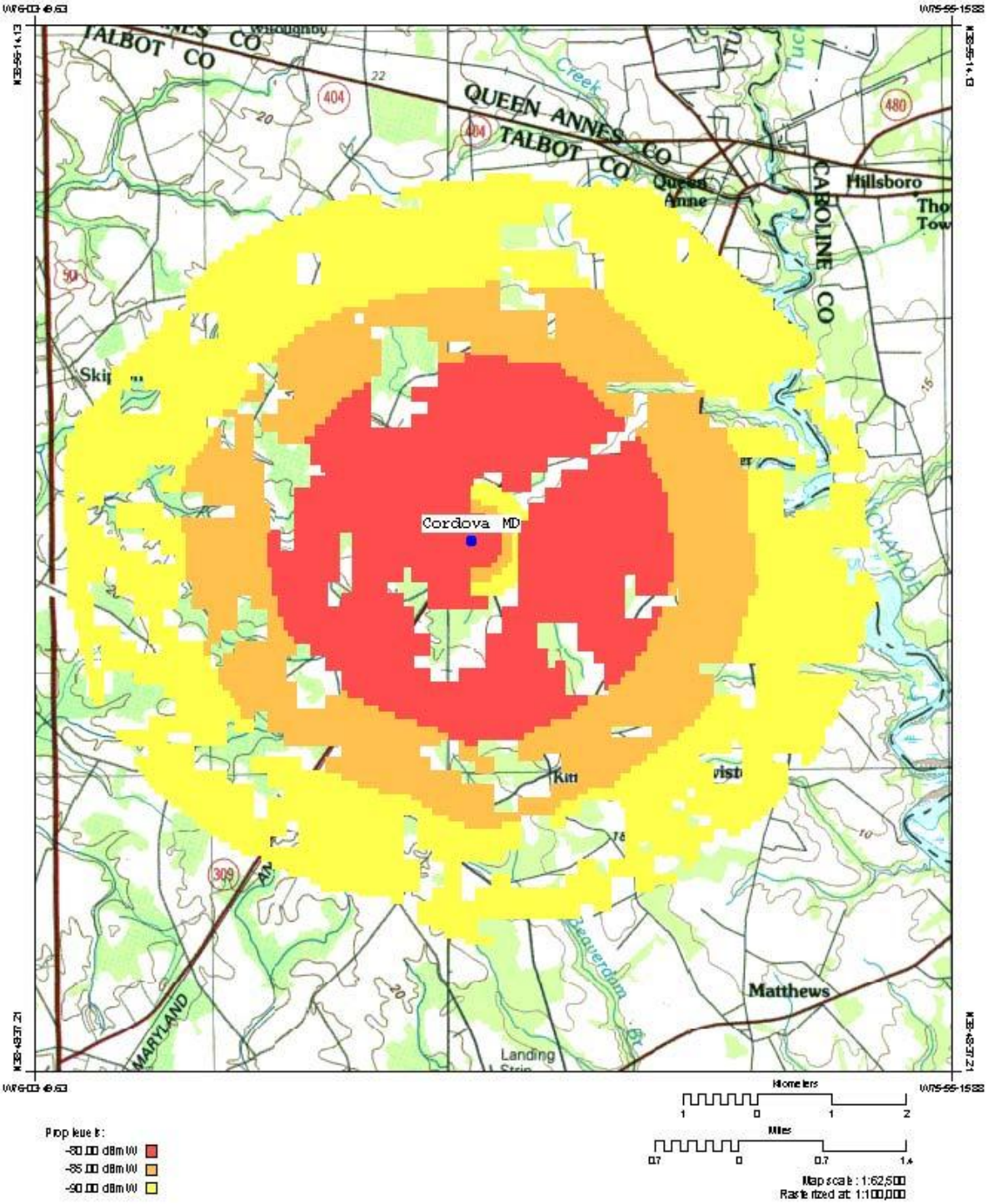


Figure 7: Calculated Service Area of a 90′ Cellular Tower

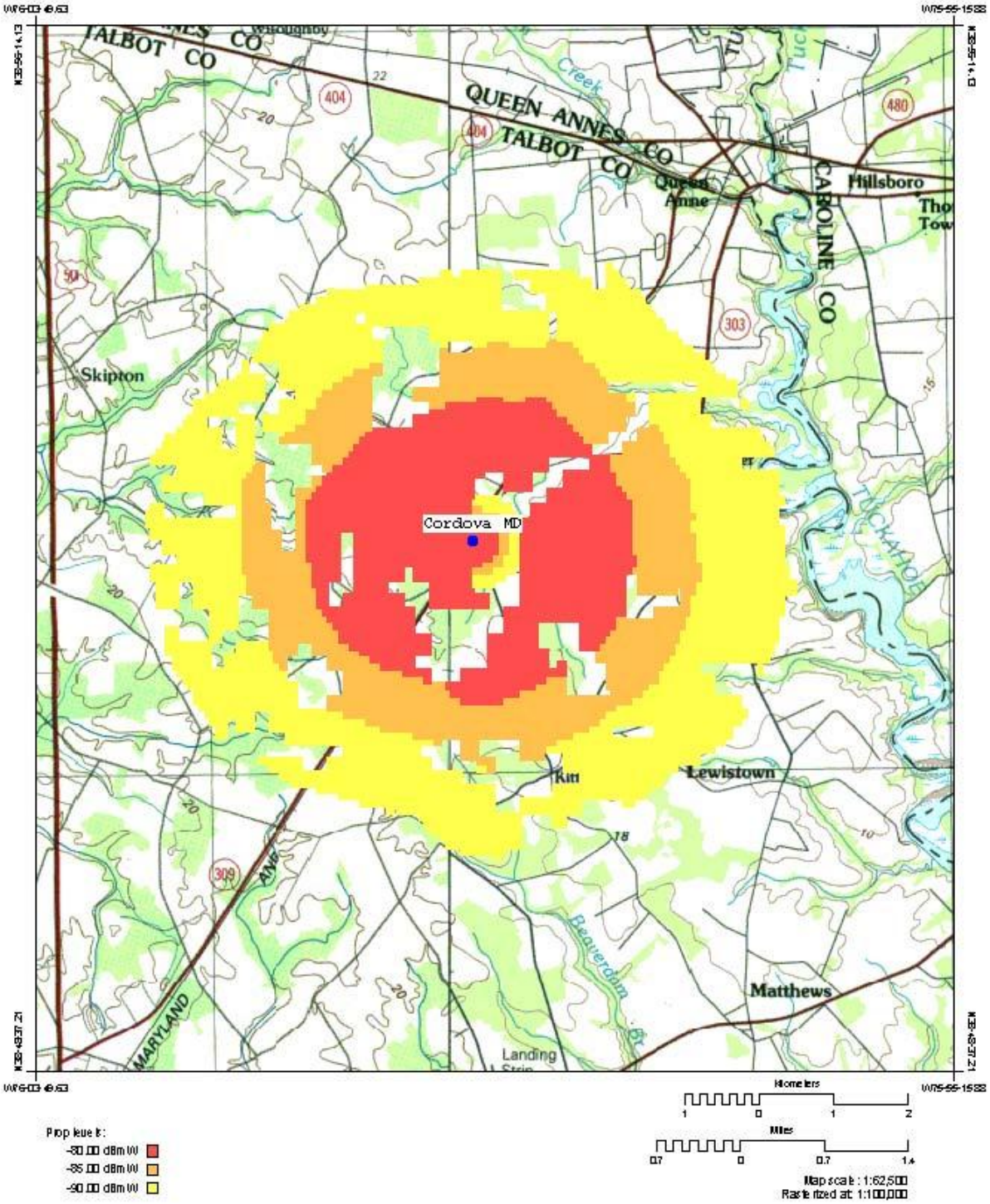
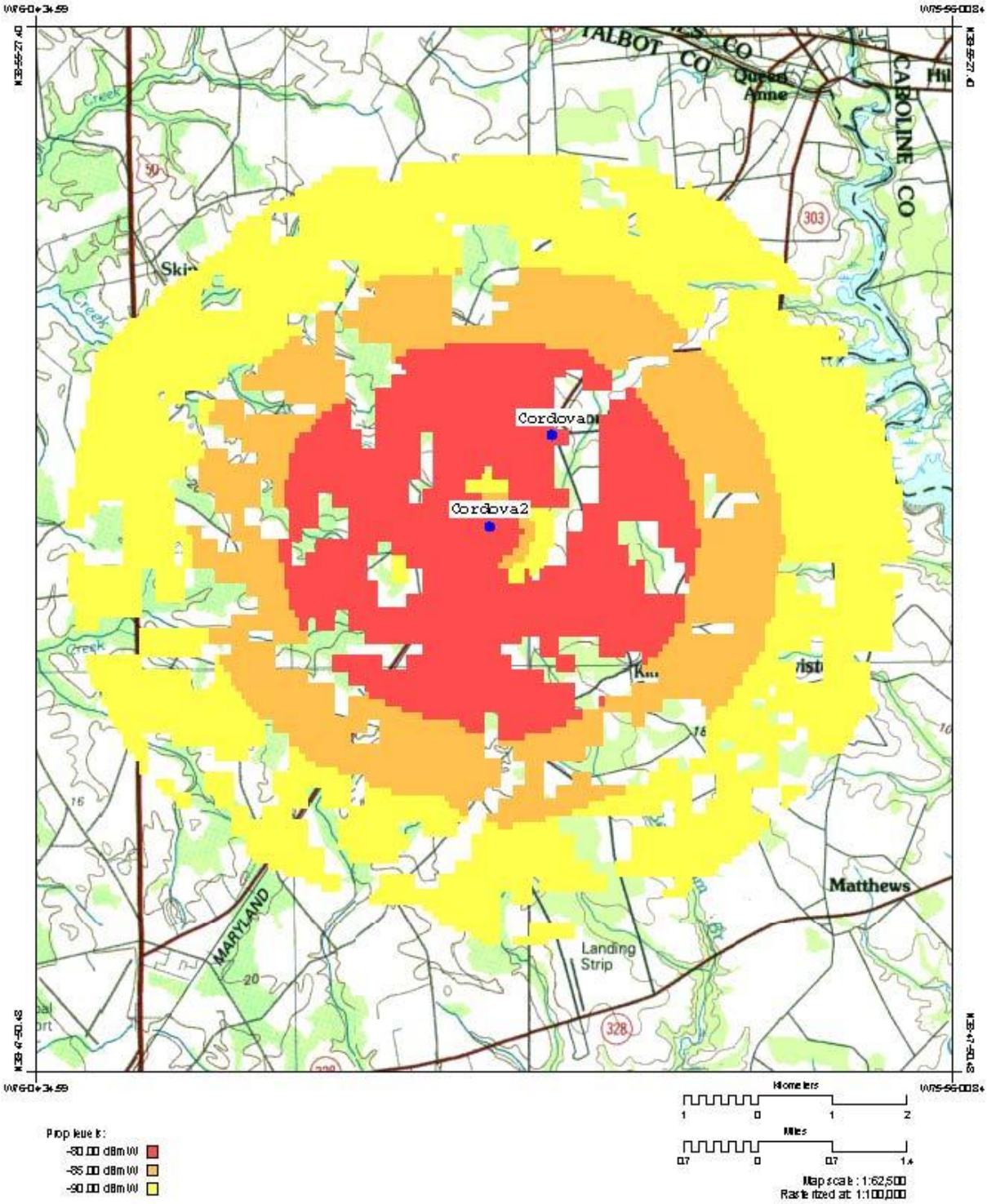


Figure 8 is the propagation (estimated coverage area) for an alternate site approximately one mile south of the fire station with an elevation of 120 feet. Note that at this site, the overall coverage area range is quite similar to the one at the fire station; however, the shadowing area is reduced because this site has a better direct view or propagation path to some lower areas. (This is the type of analysis that a carrier's radio engineering staff uses to select locations for new facilities.)

Figure 8: Calculated Service Area of a 120′ Cellular Tower South of Cordova



For further comparison, Figure 9 shows a side-by-side view of two coverage areas.

Figure 9: Calculated Service Area of a 90′ Cellular Tower Compared to Service Area of Alternate 120′ Tower

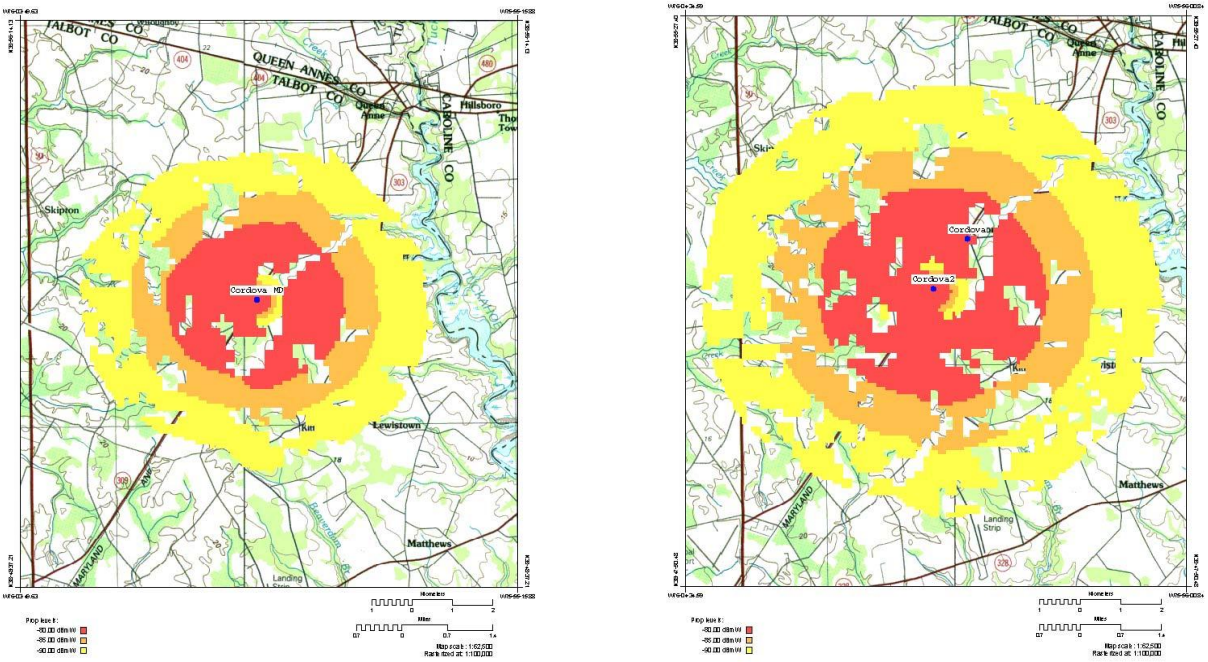
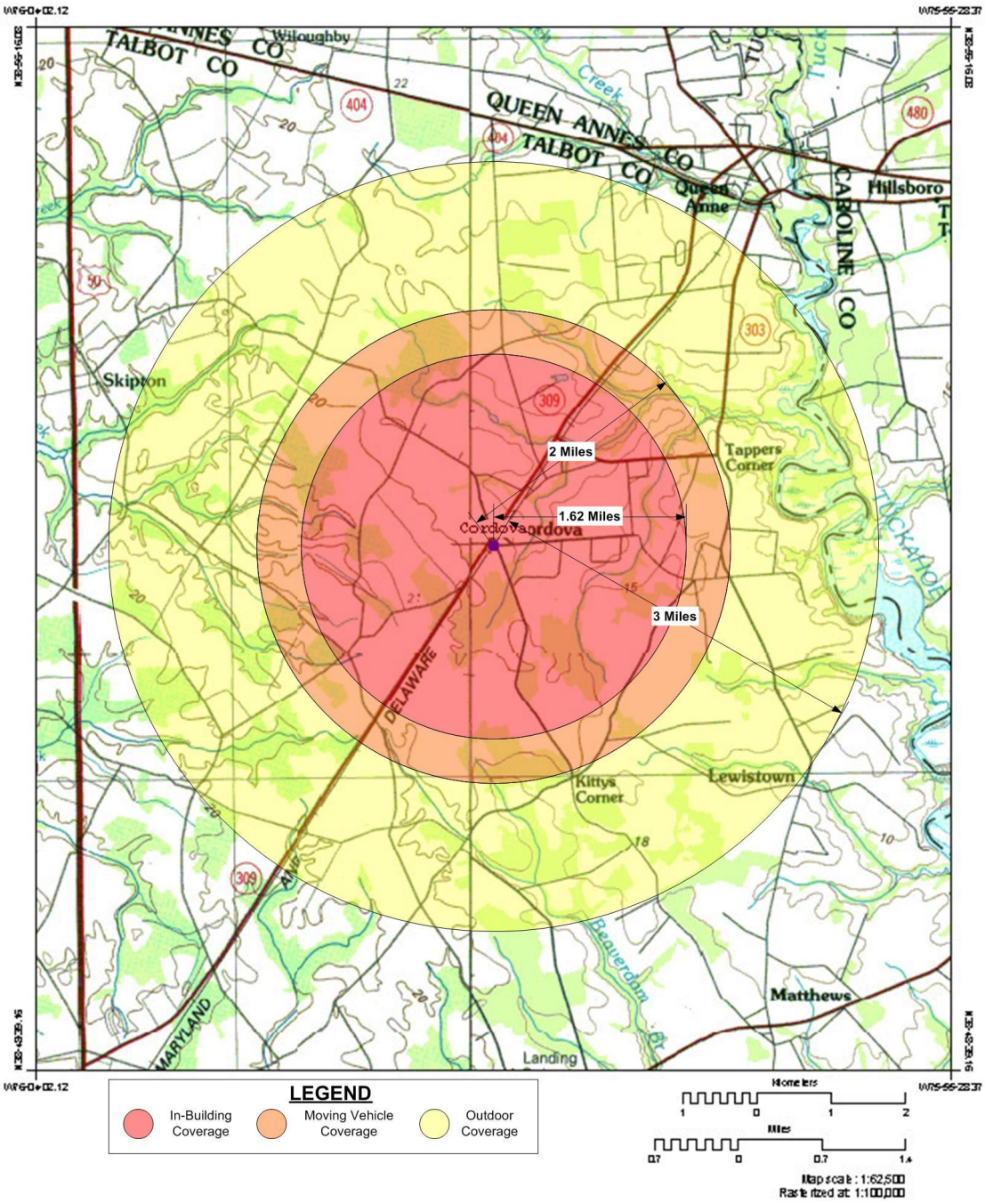


Figure 10 is an idealized coverage area map for a 120-foot tower. This is the idealized coverage area that was used to create our estimates of County coverage areas in Figure 1.

Figure 10: Idealized Service Area of a 120′ Cellular Tower



4. Candidate Areas in Talbot for New Cellular Sites

Figure 11 is a map illustrating the coverage areas of existing cell tower sites in Talbot County and adjacent sites in nearby counties. The substantial areas of the County shown in white do not have adequate cellular telephone coverage.

Using the idealized coverage model, we have defined areas in which we recommend that cell towers be placed to improve coverage within the County. (As discussed in the preceding section, many technical factors, including ideal coverage calculations, affect tower siting; additional factors include land availability and the suitability of siting based on current regulations.) The green shaded areas on the map illustrate the areas in which we believe coverage is needed, and in which private carriers are most likely to come forth with applications for new tower sites. The specific areas include centers of population and the County's most traveled highways. The areas shown in yellow have very limited cell coverage, and clearly require new cell towers or access points to meet the public's needs. These areas have been designated separately from the green areas because their population and vehicular traffic is much lower than in the green areas—meaning that private carriers will be less inclined to invest in new towers there.

For modeling purposes we have assumed that a typical cell tower will provide excellent coverage for an average distance of approximately two miles from the tower. Further, we assume that reasonably reliable communication should extend an additional mile, for a total coverage area of up to three miles from the tower.

As can be seen from the figure, coverage along the Route 50 corridor is generally good. There is a small section north of the town of Easton where coverage might be improved with the addition of a tower. It should be noted that this area is close to the Easton airport, and in the flight approach pattern from the northeast, so there may be height restrictions there associated with Federal Aviation Administration requirements.

Good coverage is also available along Route 33 west of Easton to the area north of Sherwood. Towers will be required south along Route 33 toward Tilghman, where there is currently limited or poor service. Additionally, as seen on the map, a similar situation exists on the Bozman-Neavitt peninsula and in the lower portions of the Royal Oak (Bellevue) area. In general, the remainder of the County west of Route 50 with the exception of Tunis Mills has adequate cell service coverage.

In the eastern portions of the County—specifically along routes 309, 328, and 331—there are underserved areas which we have designated in green. New towers there would substantially improve coverage.

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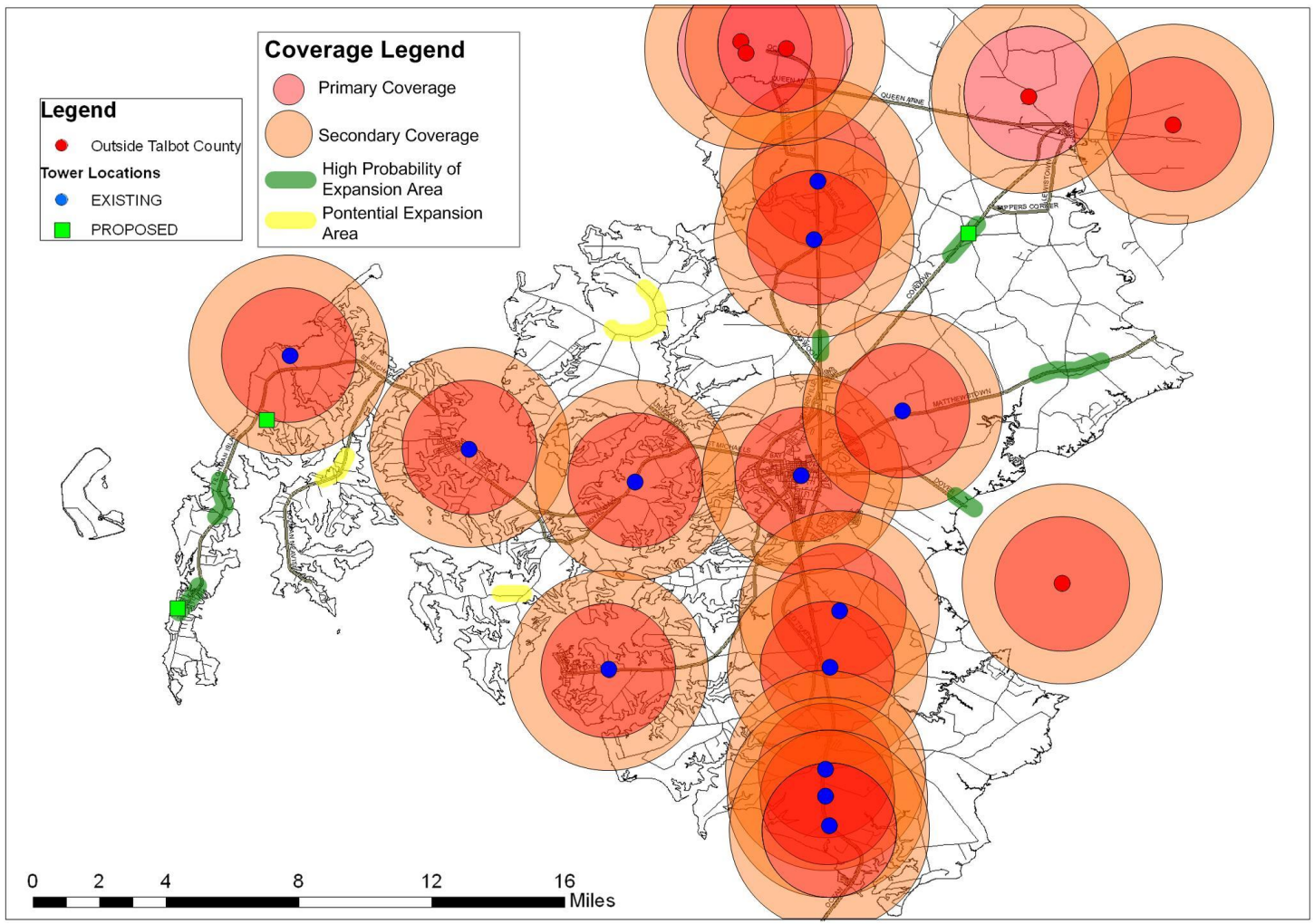
Figure 11: Candidate Areas in Talbot for New Cellular Sites



5. Additional Recommendations

In addition to preparing a countywide overview plan for the placement of cell towers, CTC was tasked with commenting on the existing cellular tower processing procedures in the County and making recommendations for improving future processing procedures.

In general we find that the existing process has worked quite well. As can be seen from the map illustrations in this report, the County's key coverage areas already have service, and in the existing coverage areas there do not appear to be any unneeded towers. Further, a preliminary review of pending applications (which were filed with the County prior to the current moratorium on new towers) shows that all address areas where there is limited or no service. We did not review the exact placements of the proposed towers, but they clearly were targeted at areas with coverage deficiencies.

In considering new applications for cellular towers we recommend the following items be addressed and included in the existing procedures for cellular tower processing:

Improve the existing tower database. The County's database should include all existing cell towers providing service in its jurisdiction. At a minimum the database should include specifics on the tower location, height, and existing tenants, and contacts for the tower owner or representative. The list should also include existing municipal facilities (towers, water towers, buildings, and land) that are available to cellular providers under a long-term lease.

Enhance the fee structure. The existing fee structure should be modified to defer the cost of cell tower oversight in the County. The fees should be consistent with those charged by other Maryland counties, and should include:

- Application fees for new facilities
- Application fees for modifications of existing facilities/co-location
- One-time grant fee to cover approval and finalization of terms of new application
- Annual regulatory fees to cover administrative oversight and database maintenance

Increase the facilities bond. The current bond that tower owners are required to pay to cover the cost of removing an unused tower and associated facilities is not adequate. The bonding fee needs to be raised to an amount that is consistent with the actual cost of removing unwanted facilities. A minimum fee might be more in the order of $25,000. We recommended that the County seek the guidance of a qualified civil engineer, and that the County direct its staff to use the established third-party review process to assist the Planning Office in determining a more appropriate bonding level. The level should be consistent with the County's land development code:

"The owner of the new wireless communications tower shall post and maintain a bond of a sufficient amount determined by the Planning Office to cover the cost of removal of the

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tower, base, foundation to six feet below ground level, and accessory structures, if the tower's use is discontinued for 12 or more continuous months. Proof of the bond shall be submitted to the Planning Office annually. An abandoned wireless communications tower shall be removed within 90 days of abandonment. If the owner of the tower does not remove the tower, the cost of the removal of the tower shall lie with the property owner. Talbot County shall retain the right to place a lien against the property until the tower is removed."

Hire on-call technical advisers. County staff will need occasional technical assistance to validate that tower applications (both for new towers and for changes to existing towers) are in compliance with the County's technical requirements. The County should utilize its existing third-party review process for independent technical evaluation of cell tower applications. Using this process as an independent technical evaluation, as other jurisdictions have done~~,~~ will address the generally proprietary nature of the applications. (Cell service providers consider their applications private because they often contain sensitive information.)