Helping Local Government Solve Wireless Telecommunications Issues

Wireless Telecommunications Master Plan

November 9, 2010

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Acknowledgements

CityScape would like to thank the following for their time and input into this project:

Buckingham County Board of Supervisors
District 1 - I. Monroe Snoddy
District 2 - F.D. "Danny" LeSueur
District 3 - E.A. "Bill" Talbert
District 4 - John D. Kitchen, Jr.
District 5 - Brian D. Bates
District 6 - Joe N. Chambers, Jr.
District 7 - Danny R., Allen

Buckingham County Planning Commission
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District 5 – Cassandra Stish, Vice-Chair
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University of North Carolina at Greensboro Department of Geography
Jeffrey C. Patton, Ph.D.
Roy S. Stein, Ph.D.
Rick Bunch, Ph.D.
Anna Tapp
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Special thanks to all who provided information as requested and to those of you who read and reviewed the document for input and corrections.

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Preface

Purpose of this plan

In recent years, the Buckingham County (the "County") has experienced wireless telecommunication infrastructure growth. Such growth requires additional towers for elevated antennas and base station ground equipment. In response to the installation of this infrastructure the County adopted public policy addressing tall towers in effort to regulate new antenna support facility construction.

The County contracted with CityScape Consultants to develop a Wireless Telecommunications Master Plan (the "Master Plan") to analyze current demand for wireless telecommunications services within the County and to recommend guidelines and policy for tower growth management as it impacts the County and its citizens into the future.

The purpose and intent of the Master Plan is similar to the goals and objectives of other long-range plans, such as roadway improvements and the extension of water and sewer lines. The Master Plan combines land-use planning strategies with industry-accepted radio frequency (RF) engineering standards to create an illustrative planning tool that aids in making public policy decisions regarding telecommunications infrastructure. The Master Plan offers strategies to reduce tower infrastructure by improving efforts to integrate wireless deployments between the wireless service providers. Effective master planning will minimize tower proliferation by increasing collocation opportunities.

The Master Plan includes the following:

- A tutorial on the history of the industry and explanations of how the equipment works and projections of future industry trends.
- An inventory of existing antenna support facilities and buildings upon which wireless antennas are currently mounted.
- Engineering analysis of potential coverage based the existing antenna locations, County-regulated height restrictions, and other network and planning design criteria.
- Analysis of reasonably anticipated wireless facility growth over the next ten years and recommendations for managing the development of wireless structures with an emphasis on minimizing the total number of telecommunications towers throughout the County.
- Identification of publicly owned land as potential new sites for future towers.
- Review of existing ordinances and codes and provide recommendations on public policy that addresses County staff, citizenry, and wireless industry goals while ensuring compliance with the Telecommunications Act of 1996 (as amended) and state law.

CityScape Consultants, Inc.

Many communities are concerned about the proliferation of telecommunications tower build-outs from the standpoint of public safety issues, aesthetics, staff time involved in the site review process, fair deployment practices, and the legal implications of upholding both the public and private interests involved. Additionally, many communities respond to tower growth in an ad hoc manner, which is the most expensive and perilous way to manage expansions to existing wireless telecommunications networks. CityScape works for only public agencies to address these identified concerns. CityScape specializes in developing land use strategies to control the proliferation of wireless infrastructure, affording the maximum continuing control of local governments, while maintaining compliance with the Telecommunications Act of 1996. CityScape Consultants, Inc. is a land-use planning, legal and radio frequency engineering consulting firm located in Boca Raton, Florida and Raleigh, North Carolina.

Chapter 1 The Telecommunications Industry

Introduction

Telecommunications is the transmission, emission or reception of radio signals, digital images, sound bytes or other information, via wires and cables; or via space, through radio frequencies, satellites, microwaves, or other electromagnetic systems. Telecommunications includes the transmission of voice, video, data, broadband, wireless and satellite technologies and others.

One-way communication for radio and television utilizes an antenna to transmit signals from the broadcast station antenna to the receiving devices found in a radio or television.

Traditional landline telephone service utilizes an extensive network of copper interconnecting lines to transmit and receive a phone call between parties. Fiber optic and T-1 data lines increases the capabilities by delivering not only traditional telephone, but also high-speed Internet and, in some situations cable television, and is capable of substantially more. The new technology involves an extensive network of fiber optic lines sited in above- and below-ground locations.

Wireless telephony, also known as wireless communications, includes mobile phones, pagers, and two-way enhanced radio systems and relies on the combination of landlines, cable and an extensive network of elevated antennas, typically found on communication towers, to transmit voice and data information. This technology is known as the first and second generation (1G and 2G) of wireless deployment.

Third, fourth and fifth generations (3G, 4G and 5G) of wireless communications will include the ability to provide instant access to e-mail, the Internet, radio, video, TV, mobile commerce, and Global Positioning Satellite (GPS), in one handheld, palm pilot type wireless telephone unit. Successful use of this technology will require the deployment of a significant amount of infrastructure, i.e. elevated antennas on above-ground structures such as towers, water tanks, rooftops, signage platforms, and light poles.

The recent evolution of telecommunications began in the 1800’s and continues to evolve at a very fast pace. Figure 1 identifies some of the most significant telecommunication benchmarks over the past 160 years.

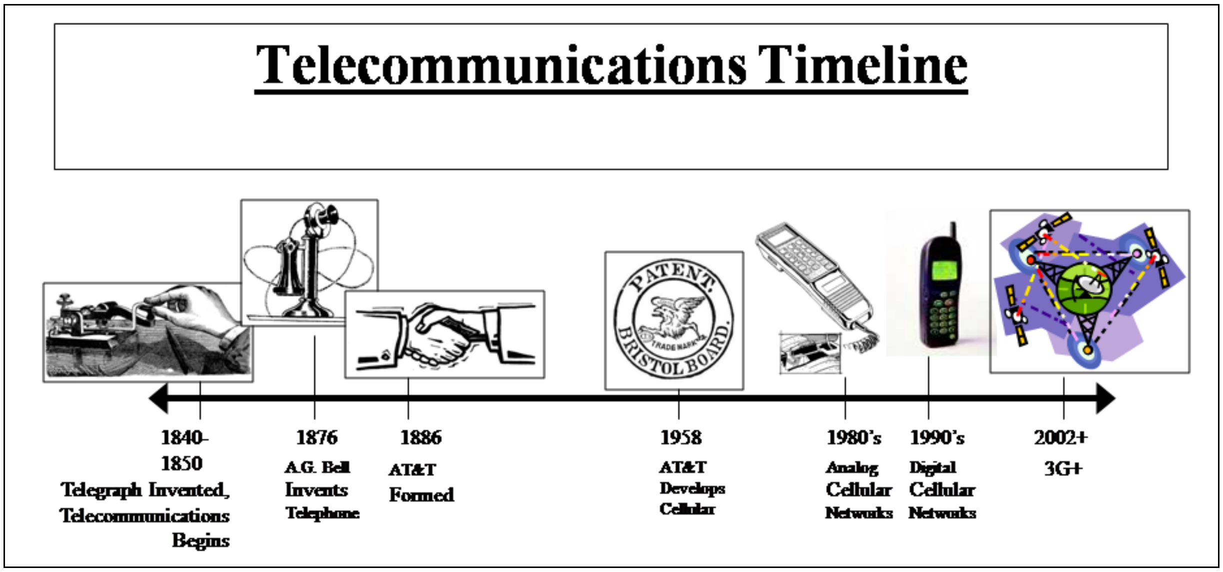


Figure 1: Telecommunication Timeline

Wired telephone networks

When the traditional wired, landline telephone networks were introduced in the United States, the first systems were built in largely populated cities where the financial return on the infrastructure investment could be quickly maximized. Telephone lines were installed alongside electrical power lines to maximize efficiency. As the technology improved the service was expanded from coast to coast. Figure 2 illustrates the wired, landline network system.

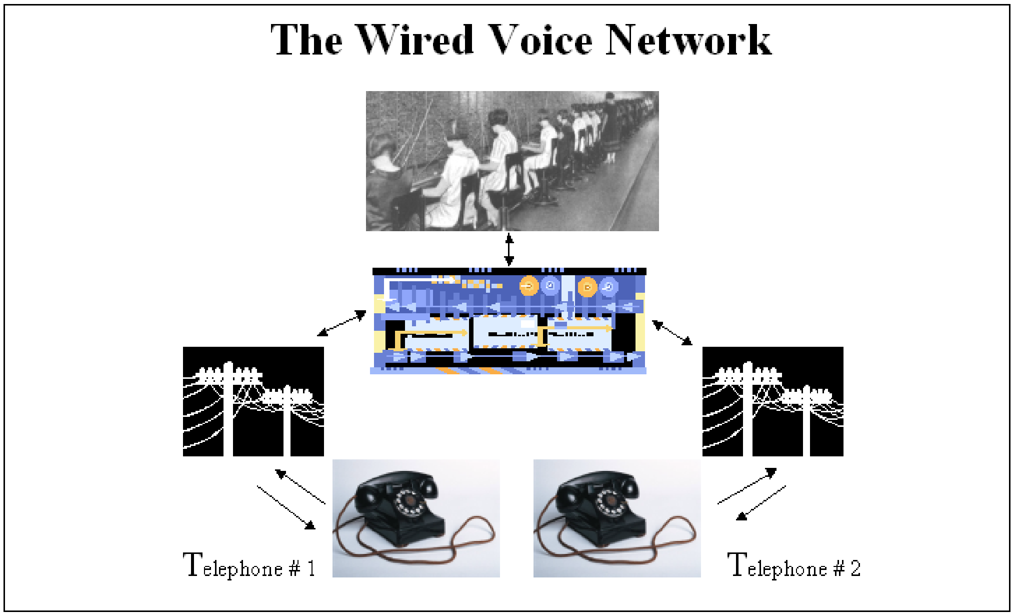


Figure 2: Wired Voice Network Systems

Wireless telephone networks

Wireless telephone networks operate utilizing wireless frequencies similar to radio and television stations. To design the wireless networks, radio frequency (RF) engineers overlay hexagonal cells representing circles on a map creating a grid system. These hexagons or circles represent an area equal to the proposed base station coverage area. The center of the hexagon pinpoints the theoretical "perfect location" for a base station. These grid systems are maintained by each individual wireless provider's engineering department, resulting in nine different grid systems in the County.

During the 1980's, the first generation of 800 MHz band cellular systems was launched nationwide. Similar to the deployment strategy for the landlines, the 800 MHz systems were first constructed in largely populated areas. Some networks in rural areas remain underdeveloped. Originally, the 800 MHz band only supported an analog radio signal. Customers using a cell phone knew when they traveled outside of the service area because a static sound on the phone similar to the sound of a weak AM or FM radio station was heard through the handset. Recent technological advancements now allow 800 MHz systems to also support digital customers, which allowed the networks an increased number of transmissions per site.

The 1990's marked the deployment of the 1900 MHz band Personal Communication Systems (PCS). This second generation of wireless technology primarily supports a digital signal, which audibly can be clearer than the analog signal, but this comes with additional trade-offs. The technology of 2G includes a static free signal, and although with a higher rate of disconnects or dropped calls, it does allow for more services such as paging devices, and the ability to send text messaging through the handset unit. Deployment of 2G also targeted largely populated areas with secondary services to much of rural America resulting in limited or no PCS coverage.

In addition to 800 MHz cellular services and 1900 MHz PCS services, there are additional wireless providers utilizing services in the 800 MHz and 900 MHz frequency range. This service is called Enhanced Specialized Mobile Radio (ESMR). The largest ESMR band provider is Nextel Communications. All three of these "telephone" operations (800, 900 and 1900 MHz) are specifically covered, along with some other services, in the Telecommunications Act of 1996.

Wireless infrastructure

Wireless communication facilities are comprised of four main apparatuses: 1) an antenna support facility; 2) antenna or antenna array; 3) feed lines; and 4) an electronic base station.

Antenna support facilities

A variety of structures can be used as antenna support facilities, such as towers, buildings, water tanks, existing 911 tower facilities, tall signage and light poles; provided that, 1) the structure is structurally capable of supporting the antenna and the feed lines; and, 2) there is sufficient ground space to accommodate the base station and accessory equipment used in operating the network. Antenna support facilities can also be concealed in some circumstances to visually blend-in with the surrounding area. Figure 3 provides examples of several antenna support facilities. The flagpole and light standard are concealed towers. The antennas are flush-mounted onto a monopole and a fiberglass cylinder is fitted over the antenna concealing them from view. The bell tower is a concealed lattice tower. The antennas are hidden above the bells and behind the artwork at the top of the structure.

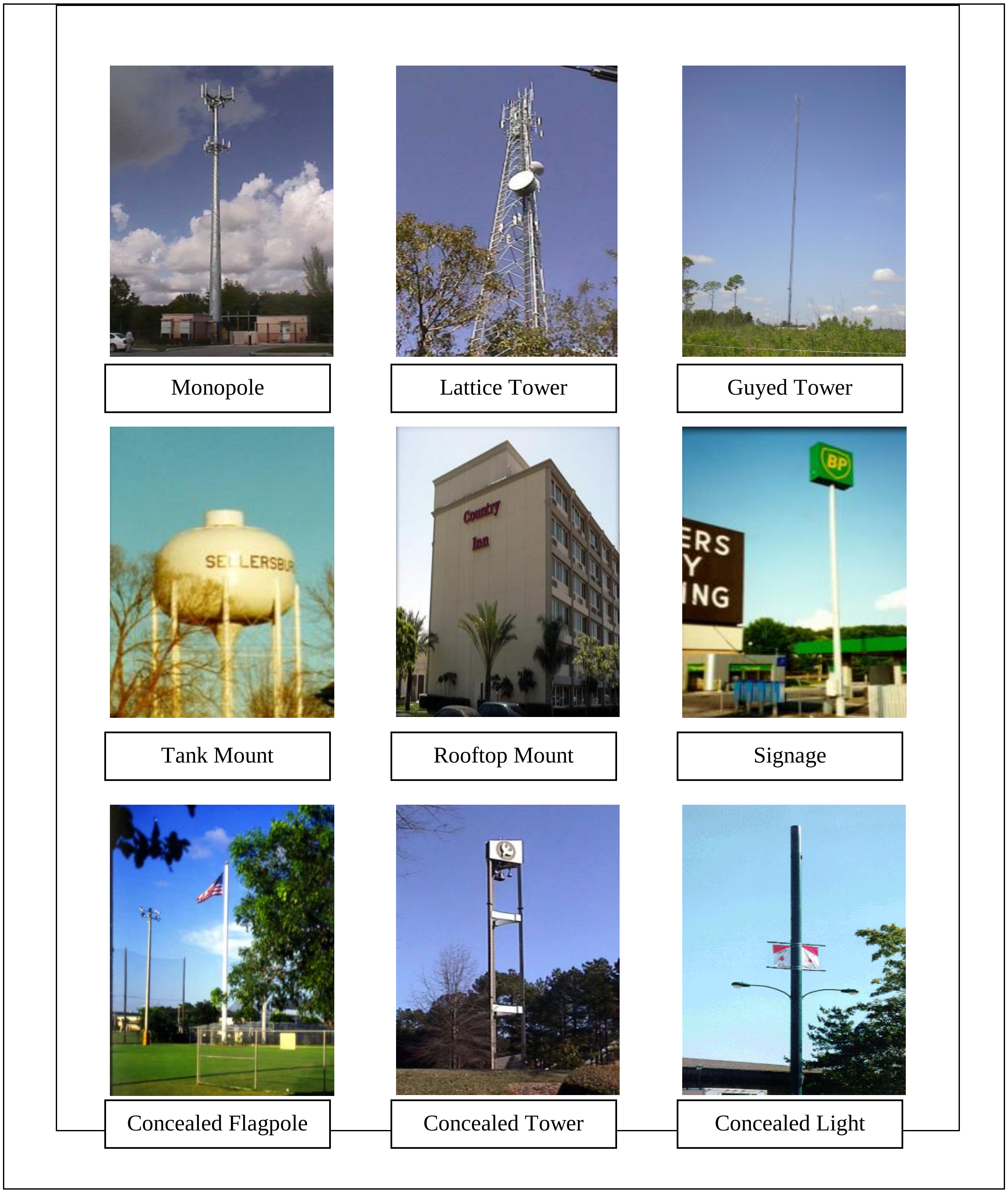


Figure 3: Examples of Base Stations

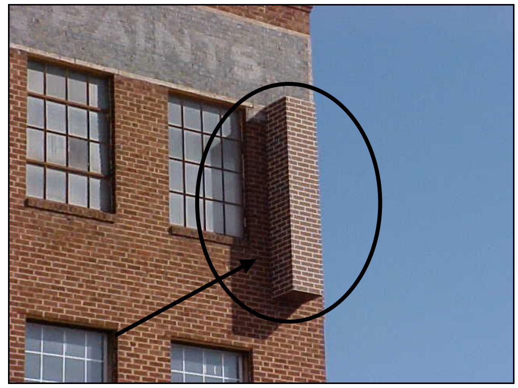
Antennas and antenna arrays for wireless telecommunications

Antennas can be a receiving and/or transmitting facility. Examples and purposes of antennas include: a single omni-directional (whip) antenna or grouped sectorized (also known as panel antennas). These antennas are used to transmit and/or receive two-way radio, Enhanced Specialize Mobile Radio (ESMR), cellular, Personal Communications Service (PCS), or Specialized Mobile Radio (SMR) signals. The single sectionalized or sectionalized panel antenna array is also used for transmitting and receiving cellular, PCS or ESMR wireless telecommunication signals.

Omni-Directional
Whip Type Antenna

Sectorized (panel)
Antenna Array

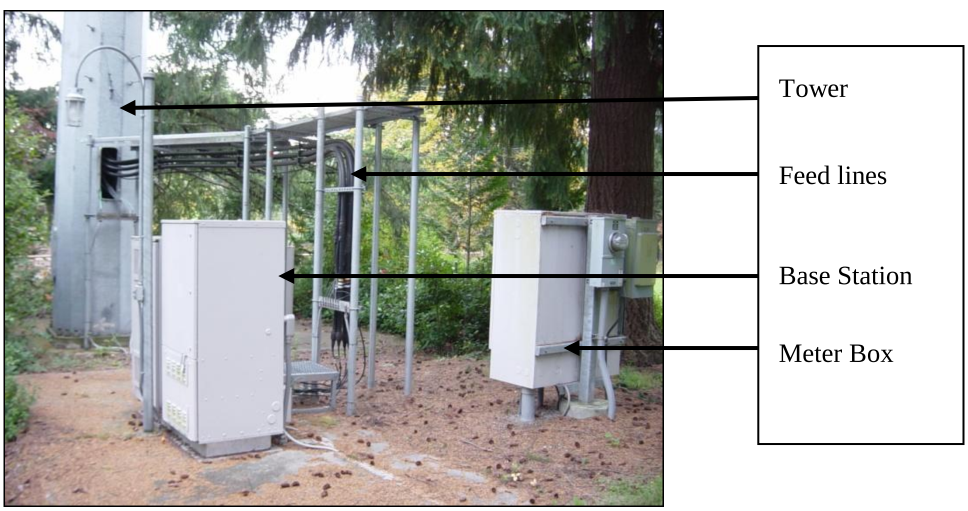
The antenna can also be concealed. Concealment techniques include: faux dormers; faux chimneys or elevator shafts encasing the antenna feed lines and/or equipment cabinet; and painted antenna and feed lines to match the color of a building or structure. A concealed attached facility is not readily identifiable as a wireless communications facility (WCF). Examples are shown in the pictures below. Concealed antennas are indicated with black arrows.



Feed lines and electronic base stations

Feed lines are the coaxial copper cables used as the interconnecting media between the transmission/receiving base station and the antenna.

Base stations are the wireless service provider's specific electronic equipment used to transmit and receive radio signals, and is usually mounted within a facility including, but not limited to: cabinets, shelters, pedestals or other similar enclosures generally used to contain electronic equipment for said purpose.



The base station shown in the photograph is a typical model for providers operating in the 1900 MHz frequencies. The electronics housed within the base station can generate substantial heat, especially the equipment used for operating the 800 MHz wireless systems. Therefore the base stations for providers operating in the 800 MHz frequencies are much larger and generally need an equipment cabinet a minimum of 400 square feet to house the equipment.

While these base stations can generate sufficient heat, they do not generate noise. The only noise that might be produced from the vicinity of the base station would be from an air conditioner or a backup generator which might be necessary in instances of no power or power failure.

Due to extreme temperatures and rain and snow accumulations County-wide, it is a common practice to elevate the base station a few feet above the ground level and/or house the base station inside a small equipment building. Figure 4 provides local examples of base station installations.

Exposed base stations

Enclosed Base Stations

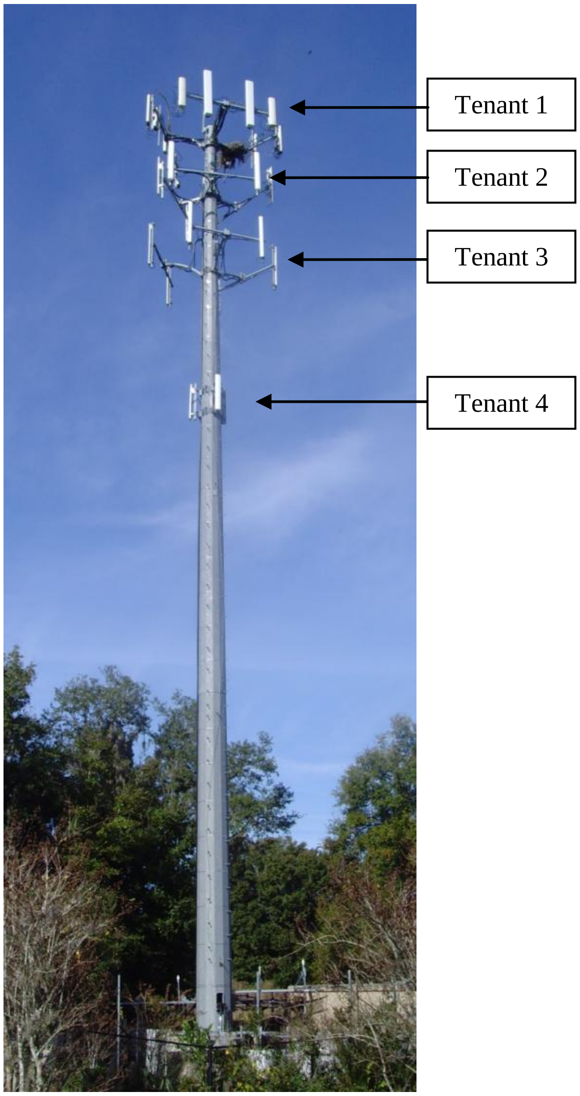
Elevated base stations

Figure 4: Base Station Examples

Collocation

Collocation is the practice of installing and operating multiple wireless service providers, and/or radio common carrier licensees on the same antenna support facility or attached telecommunication facility. Each service provider uses separate antenna(s), feed lines, and radio frequency generating equipment and each different service provider is called a tenant. Collocation on towers, water tank, and rooftops are not limited to wireless service providers. Other tenants include paging and dispatch services, wireless internet, emergency services, government agencies, and broadcast. Towers designed for collocation must be structurally designed to accommodate the weight baring loads of the multiple tenants. Generally taller towers can accommodate multiple different types of wireless and/or broadcast communication tenants.

Tall guy tower with multiple tenants



Monopole with four tenants

Figure 5: Collocation Examples

Wireless coverage and antenna mounting elevation considerations

Wireless telecommunication networks are comprised of elevated antenna or a set of elevated antenna arrays attached to a base station. The antenna(s) that transmit and receive radio signals allowing wireless telephone handsets to operate satisfactorily. Figure 6 illustrates the wireless telephone network.

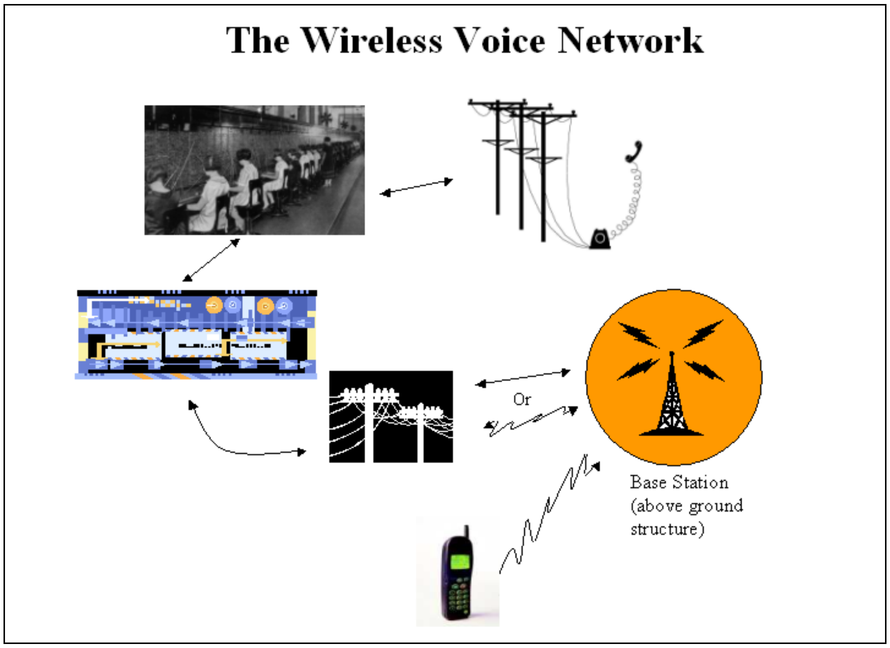


Figure 6: Wireless Voice Network

The radio frequency of the wireless network system, height of the antenna and the location of the infrastructure are all important components to a complete network plan. One set of elevated antenna arrays does not provide service to a geographic area independently of other nearby elevated antennas, rather, each set of antenna arrays work in unison to provide complete wireless coverage. Complete coverage is only attained when the radio signal from one base station antenna array successfully transfers or hands-off the radio signal to another base station antenna array without causing an interruption in service. Successful network handoff is only possible when the geographic coverage areas from individual antenna arrays properly overlap and when the base station has available capacity. Geographic areas with good site handoff and available capacity will have good wireless coverage and generally uninterrupted services.

Generally, the higher the antenna is mounted on the support structure, the larger the geographic area that will be served by the wireless signal. Taller structures may offer more opportunity for collocation, which could theoretically decrease the number of additional towers and antennas required in an area. The extent to which height may increase collocation opportunities must be verified by an RF engineering review on a case-by-case basis. Excessive subscriber demand, terrain concerns, and/or the build-out plans for some areas may require very low antenna location heights, especially in densely populated areas. Antennas located at a higher elevation on a facility are more desirable for some terrains and in some rural areas, but in many densely populated urban areas the wireless providers seek to limit the antenna height.

In wireless system evolution, a wireless provider initially built fewer base stations with relatively tall antenna support facilities to maximize the network coverage footprint. These initial 1G 800 and 1900 MHz systems sought to broadcast coverage to large geographic areas utilizing minimal infrastructure. Typically, these tall towers were spaced four to eight miles apart.

By nature, the 1900 MHz frequency band is a higher frequency than the 800 MHz band and cannot transmit nor receive a signal at an equal distance to the 800 MHz band. For equivalent coverage, these 1900 MHz base stations must be closer together. The mounting height of the antenna for 2G was not as critical as 1G, and these towers were shorter.

Network capacity

The number of base station sites in a grid network not only determines the limits of geographic coverage, but the number of subscribers (customers) the system can support at any given time. Each carrier's base station can process as many as 1,000 subscribers per minute as subscribers' transverse through particular cell sites, yet at any time an individual carrier's single cell site can handle simultaneously generally a maximum of no more than 240 calls (*although different providers prefer different numbers, 1,000 is an average*). This process is referred to as network capacity. As population, tourists and local wireless customers increase, excessive demand is put on the existing system's network capacity. When the network capacity reaches its limit, a customer will frequently hear a rapid busy signal, or get a message indicating all circuits are busy, or commonly a call goes directly to voicemail without the phone ring on the receiving end of the call.

As the wireless network reaches design network capacity, it causes the service area to shrink, further complicating coverage objectives. Network capacity can be increased several ways. The service provider can shift channels from an adjacent site, or the provider can add additional base stations with additional infrastructure.

A capacity base station has provisions for additional calling resources that enhance the network's ability to serve more wireless phone customers within a specific geographic area as its primary objective. An assumption behind the capacity base station concept is that an area already has plenty of radio signals from existing coverage base stations, and the signals are clear. But there are too many calls being sent through the existing base stations resulting in capacity blockages at the base stations and leading to no service indications for subscribers when attempting to place a call.

Wireless providers

In 1983, the Federal Communications Commission (FCC) granted licenses to two competing wireless providers to provide cellular coverage nationwide. The early stages primarily were served by the local telephone companies and on a national level by companies. There were many initial problems and growth was slow. Most wireless providers preferred tall towers in the range of three hundred to five hundred feet to service large areas. Due to the difficulty of constructing new facilities, the expansion was costly and challenging. In 1995 and 1996, the FCC auctioned four additional licenses in regional areas to competing wireless providers for purposes of building a nationwide digital wireless communication system. This auction raised over twenty-three billion dollars for the US Treasury.

Wireless infrastructure and local zoning

The location of base station antennas used for transmitting and receiving radio signals and wireless data is critical to attaining an optimum functioning wireless telecommunications network. With the deployment of first generation wireless (1G), there were only two competing wireless cellular (800 MHz) providers. But with the deployment of 2G, and six competing PCS (1900 MHz) providers, the wireless marketplace became furiously competitive. “Speed to market” and “location, location, location” became the slogans for the competing 1G and 2G providers. The concept of collocation or sharing base stations was not part of the strategy as each provider sought to have the fastest deployment, so as to develop the largest customer base, resulting in a quick return on their cost of deployment. This resulted in an extraneous amount of new tower construction without the benefit of local land use management.

Coincidently, as local governments began to adopt development standards for the wireless communications industry, the industry strategy changed again. The cost associated with each provider developing an autonomous inventory of base stations put a financial strain on their ability to deploy their networks. As a result, most of the wireless providers divested their internal real estate departments and tower inventories. This change gave birth to a new industry of vertical real estate; and it includes a consortium of tower builders, tower owners, site acquisition and site management firms.

No longer was a tower being built for an individual wireless service provider, but for a multitude of potential new tenants who would share the facility without the individual cost of building, owning and maintaining the facility. Sharing antenna space on the tower between wireless providers is called collocation.

This industry change could have benefited local governments who adopted new tower ordinances requiring collocation as a way to reduce the number of new towers. But, *initially* it did not; because the vertical real estate business model for new towers is founded on tall tower structures intended to support as many wireless providers and other wireless services as possible. As a result, local landscapes became dotted with all types of towers and communities began to adopt regulations to prohibit or have the effect of prohibiting wireless communication towers within their jurisdictional boundaries.

Wireless deployment came to a halt in many geographical areas as all involved in wireless deployment became equally frustrated with the situation. Second generation wireless providers had paid a large sum of money for the rights to provide wireless services, the license agreements between the wireless providers and the FCC mandated the networks be deployed within a specific time period and local government agencies were prohibiting the deployments through new zoning standards.

This perplexing situation prompted the adoption of Section 704 of the Federal Telecommunication Act of 1996.

Federal Telecommunications Act of 1996

Section 704 of the Federal Telecommunications Act of 1996 provides local governments zoning authority over the deployment of wireless telecommunication facilities subject to several specific guidelines.

First, land use development standards may not unreasonably discriminate among the wireless providers, and may not prohibit or have the effect of prohibiting the deployment of wireless infrastructure. For example, some communities adopted development standards restricting the distance between towers to three miles. In some geographic locations with sparse populations this may have been adequate for 1G deployment; however the Laws of Physics make it impossible for 2G wireless deployments to meet this spacing requirement. Unknowingly some communities inadvertently prohibited the deployment of 2G.

Second, local governments must act on applications for new wireless infrastructure within a "reasonable" amount of time. If a community adopts a moratorium on new wireless deployment, it must be for a limited amount of time, and the community must demonstrate a "good-faith" effort to resolve outstanding issues during the moratorium time period.

Third, land use policies may be adopted to promote the location of telecommunications facilities in certain designated areas; and the Act encourages the use of third party professional review of site applications.

Fourth, local government cannot deny an application for a new wireless facility or the expansion of an existing facility on the grounds that radio frequency emissions are harmful to the environment or to human health (provided Federal standards are met by the wireless provider).

Exposure to radio frequency emissions

The Federal Communications Commission (FCC) has rules for human exposure to electromagnetic radiation. Electromagnetic radiation should not be confused with ionizing radiation.

Ionizing radiation has sufficient energy to remove electrons from atoms, and cause changes to the molecular structure. This type of radiation can be found from many sources, including health care facilities, research institutions, nuclear reactors and their support facilities, nuclear weapon production facilities, and other various manufacturing settings, just to name a few. Some high-voltage beam-control devices, such as high-power transmitter tubes can emit ionizing radiation, but this is usually contained within the transmitter tube itself. Overexposure to ionizing radiation can have serious effects, including cancers, birth deformities and mental illness.
Electromagnetic radiation is non-ionizing radiation, which ranges from extremely low frequency (ELF) radiation to ultraviolet light. Some typical sources of non-ionizing radiation include

lasers, radio antennae, microwave ovens, and video display terminals (VDT). However, any electrical appliance or electrical wiring itself emits ELF radiation. Cellular and PCS installations must confirm Federal compliance with published standards on RF exposure levels.

Radio frequency radiation attenuates very rapidly with distance from a wireless services antenna, and most wireless sites not accompanying broadcast facilities will easily comply.

The RF exposure rules adopted by the FCC are based on the potential for RF to heat human tissue. Basically, the level at which human tissue heating occurs has been studied, and rules are set such that humans are not to be exposed anywhere near the level that can cause measurable heating. Cellular telephones and their supporting equipment have now been in use worldwide for nearly thirty years. During that period there has not been a single documented health issue to be traced to this industry.

There have been extensive long-term studies and at best they are inconclusive as to any harmful effects. Debate continues and may never be concluded on whether or not there might be biological effects associated with “non-thermal” causes, such as magnetic fields. Based on these findings the Federal Government has maintained jurisdiction on such issues. The FCC publication entitled, “A Local Government Official’s Guide to Transmitting Antenna RF Emission Safety: Rules, Procedures, and Practical Guidance” is included as Appendix A.

In addition to the RF study and interpretation by FCC the World Health Organization (WHO) has conducted a study on RF and a brief detailing their findings are published an article dated May 2006 and entitled, “Electromagnetic fields and public health; Base Stations and wireless technologies.” The conclusion states, “Considering the very low exposure levels and research results collected to date, there is no convincing scientific evidence that the weak RF signals from base stations and wireless networks cause adverse health effects.” The WHO Fact Sheet is provided as Appendix B.

Antenna and base stations

For the cellular and PCS bands, human exposure limitations are given in terms of power density, with the unit’s milliwatts per centimeter squared (mW/cm^2). The power density associated with a cellular/PCS installation may be easily calculated or measured with instruments.

Time averaging is used along with the level measured. This means that the level must not exceed the standard value over any period. For instance, if the standard calls for a limitation of 1.0 mW/cm^2 averaged over thirty minutes, the standard permits a level of 2.0 mW/cm^2 for up to fifteen minutes as long as this is followed by a fifteen minute period of no exposure.

In general, the FCC’s general population/uncontrolled exposure limitation must be used in the service, unless it can be clearly demonstrated that unsuspecting persons can be radiated at standard levels from a site.

In many cases, no field evaluation is required, since the site is categorically excluded, based on the presumption that in its radio service there is no possibility of an excessive RF level if the provider certifies such compliance. For example, facilities on towers with the antennas higher than ten meters (32.8 feet) and a power less than 2,000 watts require no further consideration.

Currently base stations can vary power based on a communications code in each handset. The base station is measure the incoming power from the handset and will adjust the base station power to effectively provide the necessary signal strength for the most efficient communications. Base stations can operate at various power levels, and the more individual service providers on any particular base station support structure (tower) the higher the composite signal level from that base station. Powers can vary from a few watts to a few thousand watts as needed for compatible communications.

Wireless Tower	20 watts
Police & Fire Tower	500 watts
Household Microwave Oven	650 watts
Household Toaster	1,700 watts
AM Radio Tower (*up to)*	50,000 watts
FM Radio Tower (*up to)*	100,000 watts
UHF TV Tower (*up to)*	5 million watts

Table 1: Examples of Power Levels

In general, single provider installations on towers will be categorically excluded. Multiple provider collocations and very high power sites will require further consideration.

In consideration of how conservative the evaluation method is, an engineer may wish to make actual power density measurements. In almost all cases, those measurements have been below the calculated values.

If the site does not comply, some alternatives include:

- Limit the site access such that only authorized personnel can reach the vicinity of the antennas. The applicable standard then becomes the occupational/controlled one.
- Raise the height of the antennas.
- Reduce the power.
- Reposition antennas such that people cannot get in close proximity to them.

In multi-transmitter facilities, it is necessary to evaluate each contributor individually. Its percent of standard figure is computed (or measured), and added together to sum all percentage figures to determine the total site exposure.

Phones

In July 2001, the Federal Drug Administration (FDA) issued a Consumer Update on Wireless Phones, which stated that "[t]he available scientific evidence does not show that any health problems are associated with using wireless phones," while noting that "[t]here is no proof, however, that wireless phones are absolutely safe."

The FCC issued a Consumer Information Bureau Publication in July 2001, which stated, "[t]here is no scientific evidence to date that proves that wireless phone usage can lead to cancer or other adverse health effects, like headaches, dizziness, elevated blood pressure, or memory loss."

Before a wireless phone model is available for sale to the public, it must be tested by the manufacturer and certified to the FCC that it does not exceed limits established by the FCC.

One of these limits is expressed as Specific Absorption Rate (SAR). SAR is a measure of the rate of absorption of RF energy in the body. Since 1996, the FCC has required that the SAR of handheld wireless phones not exceed 1.6 watts per kilogram, averaged over one gram of tissue.

If one is concerned about SAR exposure that individual can take the following actions to minimize RF exposure from the phone:

- Reduce talk time;
- Place more distance between the body and the source of the RF; and
- In a vehicle, use the phone with an antenna on the outside of the vehicle.

The FDA states "[t]he scientific evidence does not show a danger to users of wireless phones, including children and teenagers." People who remain concerned about RF exposure may choose to restrict their wireless phone use.

Third Generation and future wireless generations

At the onset of this millennium economists and telecommunication forecasters debated the actuality of third, fourth and fifth generations of wireless coming to fruition in the United States. Skepticism that customers would have little demand for the emerging wireless services appeared in articles and newsrooms, while others recognized the infrastructure in the United States was significantly behind schedule as compared to European and Asian deployments. Predictions were that consumers would demand the 3G products once network upgrades were completed. Third generation upgrades to 800 MHz and 1900 MHz infrastructure has been accomplished primarily through software improvements at existing base stations. Third generation has come to fruition and wireless handsets available in late 2006 and in 2009 most new handsets are 3G compatible.

Third generation handsets feature text messaging which is similar to e-mail. The messages are usually direct phrases with minimal words. Wireless customers can send text messages through the wireless handset and the message can be delivered anywhere at any time. Text messaging can operate on 700, 800, 900, 1900, and 2100 MHz networks.

At the turn of this century there were one billion messages sent per day globally. Every digital phone that is sold today in the United States has messaging capability. In 2005 European providers reported that fifteen percent of the providers' revenue derived from text messaging. The growth of text messaging in the United States will undoubtedly lead to a greater demand for wireless facilities because the additional spectrum use by text messages will create a system capacity demand for providers.

Handsets for 3G are not just limited to voice and short data text messaging capabilities. Most handsets include built-in cameras, access to internet web browsers and the ability to download, store, and play music files. 2009 trendsetting handsets now have touch screen monitors, built-in camera and video camera features, and multi-media rich features like gaming, music downloads, and interactive GPS. Future features include banking, video streaming, and access to cable television.

Satellite technologies

Satellite growth has surpassed the highest expectations of only a few years ago. The reason is simple; cost. Previously, relaying information, data, and other related materials were cumbersome and required many relay stations in very specific locations and relatively close together. Initially, satellite use was expensive because of the rarity and limited amount of available airtime needed. With the deployment of additional satellites, along with advancing technologies which allow more usage of the same amount of bandwidth, satellite airtime has become more affordable. Competition always holds down cost, and that is what has occurred. In addition, satellite services are in the early stages of designing more localized networks; contributing to the already rapid growth.

Satellite technology has its limitations, which are all based on the Laws of Physics. Some licensee's of satellite services such as XM Radio, Sirius Radio and satellite telephone services petitioned the FCC and has been allowed additional deployment of land-based supplemental transmission relay stations for the ability to compete more aggressively with existing ground base services, and overcome obstacles typical to satellite technology. Subscribers found the delay in talk times unacceptable along with fade and signal dropout. The FCC is looking favorably upon this request, even though the existing land-based services are strongly objecting for various reasons. Both XM Radio and Sirius Radio were successful in getting ground base supplemental transmitters, and is rapidly becoming one of the largest users of ground base transmitters. This will place more demands on governmental agencies as another service begins to construct a land-based infrastructure.

Enhanced Specialized Mobile Radio

Enhanced Specialized Mobile Radio (ESMR) systems operate similar to standard cellular type communications; in addition they can easily operate like a two way radios system (similar to walkie-talkies) whereby two or more handsets are linked together by repeaters. Digital networks offer voice, data, messaging, and dispatch on one handheld unit similar to most wireless handsets. The technology used for ESMR networks has been problematic to adjacent frequency channels used by other service providers through no fault of the service provider in most situations. In order to reduce any potential for future interference issues, ESMR network operators successfully petitioned the FCC to shift frequencies from the 800 MHz and 900 MHz band to the 2500 MHz band. The reallocation from 800 MHz to 900 MHz is still in transition. Once again this frequency shift will cause the need for additional support structures and create additional impacts to local governments.

The FCC announced it would permit the phasing out of analog compatibility requirements for cellular phones. This project was to be completed by the end of year 2008. The FCC's action still allows providers the option to continue analog services as needed to meet customer needs. According to the International Association for the Wireless Telecommunications Industry (CTIA) about 85 percent of all wireless subscribers are presently using digital technology, and wireless users generally replace their phones every eighteen months. Thus, the analog system will be phased out eventually and the remaining analog users will migrate to digital, which also has the added benefit of increasing cell site capacity, as a single analog channel can be converted to multiple digital channels.

Third, fourth and fifth generations of wireless deployment will bring the next phases of wireless technology and place great demands on network capacity. With voice, text, digital music, digital video, GPS and data all competing for spectrum space, providers will need to maximize their spectrum allocations by creating more compact base station facilities at closer intervals.

700 MHz

The decision by the FCC to convert the United States television systems to digital or High Definition only service, created a new Table of Allotments. The first phase of the transition was the elimination of TV channels 51 and above. These TV channels operated from 700 MHz to 806 megahertz. By the late 1990's most of the TV channels on 51 and above were migrated to lower channels. The FCC found benefits of making additional spectrum available. Initially the spectrum was to go to Public Safety; however lobbyist successfully convinced the FCC and Congress to divert most of the new spectrum to the wireless industry. There have already been assignments to the 700 MHz band and in some locations new facilities are in service.

Chapter 2 Wireless Technical Issues

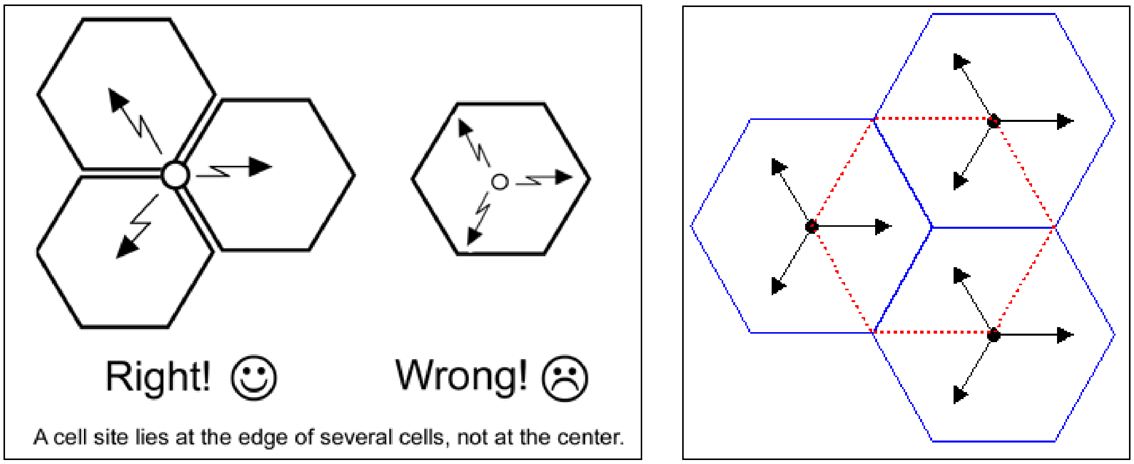
Brief Overview

Cellular and PCS wireless providers attain service coverage through a network of ground equipment base stations and elevated antennas located on towers, water tanks, buildings or other similar elevated structures. As explained in Chapter 1, the height and location of the elevated antenna platform on the elevated structure is critical to two aspects of radio frequency (RF) engineering, coverage and capacity. Generally, the higher the antenna is mounted on the support structure, the larger the geographic area that will be served by the wireless signal. Base stations located in geographic areas where wireless subscribers are significant and the usage of airtime minutes is higher, operate at maximum capacity, and on some occasions are over-capacity, causing busy signals and direct-to-message incoming calls for many subscribers. To help remedy this situation, smaller antenna configurations and/or the antenna are mounted at lower elevations than would be necessary for coverage. This is defined as "capacity" planning.

The second engineering issue concerns the relationship between tower location and frequency planning. Cellular and PCS wireless providers carefully choose the frequencies deployed at each base station to avoid interference. Rules of frequency planning require a certain physical distance between base stations to minimize this interference. Slightly different considerations apply to some PCS providers using code division multiple access (CDMA) technology (Sprint PCS and Verizon). In a CDMA system, all base stations in a coverage area use the same, or a very limited set of several frequencies. However, wireless service customers experience interference from other subscribers and from signals from other base stations when subscriber usage increases. Avoidance of this interference requires precision of the antenna locations.

As demonstrated in Figure 7, base station network design is founded on the principles of a grid system that is maintained by each wireless provider's engineering department. The hexagonal cells on the grid represent the radius equal to the proposed cells' coverage area. Common points of adjoining hexagons pinpoint the theoretical perfect location for a prospective new base station. For these reasons, deviation from these specified locations can significantly affect the wireless provider's deployment network.

"Most people see the cell as the blue hexagon, being defined by the tower in the center, with the antennas pointing in the directions indicated by the arrows. In reality, the cell is the red hexagon; with the towers at the corners…the confusion comes from not realizing that a cell is a geographic area, not a point."



(Courtesy of Tom Farley http://www.telecomwriting.com/index.html)

Figure 7: Network Grid

Search area within proposed coverage areas

The search area for new wireless infrastructure is ideally specified in a document provided to site search consultants in pursuit of a lease for property on which to place their facilities, whether a new tower, a rooftop or some other existing structure that could accommodate wireless antennas. From an engineering perspective, any location within the proposed search area is considered to be acceptable for the provider, with certain considerations based on terrain and sometimes population balance.

Search Area Radii

Search areas for the 800 MHz (cellular and ESMR) frequencies and 1900 MHz (PCS) frequencies are computed in the Tables 2 and 3. The tables utilize the "Okumura-Hata" propagation path loss formula for 800 MHz, and the "COST-231" formula for 1900 MHz. Maximum coverage radii for typical in-vehicle coverage is calculated for various tower heights, and is de-rated by twenty percent to account for a reasonable handoff zone, then divided by four to obtain a search area radius for each tower height. Thus, for an 800 MHz antenna mounted at the 100-foot elevation, the search area would have a radius of 0.72 miles, and 0.36 miles for 1900 MHz, again sometimes more restrictive due to terrain.

Okumura-Hata Coverage Predictions

Antenna mounting height	50’	80’	100’	115’	150’	180’
Radius, miles	2.53	3.20	3.60	3.88	3.91	4.40
Allow for handoff	2.03	2.56	2.88	3.10	3.60	4.00
Search area, miles	0.51	0.64	0.72	0.78	0.90	1.00

Table 2: Okumura-Hata Coverage Predictions for 800 MHz

COST 231 Coverage Predictions

Antenna mounting height	50’	80’	100’	115’	150’	180’
Radius, miles	1.33	1.64	1.82	1.95	2.32	2.45
Allow for handoff	1.07	1.31	1.46	1.56	1.79	1.96
Search area, miles	0.27	0.33	0.36	0.39	0.45	0.49

Table 3: COST 231 Coverage Predictions for 1900 MHz

Wireless telephone search areas are usually circles of approximately one-quarter the radius of the proposed cell. In practice it is fairly simple to determine whether the search area radius is reasonable. The distance from the closest existing site is determined, halved, and a handoff overlap of about twenty percent is added. One fourth of this distance is the search area radius.

Tower height and antenna mounting elevation considerations

Taller structures (towers, rooftops, and water tanks) may offer more opportunity for collocation, which could theoretically decrease the number of additional towers and antennas required in an area, but capacity issues could circumvent any advantage of taller towers. The extent to which height may increase collocation opportunities must be verified by an RF engineering review on a case-by-case basis. In geographic areas where there is a larger wireless phone subscriber base or terrain concerns, build-out plans may require lowers antenna mounting elevations, especially in densely populated areas. Antennas located at higher elevations on the antenna support facility are indicative of rural areas. In some cases, the wireless providers seek to limit the height in more populous geographic areas because they may need differing heights on a single tower to reduce the potential for interference between the same provider and/or a competing wireless provider.

Global System for Mobile Communications

Wireless providers are presently deploying new technology equipment in the United States to support data services over the wireless interface. One example of this type of deployment has been a Global System for Mobile Communications (GSM) overlay on top of existing facilities, in recognition of GSM’s data-handling capability. GSM is a digital cellular technology that is open and can transmit voice and data. GSM differs from older technology because the system divides each channel into eight time-slots which allow the same phone to be used around the world. Using a GSM phone provides the user access to the same services on the phone whether in the United States or Europe or anywhere else there is a signal. This allows use of the same telephone number and same access in the user's hometown and in more than 200 hundred countries. This is important because a GSM world cell phone gives the user the ability to have only one phone to travel around the world. The cell phone user does not have to worry about changing SIM cards and other elements of the phone or the dreaded necessity of carrying a second cell phone. For the vast majority of travelers, these cell phones will be the only cell phone needed.

In certain cases, the GSM overlay is on 1900 MHz, where signals only cover about half the distance of the existing system, implying more wireless facility locations will be required to meet coverage and network capacity objectives.

Some service providers are now evolving into Universal Mobile Telecommunications Systems (UMTS) networks. Third generation (3G) networks use HSDPA/UMTS (High Speed Downlink Packet Access/Universal Mobile Telecommunications System) technology. The 3G network is also based on the GSM standard, the most widely used technology in the world. More than 2.7 billion people use wireless devices powered by GSM, representing more than ninety percent of the world's wireless users.

Subscribers who use a GSM phone can take their device with them when they travel abroad and can benefit from worldwide access through the GSM standard, and have the ability to browse the web and perform other data functions in more than 135 countries, and they can make a phone call in more than 190 countries and territories.

The 3G network also provides the simultaneous delivery of voice and data, a capability not offered by all wireless providers. One example of a 3G service is Video Share, which enables users to share live video over wireless phones while carrying on a voice call – providing a new way to share personal moments and key events beyond the capabilities of voice and text. Users can allow others to "see what I see, when I see it."

Among several other benefits, the simultaneous data and voice capability allows customers to participate on a conference call from their 3G device while they download a presentation or access the Internet.

Chapter 3 Engineering Analysis

Plan design process

This chapter of the Tower Master Plan evaluates wireless coverage for the County, and is accomplished by:

- Designing an engineered search radii template and applying it over the jurisdictional boundary of the County to evaluate theoretical build-out conditions.
- Researching the inventory of existing antenna locations on support structures and buildings and evaluating the possible 800 MHz and 1900 MHz coverage from those sites.
- Forecasting future infrastructure needs based on the status of the existing deployments and population trends.

Basic coverage predictions and wireless coverage handoff

Chapters 1 and 2 explain the details of wireless telecommunications deployment practices. Chapter 3 illustrates how this infrastructure forms a network of service throughout the County's geographic boundary.

CityScape provides a series of maps to help visualize the number of antenna locations that would be necessary to provide wireless communications coverage county-wide. To accomplish this task, CityScape has created a series of root mean square (RMS) theoretical coverage and handoff maps by randomly selecting existing antenna locations throughout the County. This hypothetical network demonstrates the minimum number of base station locations required for one provider to provide complete coverage county-wide. To being this analysis an antenna mounting elevation must be determined. CityScape has reviewed the existing tower inventory for the County and determined the average tower height of the towers used for wireless telecommunications purposes to be around 260 feet. Thus, 260 feet was chosen for the initial theoretical Master Plan maps.

According to the Okumura-Hata propagation path loss formula in Table 2 coverage for 800 MHz, a reasonable coverage area for an antenna mounted at 260 feet for cellular deployment on flat terrain is 5.3 miles. This means a single antenna mounted at 260 feet with flat terrain and minimal subscribers would provide a wireless signal to a 5.3 mile geographic radius. Using these three variables (flat terrain, 800 MHz and 260-foot antenna mounting elevations) CityScape has created a wireless network grid covering Buckingham County. Figure 8 illustrates that it requires eleven towers spaced equally apart to provide complete 800 MHz cellular coverage to the defined geographic study area. These sites represent a theoretical build-out for antennas mounted at the 260-foot elevation at equal dispersion, in a perfect radio frequency environment, with no consideration of adjacent community wireless deployment for a single cellular provider *and excluding topographic and population variables*. The black dot within each circle indicates the antenna location. The smaller circles shown within the larger circles represent the limits of the search area for locating the tower. The fourteen cells would theoretically provide wireless service throughout the study area for one provider to address coverage objectives and not capacity objectives.

Referring to the "COST-231" formula for 1900 MHz a reasonable coverage area for an antenna mounted at 260 feet for a PCS site on flat terrain is approximately 3 miles. The coverage reduction form 6.3 miles to 3 miles reflects the variable change from 800 MHz to 1900 megahertz. Figure 9 illustrates it would take up to forty-two antenna locations to cover the same geographic area as in Figure 8. These 1900 MHz PCS sites represent a theoretical build-out of one antenna mounted at the 260-foot elevation at equal dispersion for one PCS provider; *with no* dispersion for one PCS provider; *with no consideration of terrain or demographic variables.*

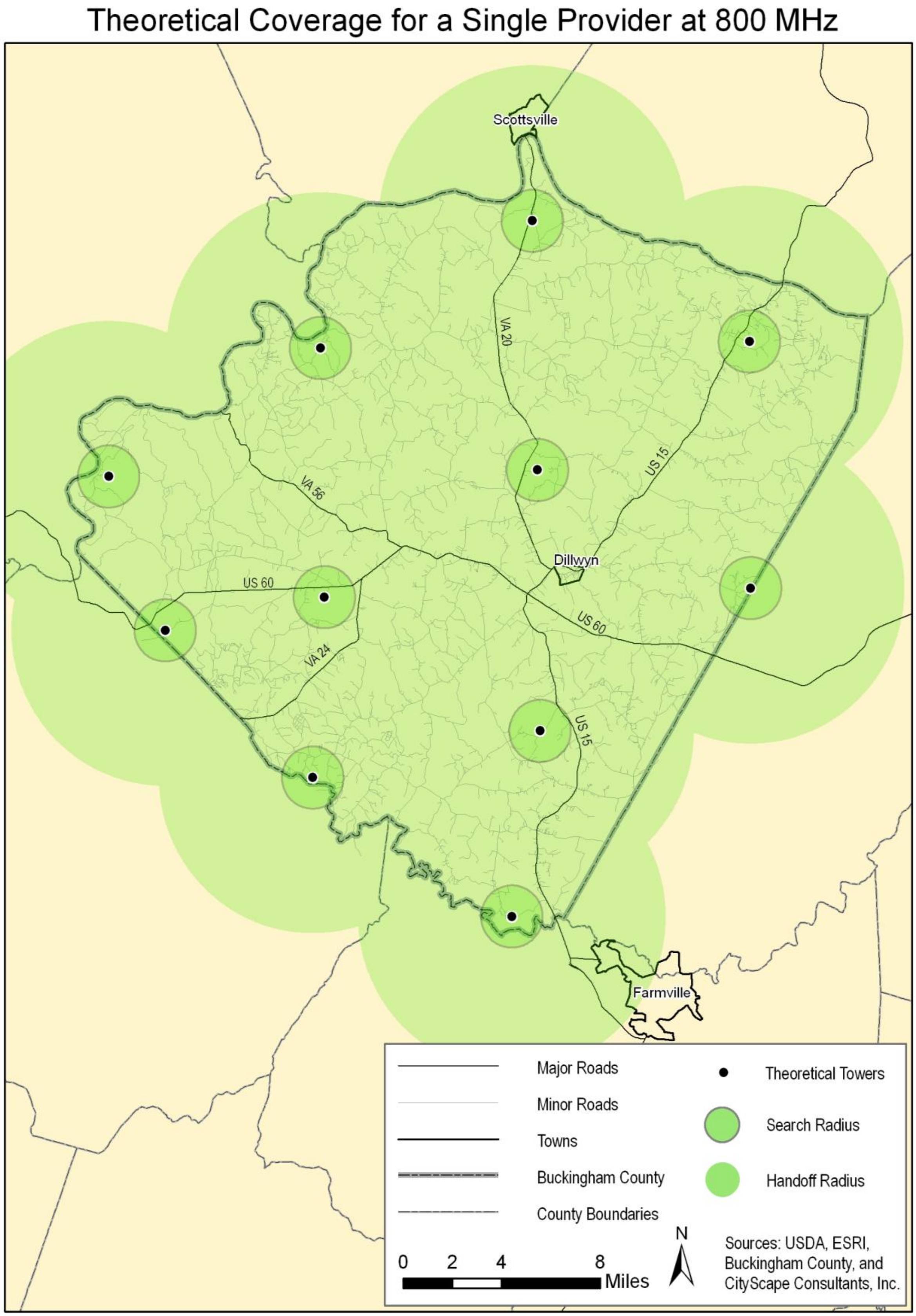


Figure 8: RMS 800 MHz Handoff and Search Areas at 260' Antenna Mounting Elevations

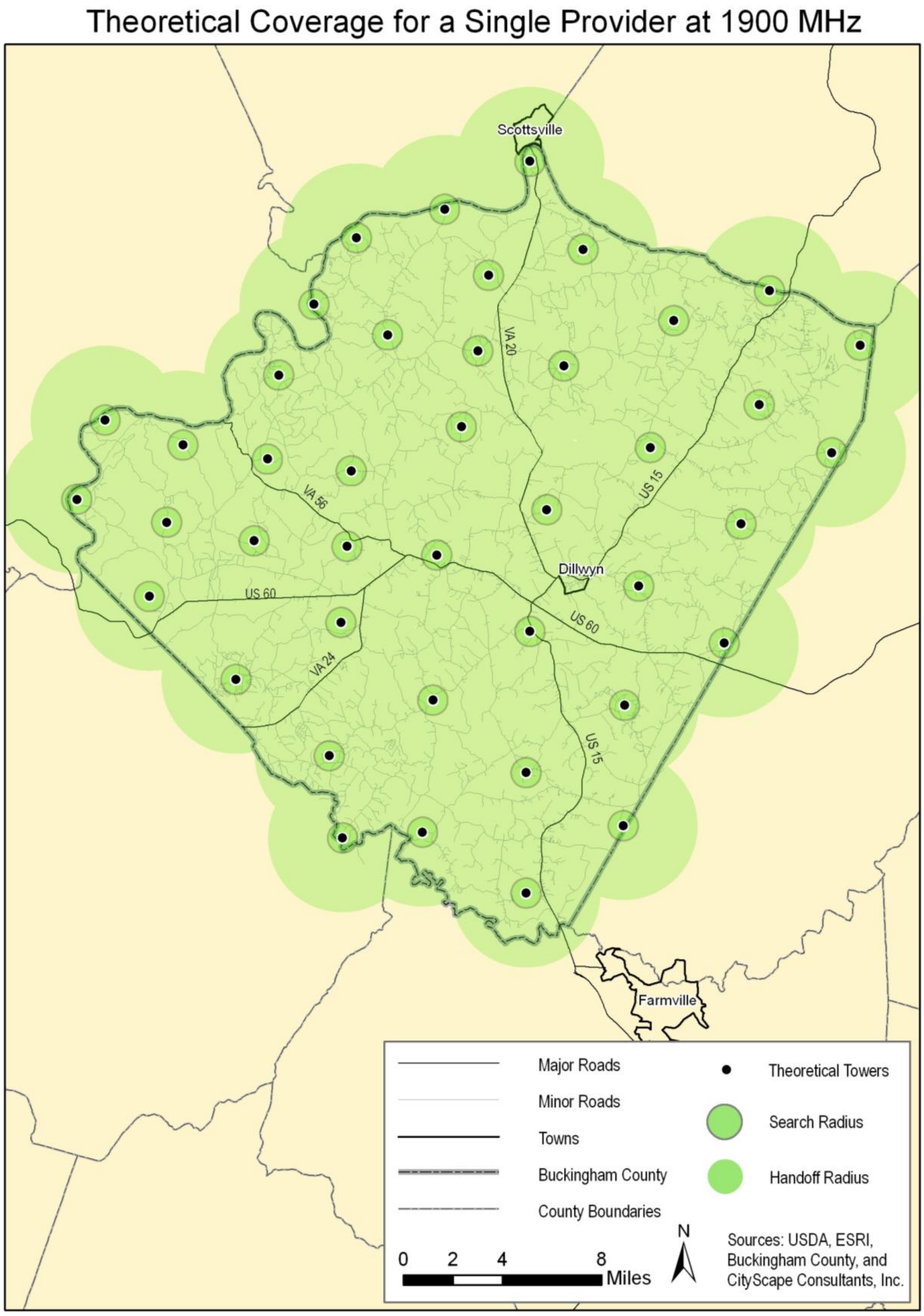


Figure 9: RMS 1900 MHz Handoff and Search Areas at 260’ Antenna Mounting Elevations

Topographic variable on theoretical coverage

As previously described in flat terrain and sparsely populated areas, base station prediction is an easier art. The impact terrain has on a service area can be the most dramatic. Radio frequency propagation is line-of-sight technology. Line of sight works best with an unobstructed path between the base station and the handset. There are some variations of this principle. The analogy of a light bulb works well to explain how a wireless signal gets from point A to point B.

In this manner communication signals perform very similar to light. The areas closest to the light are illuminated the brightest. Adding a lampshade over the light bulb dims the light. Walls, closed doors, and other opaque object obscure the light. Similarly for best results in wireless communications there should be nothing in the transmission line of sight path between antenna point A and antenna point B, but that is usually impossible. Reflected or refracted signal will fill in some geographic areas but at a reduced power level.

Therefore, on flat terrain service areas with minimal vegetation, the coverage network from each antenna propagates in an even circular pattern. In areas with varying terrain conditions, the line of-sight coverage will be altered by higher and lower ground elevations. The County has minimal topographical variations so terrain should not drastically alter the theoretical maps.

Using the same random grid antenna locations identified in Figure 8 (RMS 800 MHz Handoff and Search Areas at 260' Antenna Elevations) and Figure 9 (RMS 1900 MHz Handoff and Search Areas at 260' Antenna Elevations); Figures 10 and 11 illustrate how wireless service coverage is affected when the topographic variables are added to the propagation formulas. The areas in green show the extent of the coverage area. Gray and shades of gray/green mix illustrate geographic areas with diminished coverage resultant of terrain. Buckingham County has terrain variations. For this reason only large geographic areas are affected by the topography. The areas that show gray colorings indicate that additional infrastructure would be needed to fill in the gaps to improve coverage objectives.

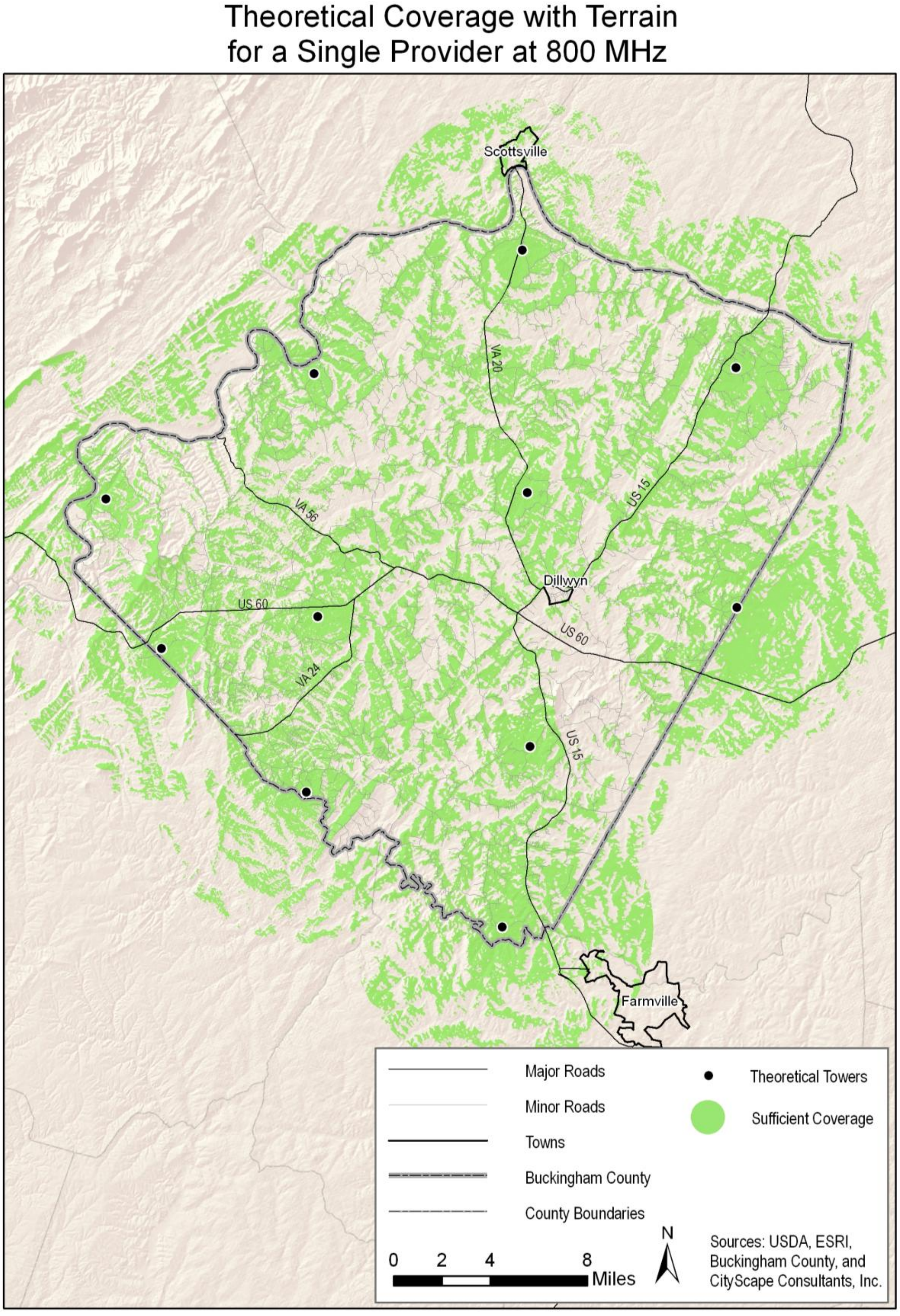


Figure 10: 800 MHz Handoff at 260' Antenna Mounting Elevations with Terrain

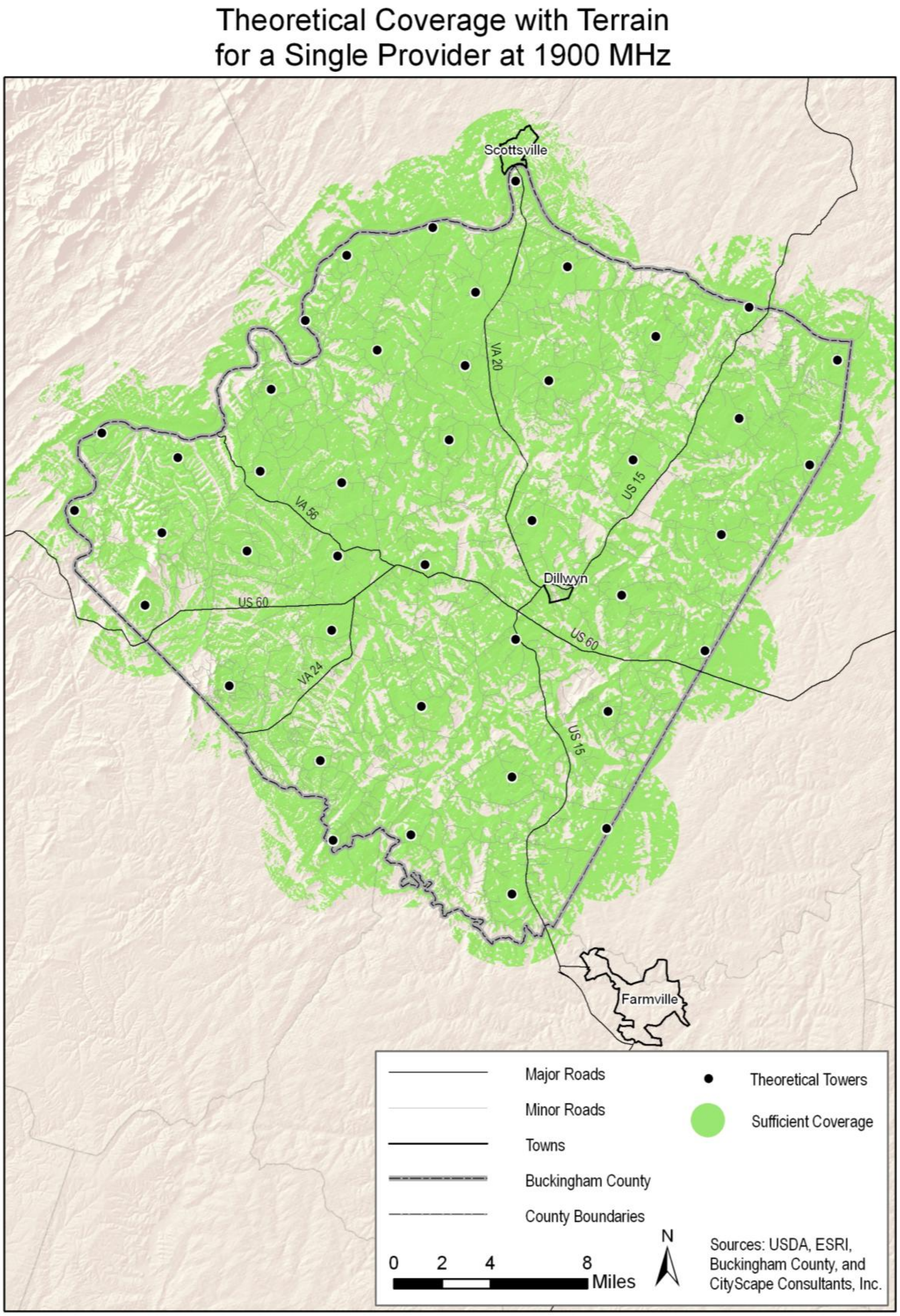


Figure 11: 1900 MHz Handoff with 260' Antenna Mounting Elevations with Terrain

Signal strength on theoretical coverage

Signal strength

The theoretical maps to this point in the master plan illustrate general coverage area from identified sites. Propagation mapping is a process that illustrates the level of coverage from an individual antenna site. Signal strength, in this application, is a term used to describe the level of operability of a handheld portable phone. The stronger the signal between the elevated antenna and the handheld wireless phone, the more likely the phone and all the built-in features will work. A reduced signal decreases the opportunity for satisfactory service caused by dropped calls or failed calls on the wireless device. Distance between the wireless handset and the elevated antennas, in addition to existing obstructions such as topography, buildings, and the physical location of the person using the handset (indoors or outdoors) are variables that affect signal strength.

The level of propagation signal strength is shown through the graduation of colors from yellow to blue. The geographic areas in yellow identify superior signal strength; green equates to areas with average signal strength; shades of blue symbolize acceptable signal strength; and gray shades show marginal or no signal strength. Generally, the closer the proximity to the antenna, the brighter shades of yellow within the geographic service area; which means the better quality of wireless service between the elevated antenna and the wireless handset. As distance is increased between the handset and the antenna the green and blue shades appear indicating geographic service areas with good, marginal, sporadic, or no signal strength, respectively. Table 4 provides further explanation of the color coding relative to propagation signals.

Signal Strength Color	Signal Strength Title	Signal Strength Description
Yellow	Superior	Signal strength strong enough to receive signal in many buildings
Green	Average	Signal strength strong enough to receive signal in a car, but not inside most buildings
Blue	Acceptable	Signal strength strong enough to receive signal outside for many handsets, but no expectation of receiving a signal in a car or building

Table 4: Signal Strength

Seasonal variables

Radio frequency propagation is also affected by vegetative cover. For example, pine needles absorb radio frequency emissions which distort the propagation from the antenna. Summer leaf foliage has a similar effect on propagation. Geographic land areas predominately covered by deciduous vegetation will have improved network coverage in the winter when the leaves are off the trees.

Using the same random antenna locations identified in Figure 7 (RMS 800 MHz Handoff and Search Areas at 260' Antenna Elevations) and Figure 8 (RMS 1900 MHz Handoff and Search Areas at 260' Antenna Elevations); Figures 12 through 15 illustrates the various levels of signal coverage from the theoretical antenna locations in summer and winter, respectfully. The areas in yellow identify geographic areas with superior signal strength; green equates to areas with average signal strength; shades of blue symbolize distinguish acceptable signal strength; and gray shades show marginal or no signal strength. Figures 12 and 13 are 800 MHz propagations and Figures 14 and 15 are 1900 MHz propagations.

Due to the mix of deciduous land cover throughout the County, the summer propagation patterns in Figures 12 through 14 illustrate slightly larger geographic areas of greens (Figure 12) and blues (Figure 14) as compared to the winter propagation maps. These area of green and blue represent diminished coverage during the months the vegetation is covered in leaves.

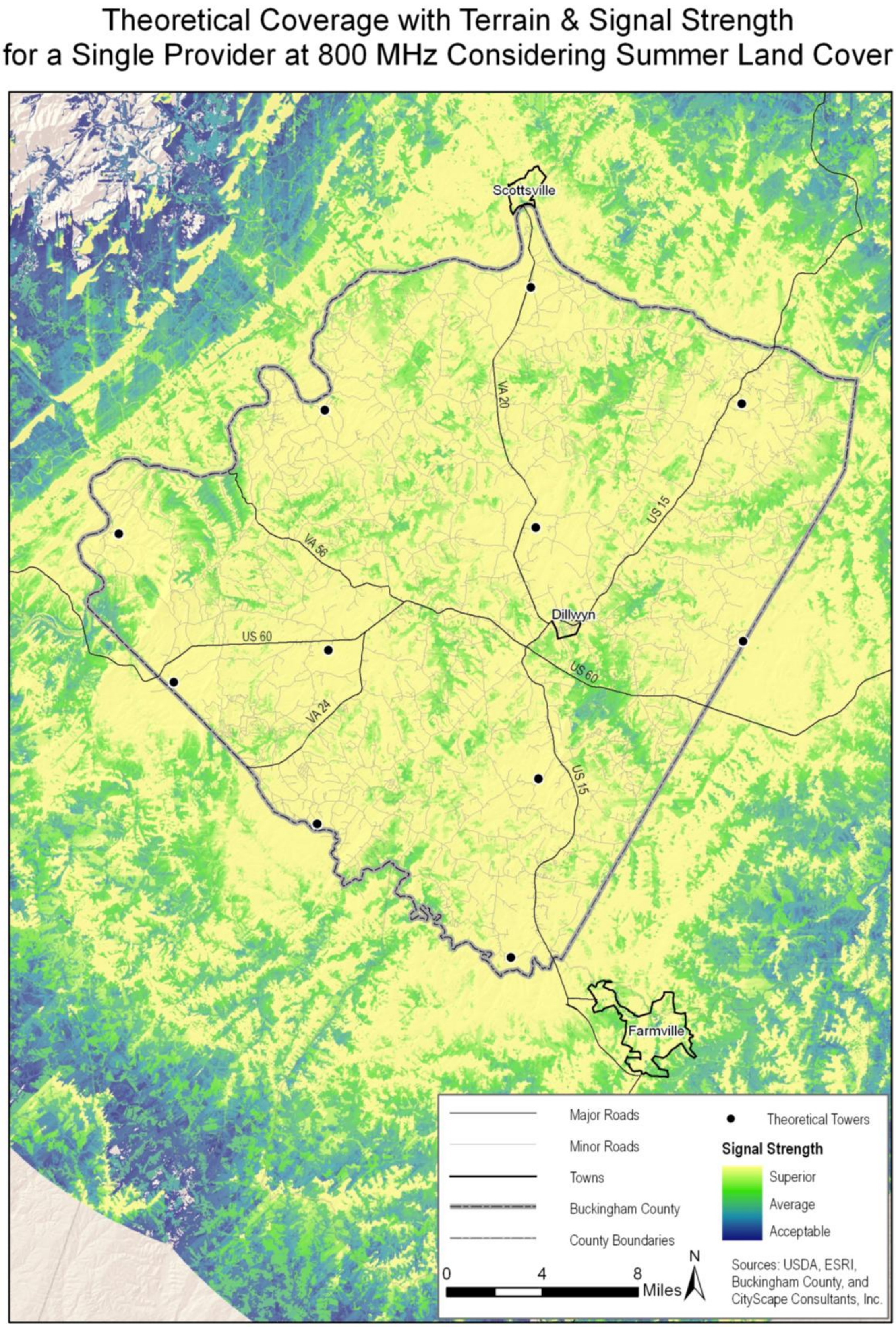


Figure 12: RMS Coverage and Signal Strength for a Single Theoretical 800 MHz Wireless Provider

Theoretical Coverage with Terrain & Signal Strength
for a Single Provider at 800 MHz Considering Winter Land Cover

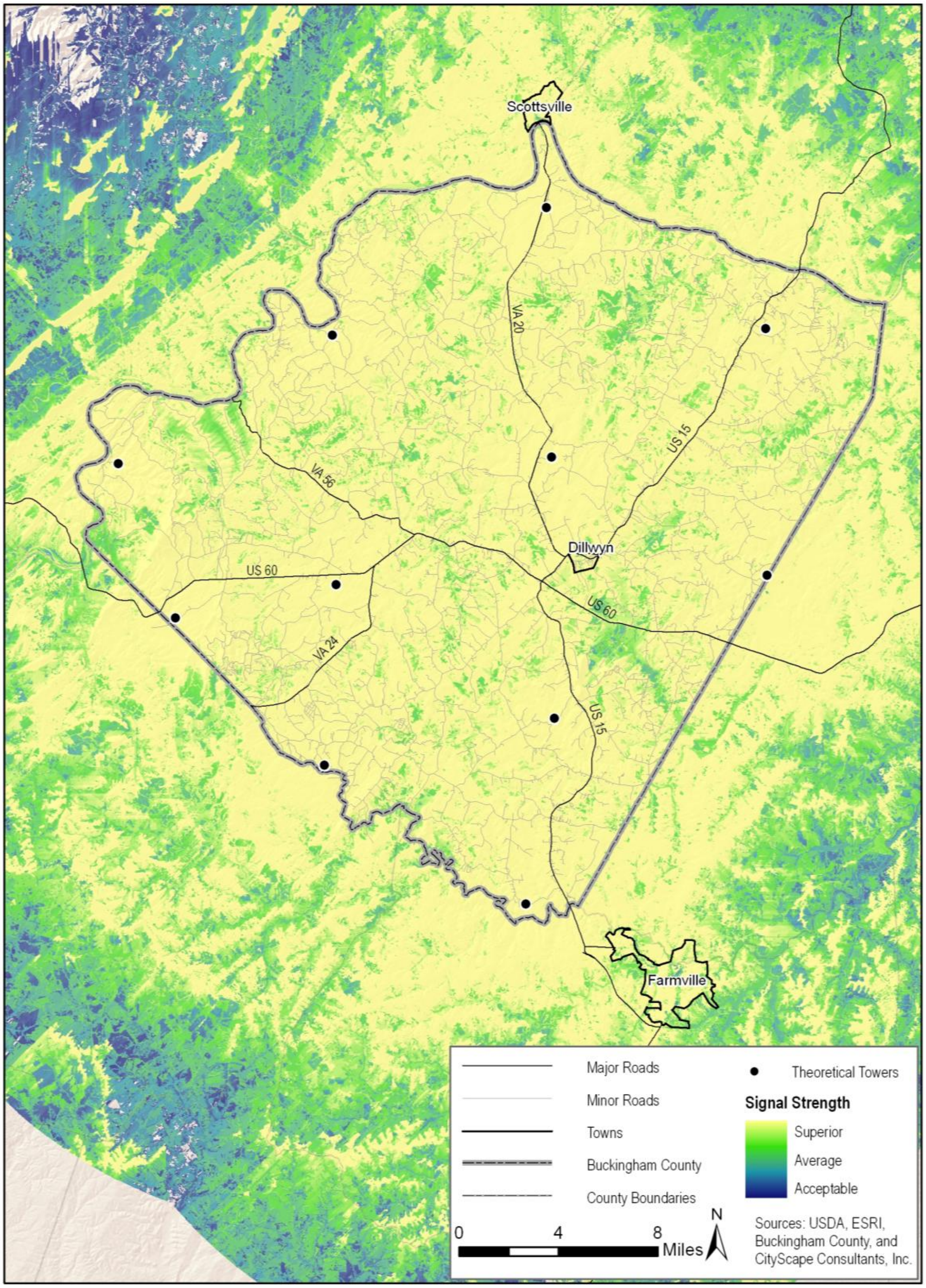


Figure 13: RMS Coverage and Signal Strength for a Single Theoretical 800 MHz Wireless Provider

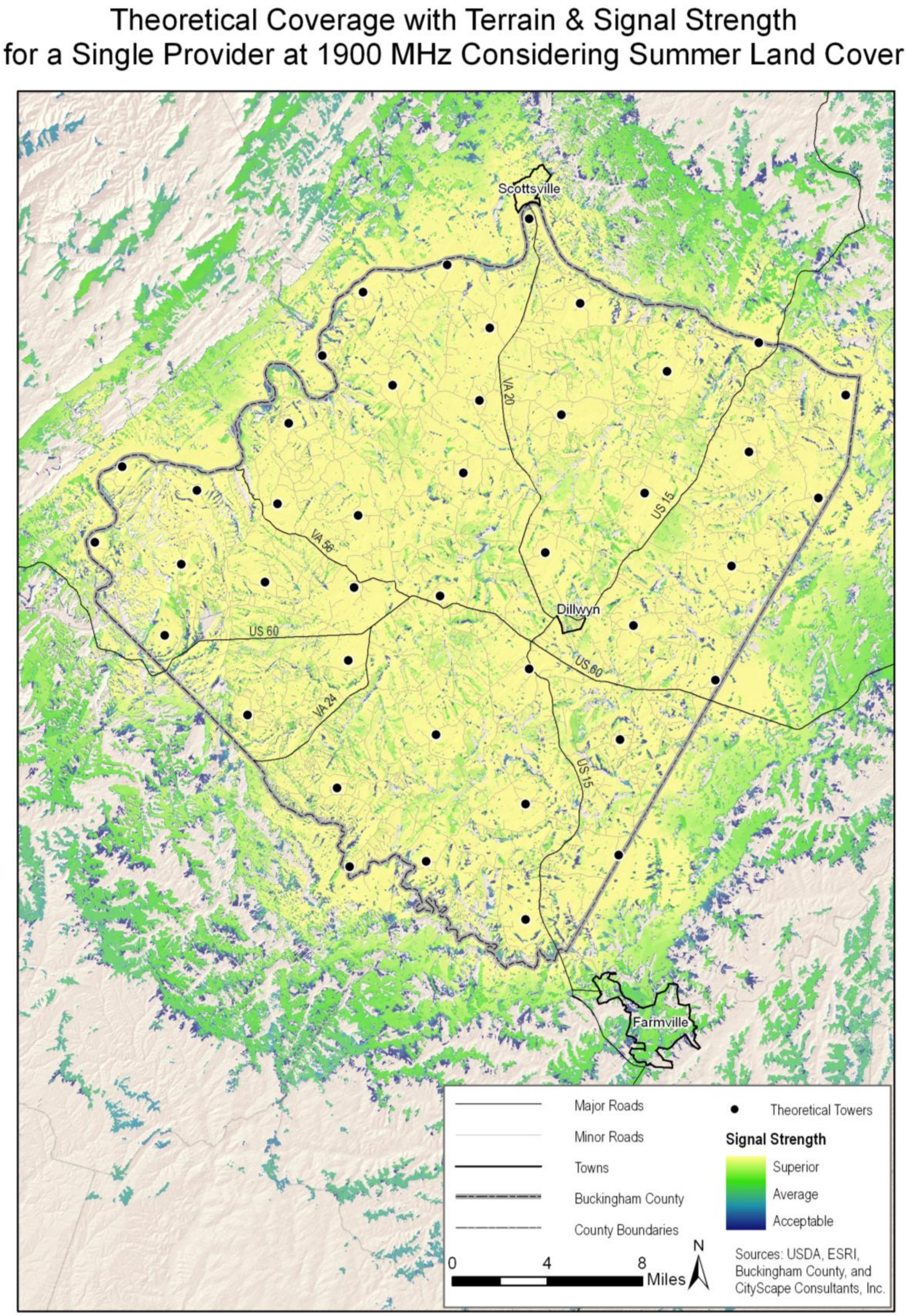


Figure 14: RMS Coverage and Signal Strength for a Single Theoretical 1900 MHz Wireless Provider

Theoretical Coverage with Terrain & Signal Strength
for a Single Provider at 1900 MHz Considering Winter Land Cover

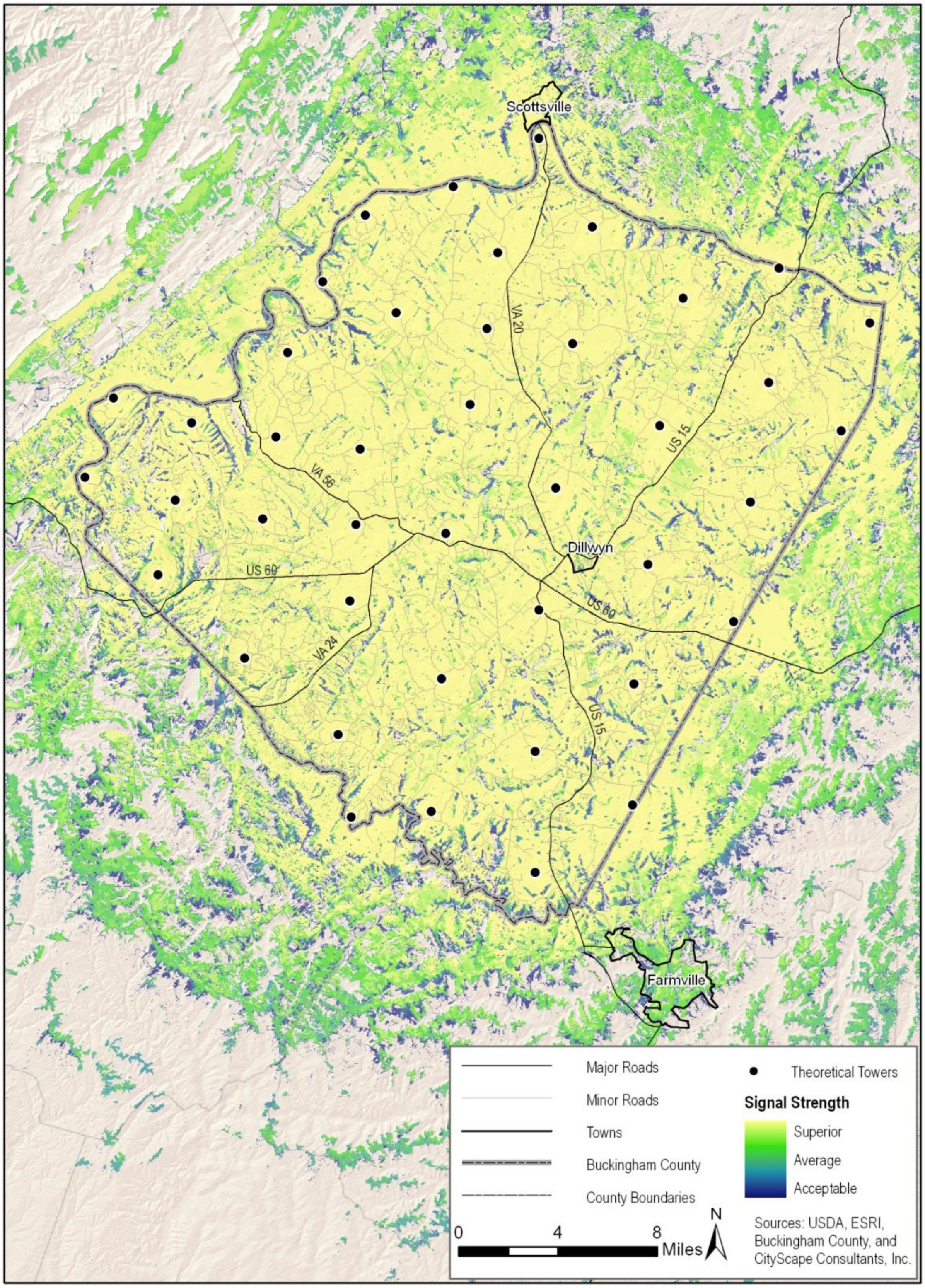


Figure 15: RMS Coverage and Signal Strength for a Single Theoretical 1900 MHz Wireless Provider

Existing antenna locations

Mapping the existing antenna sites creates a base map from which observations and analysis are derived relative to current and future deployment patterns. The County provided existing facility locations to CityScape and other locations were attained from tower owners and the FCC database. Multiple facilities were found through various antenna locater search engines or found in the field during the site assessment process. Once these sites were mapped CityScape assesses each of the existing antenna locations throughout the County to identify the following: 1) the location of existing telecommunications facilities currently within the County; and 2) the availability of future potential collocations on the existing structures.

The assessment is achieved through actual site visits to each of the base station locations. The study are includes all unincorporated areas of Buckingham County and a one mile perimeter boundary around the unincorporated lands. The wireless infrastructure assessment for Buckingham County identifies 20 existing wireless communication facilities and 8 proposed locations within the study area.

Antennas mounted on towers are symbolized with a black dot. Brown dots indicate towers that are proposed. Orange dots identify facilities that are approved but which had not been constructed at the time of our site assessments. Towers outside of Buckingham County and within 1 mile of the Buckingham jurisdictional boundary are symbolized with a pink dot. Blue dots represent antenna mounted on water tanks. Red dots note the location of existing towers that are owned by the County and used primarily for emergency management communications. Green dots identify County-owned land as possible new tower sites. These antenna locations are identified in Figure 16.

The present deployment pattern of existing antenna locations and proposed new sites illustrates that visible chain of facilities parallel the US Highway 15 and US Highway 60 corridors; and parallel VA 20, VA 56, and VA 24. This pattern of deployment is consistent with other deployment patterns in rural areas throughout the United States as providers seek to develop their wireless networks for customers utilizing their wireless handsets while traveling in their vehicles.

A second geographic area with a denser concentration of antenna sites is the geographic area the Town of Dillwyn. The concentration of antenna locations in this region is expected given the commercial development and residential population densities.

The overall deployment pattern parallel the major roadways and throughout the residential areas are largely incomplete and indicate phase 1 (network coverage) wireless deployment practices.

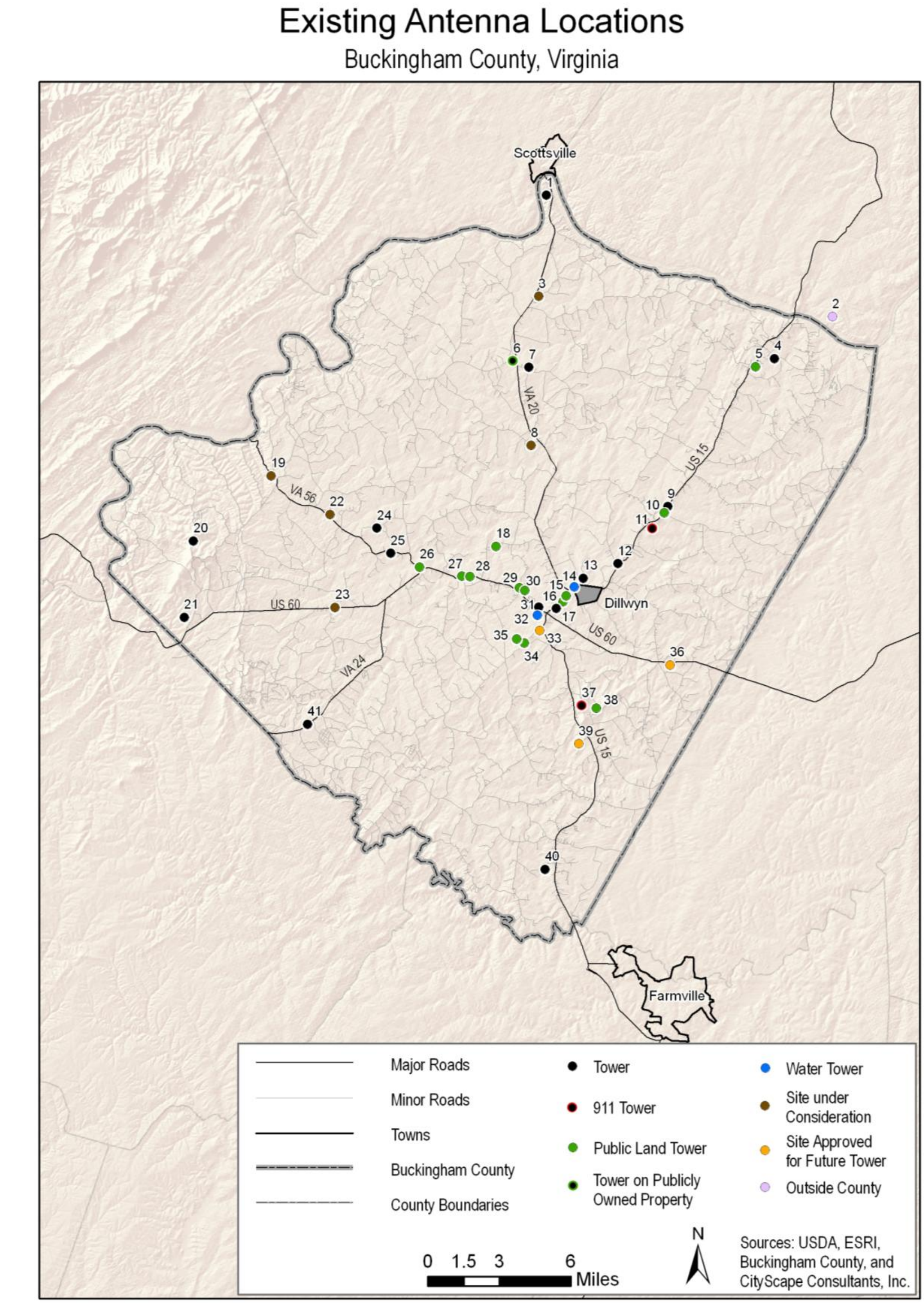


Figure 16: Existing Antenna Locations

The industry and infrastructure

Prior to the granting of the cellular licenses in 1980 for the first phase of deployment, the United States was divided into 51 regions by Rand McNally and Company. These regions are described as Metropolitan Trading Areas (MTA). The spectrum auction conducted by the Federal Government for the 1900 MHz bands for 2G (PCS), further divided the United States into 493 geographic areas called Basic Trading Areas (BTA). The County is located in the "Washington-Baltimore" MTA (a.k.a. MTA 10) and the "Charlottesville" BTA (a.k.a. BTA 75).

Presently throughout the County there are two providers licensed to operate in the blocks of cellular services allocated in the 800 MHz band: Alltel (recently purchased by Verizon), Verizon, and US Cellular.

There are six blocks of Personal Communications Services (PCS) licensed to operate in the 1900 MHz band: AT&T Mobility, Sprint Nextel and Ntelos (for Verizon).

Per Section 704 of the Telecommunications Act of 1996 all six service providers (AT&T, Sprint Nextel, T-Mobile, Verizon, Metro PCS, and Strata8) will require uninterrupted and continuous handoff service throughout the County.

Additionally the follow services providers have purchased licenses to offer services in the 700 MHz frequencies: AT&T Mobility, Buggs Island Telephone Cooperative, Continuum 700 LLC, Frontier Wireless, Qualcomm, Verizon Wireless, and Xanadoo Company.

Of the 28 antenna locations throughout the County, CityScape can identify the ownership of 26 of the existing facilities. Tables 5 and 6 below identify the facility owners. The following eight facility owners each own one asset and combined are referenced as "others": AT&T Mobility, American Tower Corporation; Communication Enhancement, LLC; VA State Police; Toga Volunteer Fire Department; VA Electric and Power Company; Vision Ventures; and WKGM. The ownership of two facilities is unknown.

Support Structure Owners	Number of Towers
Alltel	3
County	3
US Cellular	3
National Tower	4
Verizon	5
Unknown	2
Others	8
	28

Table 5: Primary Tower Owners

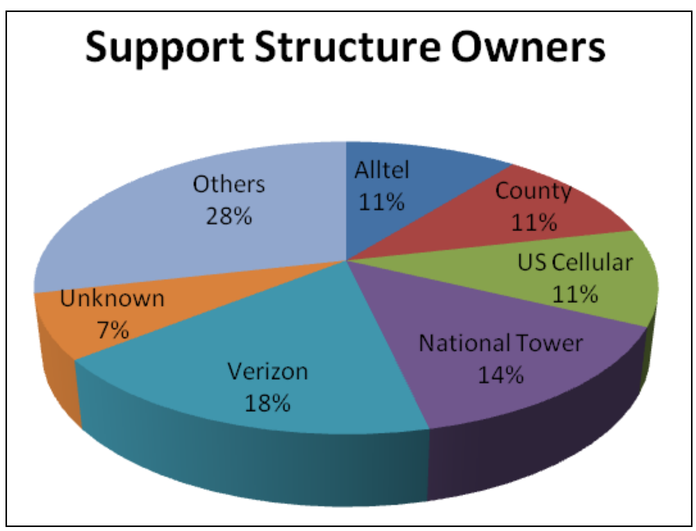


Table 6: Pie Chart of Primary Tower Owner Stakeholders

Most of the support structures for the antenna are guy wire and lattice type construction. Table 7 identifies the number and type of supports structures County-wide.

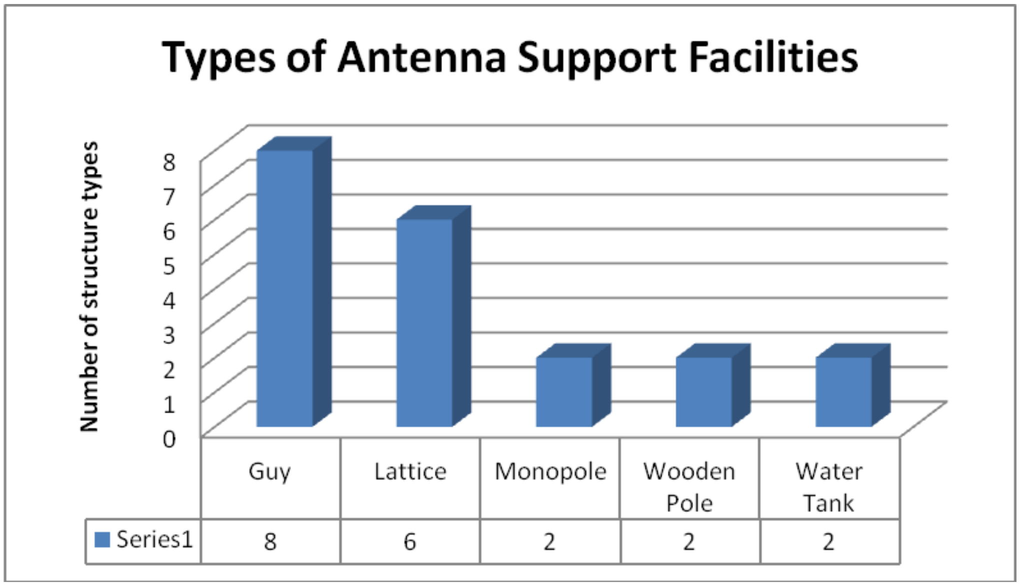


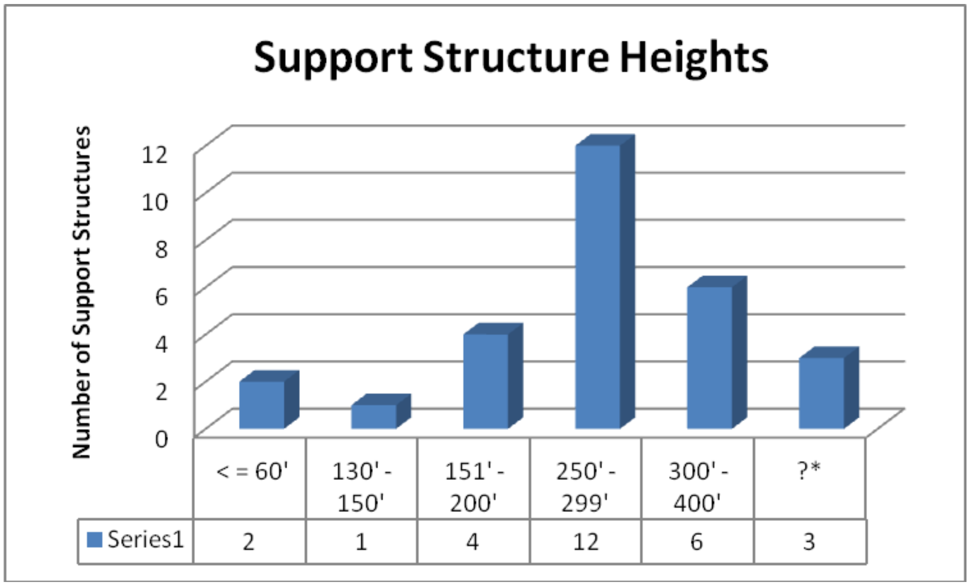
Table 7: Types of Antenna Support Facilities

Heights of support facilities are known for all but 3 of the identified antenna locations. Of the known support structure heights the majority of the sites (44 percent) are between 250 and 299 feet. Tables 8 and 9 provide the height ranges of the identified support facilities in the Master Plan study area.

Number of Known Support Facility Heights	Height of Support Facility	Percentage of Support Facilities in Given Height Range
< = 60'	2	7%
130' - 150'	1	4%
151' - 200'	4	14%
250' - 299'	12	43%
300' - 400'	6	21%
?*	3	11%
Total	**28**	**100%**

* Indicates towers that appear in the inventory but for which height could not be determined.

Table 8: Support Facility Elevations



* Indicates towers that appear in the inventory but for which height could not be determined.

Table 9: Bar Graph of Support Facility Elevations

Theoretical coverage from existing antenna locations

The next step in the evaluation process is to examine the coverage from all known existing antenna locations to determine if any area of the County has unsatisfactory or no service at all. CityScape theorizes how existing antenna locations might be used by the wireless industry.

For example, CityScape asks the following questions. First, “Would network coverage gaps be visible if a single Cellular (800 MHz) and PCS (1900 MHz) provider utilized all identified antenna locations?” And second, “Does the County have adequate existing infrastructure suitable for provides to meet complete network coverage objectives?”

Figure 17 demonstrates the theoretical coverage for a single 800 MHz service provider with antenna mounted at the top mounting position of all known support structures used for 800 MHz and/or 1900 MHz antenna. These maps do include the 8 sites that are proposed and not built yet. Theoretical coverage in green indicates geographic areas that would have coverage from the nearby antenna. Areas of gray indicate insufficient coverage. *Figure 17 does not include terrain or other variables.* Figure 17 shows almost complete county-wide coverage if indeed one 800 MHz provider was located at each of these sites.

Figure 18 demonstrates the theoretical coverage for a single 1900 MHz provider with antenna mounted at the top mounting position of all known support structures used for 800 MHz and/or 1900 MHz antenna. These maps do include the 8 sites that are proposed and not built yet. Theoretical coverage in green indicates geographic areas that would have coverage from the nearby antenna. Areas of gray indicate insufficient coverage. *Figure 18 does not include terrain or any other variables*. Figure 18 illustrate incomplete network coverage from the existing antenna locations for one provider operating in the 1900 MHz frequency.

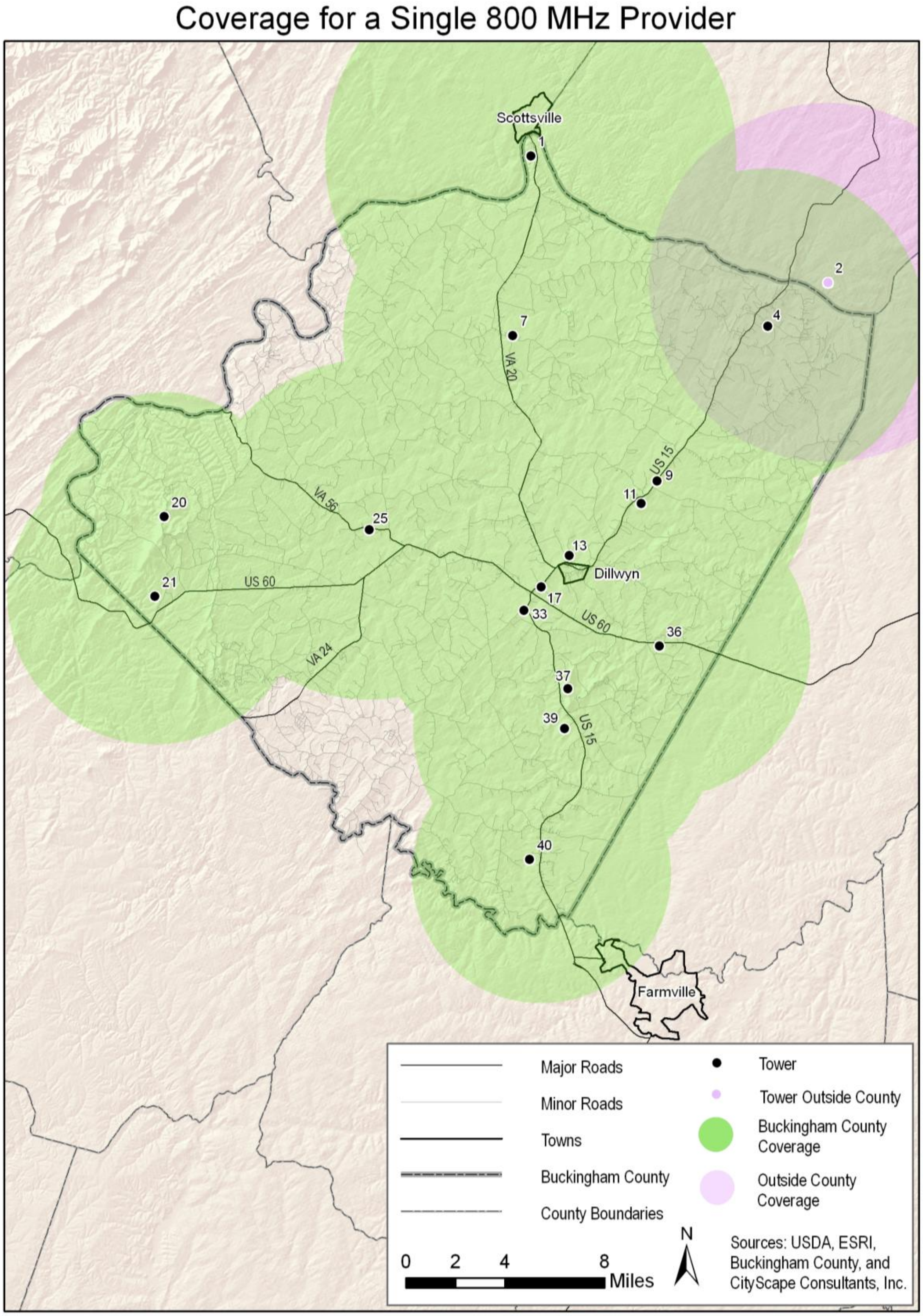


Figure 17: RMS Coverage for a Single Theoretical 800 MHz Wireless Provider from All Existing Antenna Locations

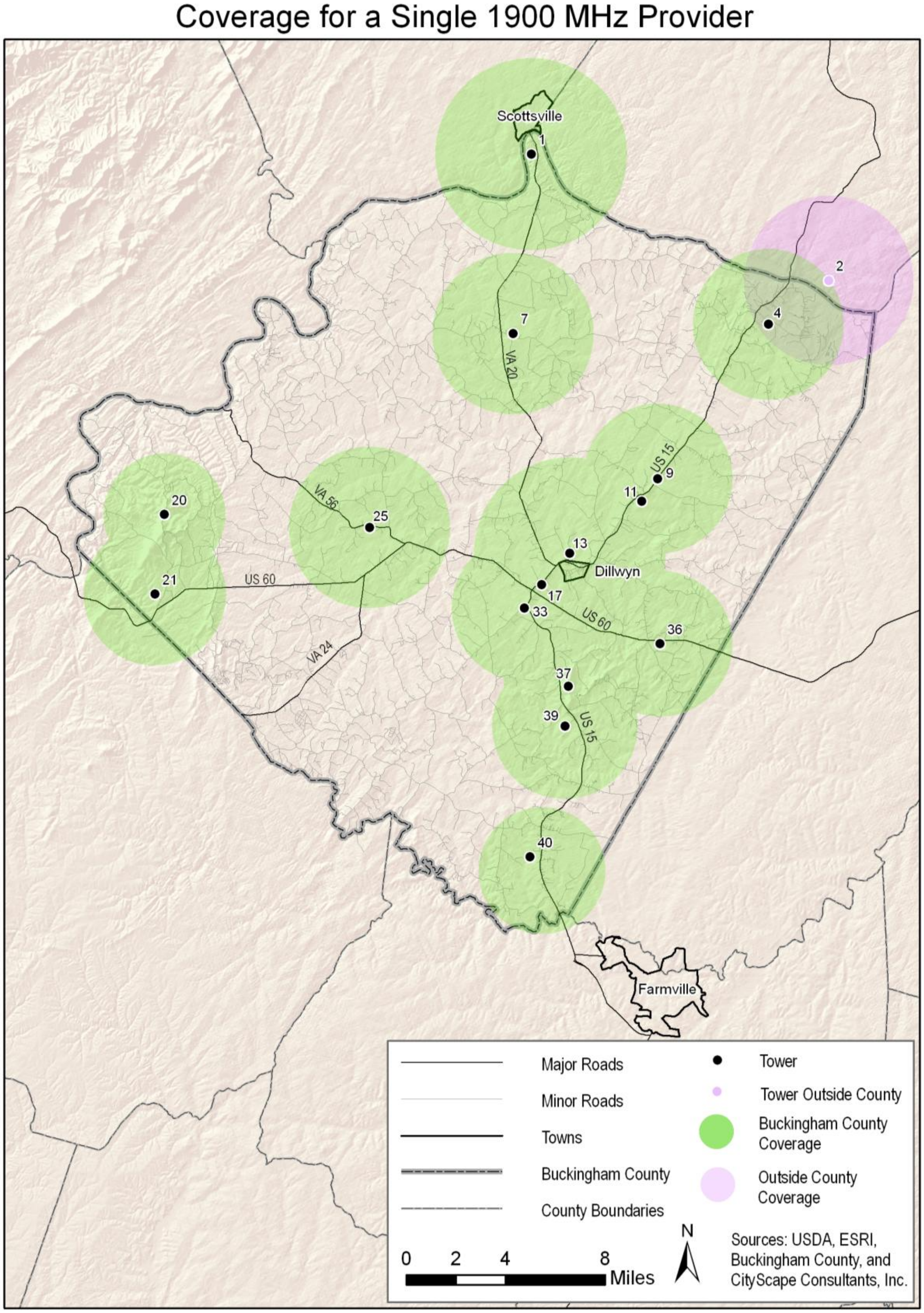


Figure 18: RMS Coverage for a Single Theoretical 1900 MHz Wireless Provider from All Existing Antenna Locations

Topographic variables

Using the same existing antenna locations identified in Figures 17 and 18 (Coverage for a Single Theoretical 800 MHz and 1900 MHz Wireless Provider from All Existing Antenna Locations, respectfully), Figures 19 and 20 illustrate the effects of terrain on the wireless service coverage areas. Given the topographic variations throughout Buckingham County Figures 19 and 20 illustrate significant changes to the wireless network coverage area. Geographic areas with good wireless coverage are shown in green. The scattered areas in gray in Figure 19 and the large swaths of land in Figure 20 illustrate gaps in network coverage.

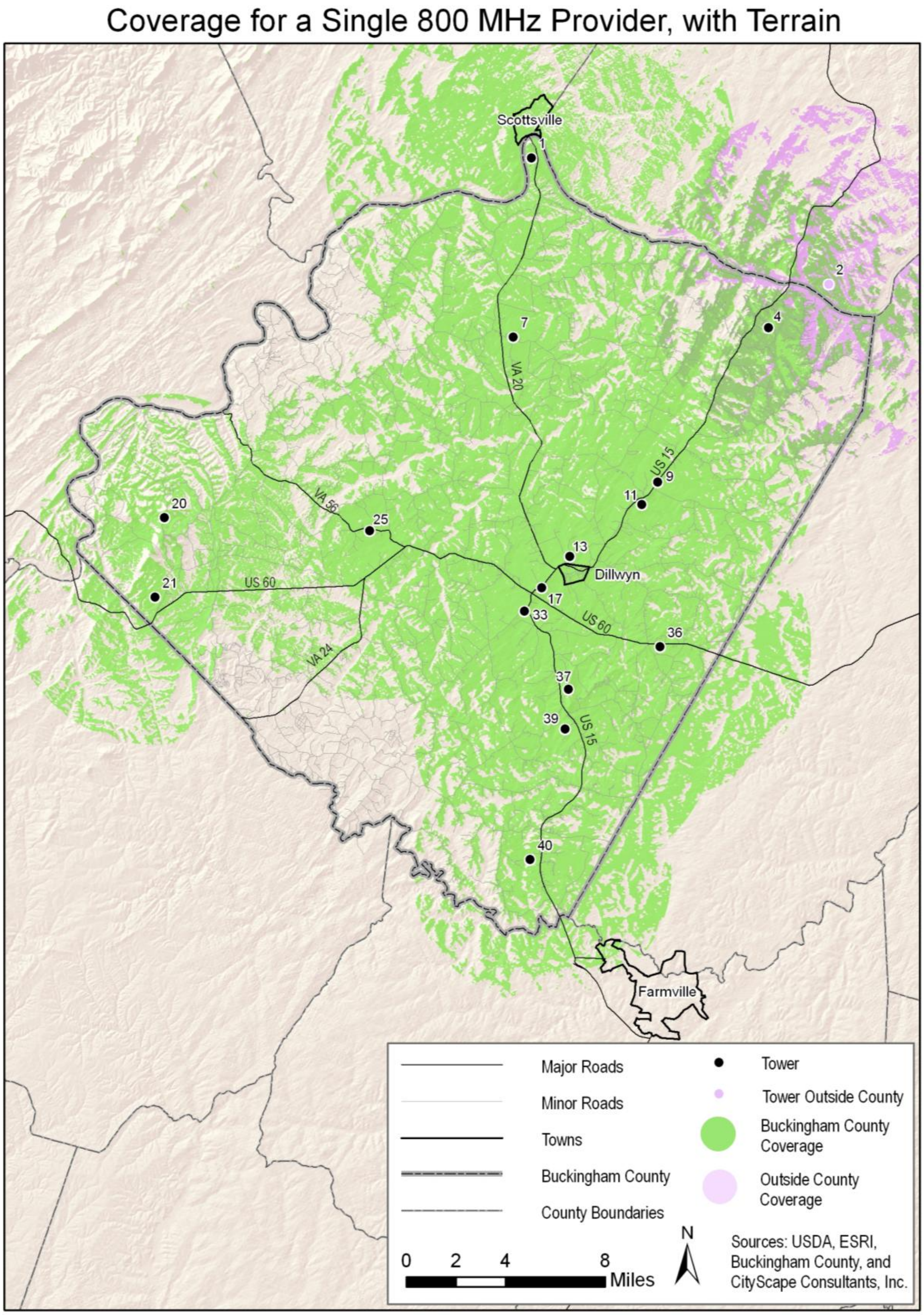


Figure 19: Coverage for a Single Theoretical 800 MHz Wireless Provider from All Existing Antenna Locations with terrain

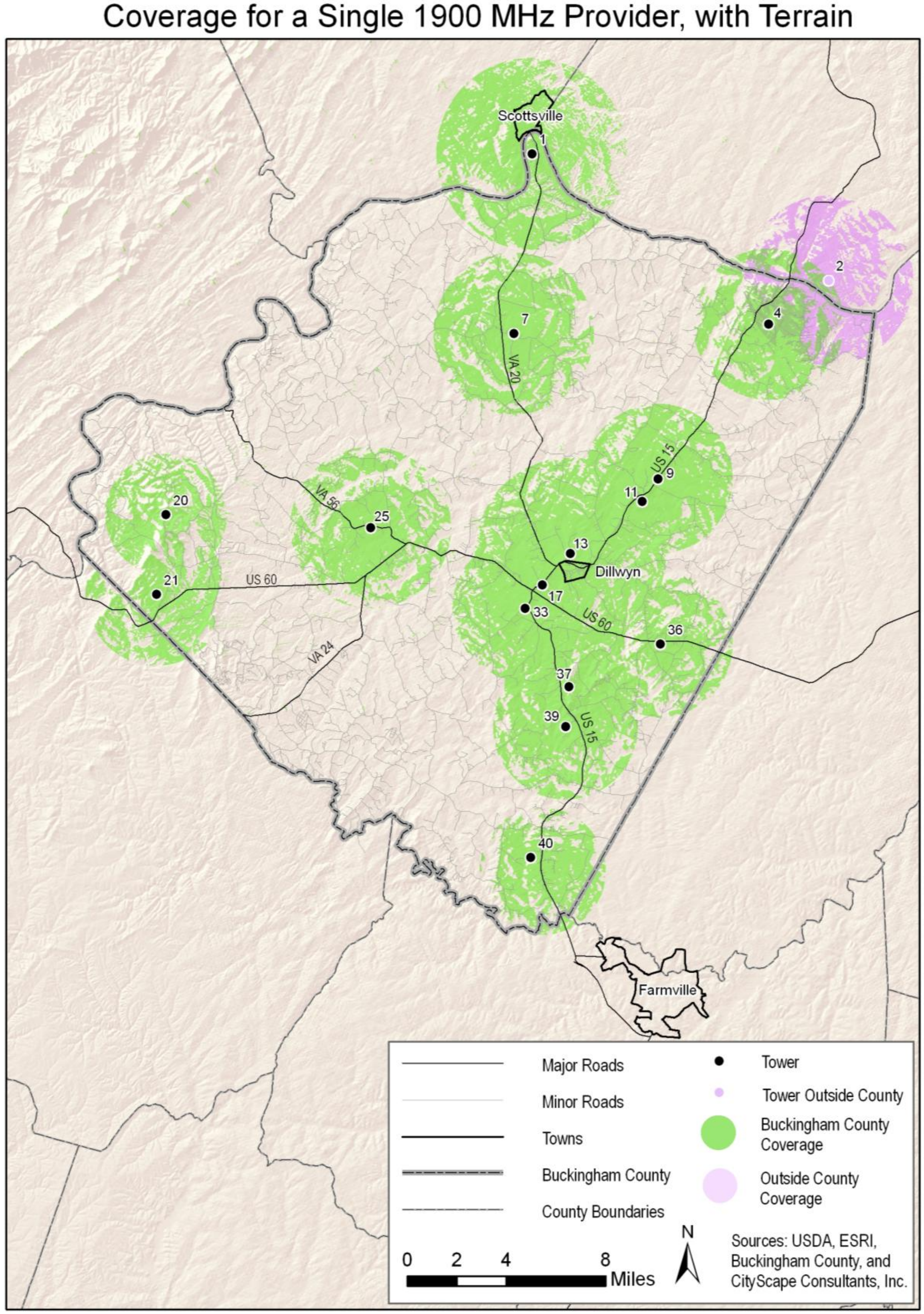


Figure 20: Coverage for a Single Theoretical 1900 MHz Wireless Provider from All Existing Antenna Locations with terrain

Signal strength

Figures 21 and 22 illustrate the propagation (level of signal strength) for 800 MHz and 1900 MHz networks, respectfully from the existing and proposed antenna locations including the summer vegetation and terrain variables.

While Figure 21 appears to illustrate good coverage from the existing towers it is important to remember that no one single 800 MHz or 1900 MHz wireless provider has equipment at all of these sites. For this reason the coverage pattern by the individual wireless providers are not as widespread and largely incomplete parallel the major roadways and throughout much of the county.

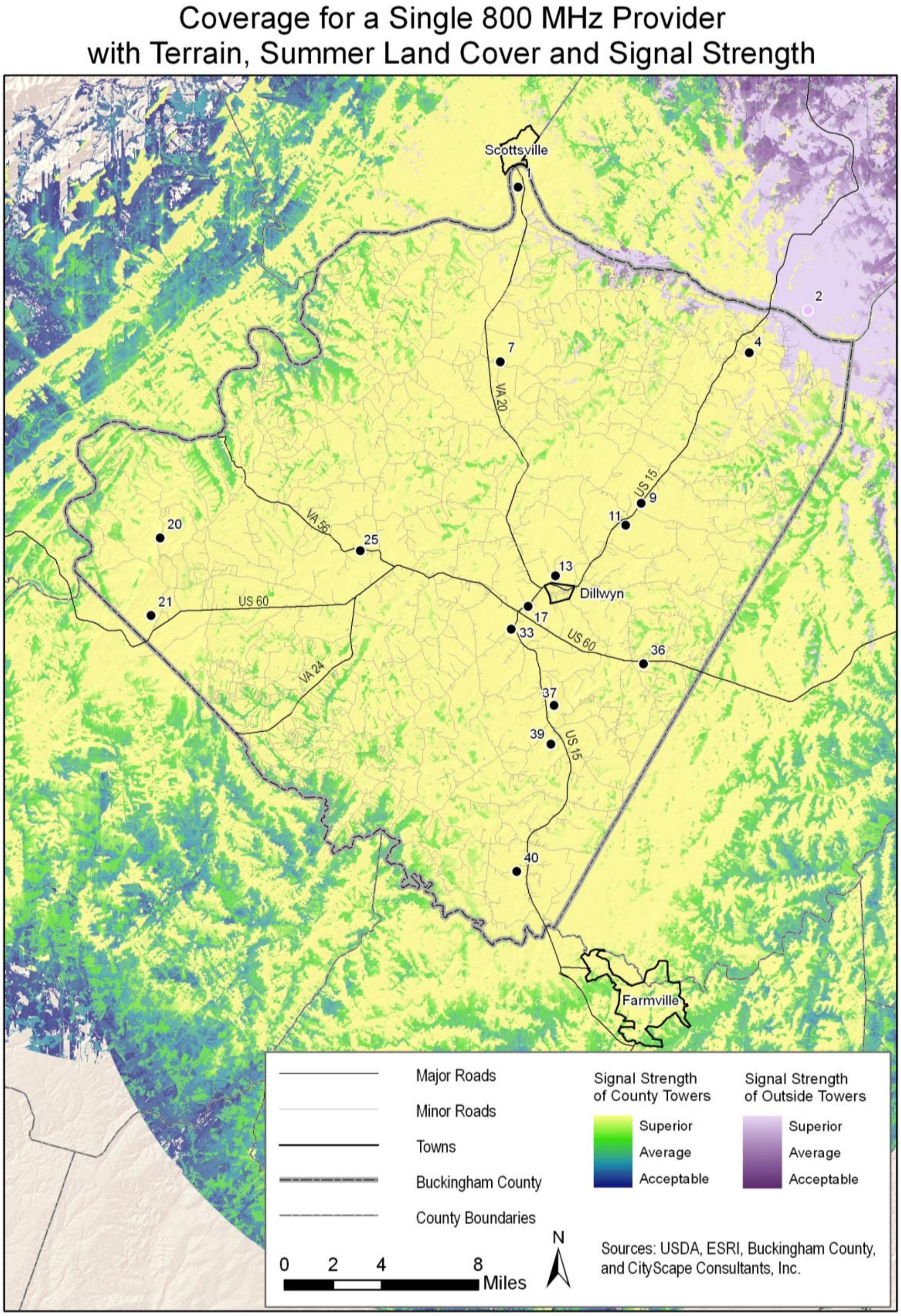


Figure 21: Coverage for a Single 800 MHz Wireless Provider from Existing Antenna Locations with Summer Signal Strength

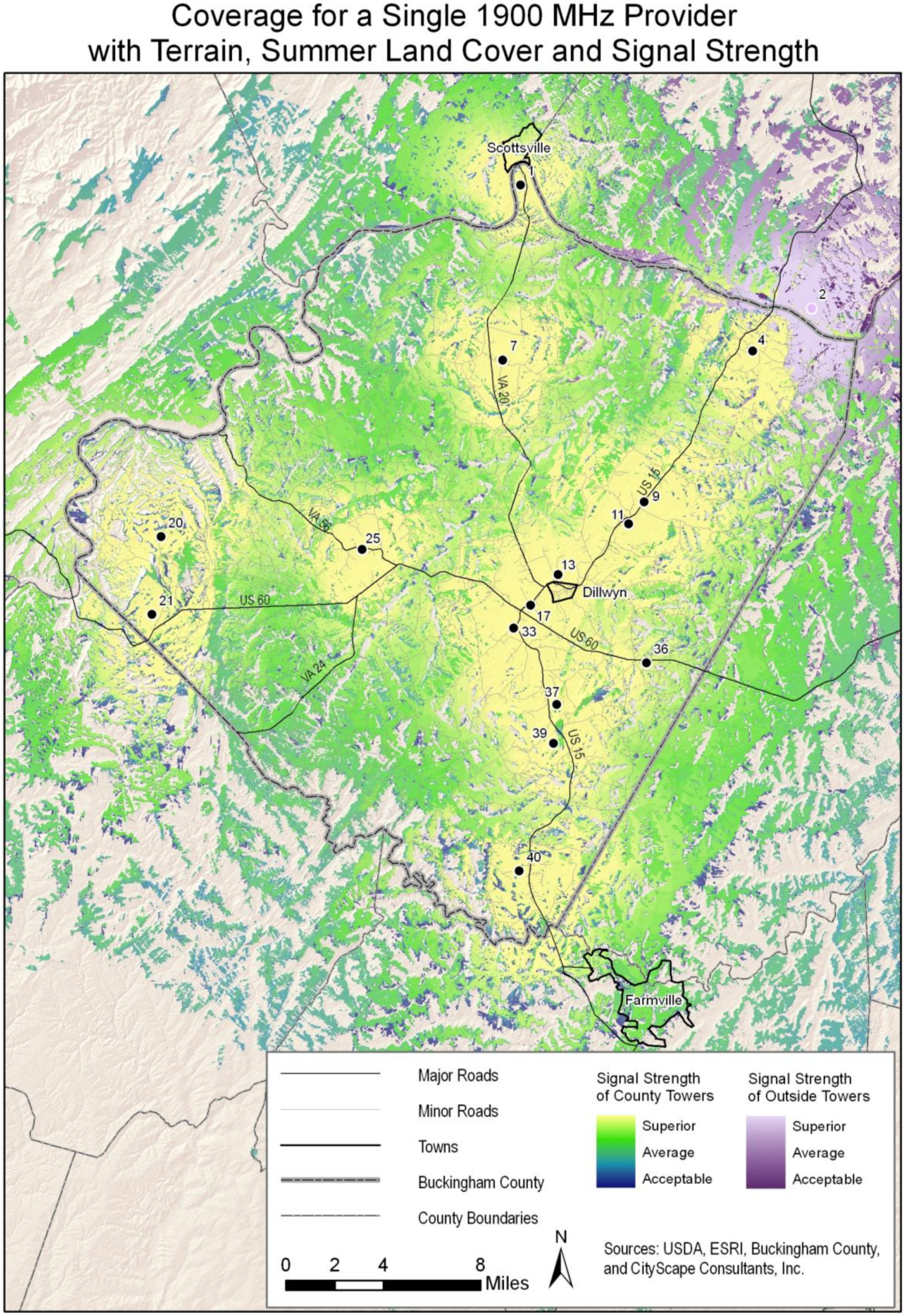


Figure 22: Coverage for a Single 1900 MHz Wireless Provider from Existing Antenna Locations with Summer Signal Strength

Population analysis

Buckingham County is a rural county located in the central portion of Virginia southeast of Charlottesville and southwest of Richmond. US Highway 15 traverses the County in a north/south direction and US Highway 60 traverses the southern portion of the County in a east/west direction. Additional major roadways include: VA 20, VA 56, and VA 24.

According to the 2000 United States Census (the Census) the physical size of the County is approximately 582 square miles. The population data is from the U.S. Census Bureau's Population Estimates Program, specifically the 2000 Census Place districts data. This dataset is reported by the Census at the county level across the United States. The County was estimated by the Census Bureau to have increased in population by 2.3 percent between 2000 and 2008 that brings the population for Buckingham County to about 15,977. This equates to an average of 27 persons per square mile.

According to the Census population by zip code the largest population density is in the southeastern part of the County where seventy-six is the average person per square mile. Other population densities are located parallel and around the vicinities of US Highway 15, VA 20, Dillwyn, and Buckingham. The population density ranges between thirty-six and forty-two persons per square mile. CityScape realizes that growth rates vary between local community estimates and the US Census; but for the purposes of this plan, CityScape uses the US Census data. It is no coincidence the existing wireless telecommunications infrastructure is found in these same geographic areas.

Figure 23 is a side by side comparison between the US Census population densities and the propagation coverage map from the existing antenna locations. The map on the left illustrates the distribution of population County-wide by zip code. The deep shade of green identifies the greatest population concentration in the County; with the lighter shades of green being the next most populated areas. Pale shades identify low population profiles. The map on the right illustrates the propagation coverage from the existing and proposed wireless infrastructure. Existing network coverage is shown to be incomplete and spotty along the major transportation networks and throughout the larger population centers.

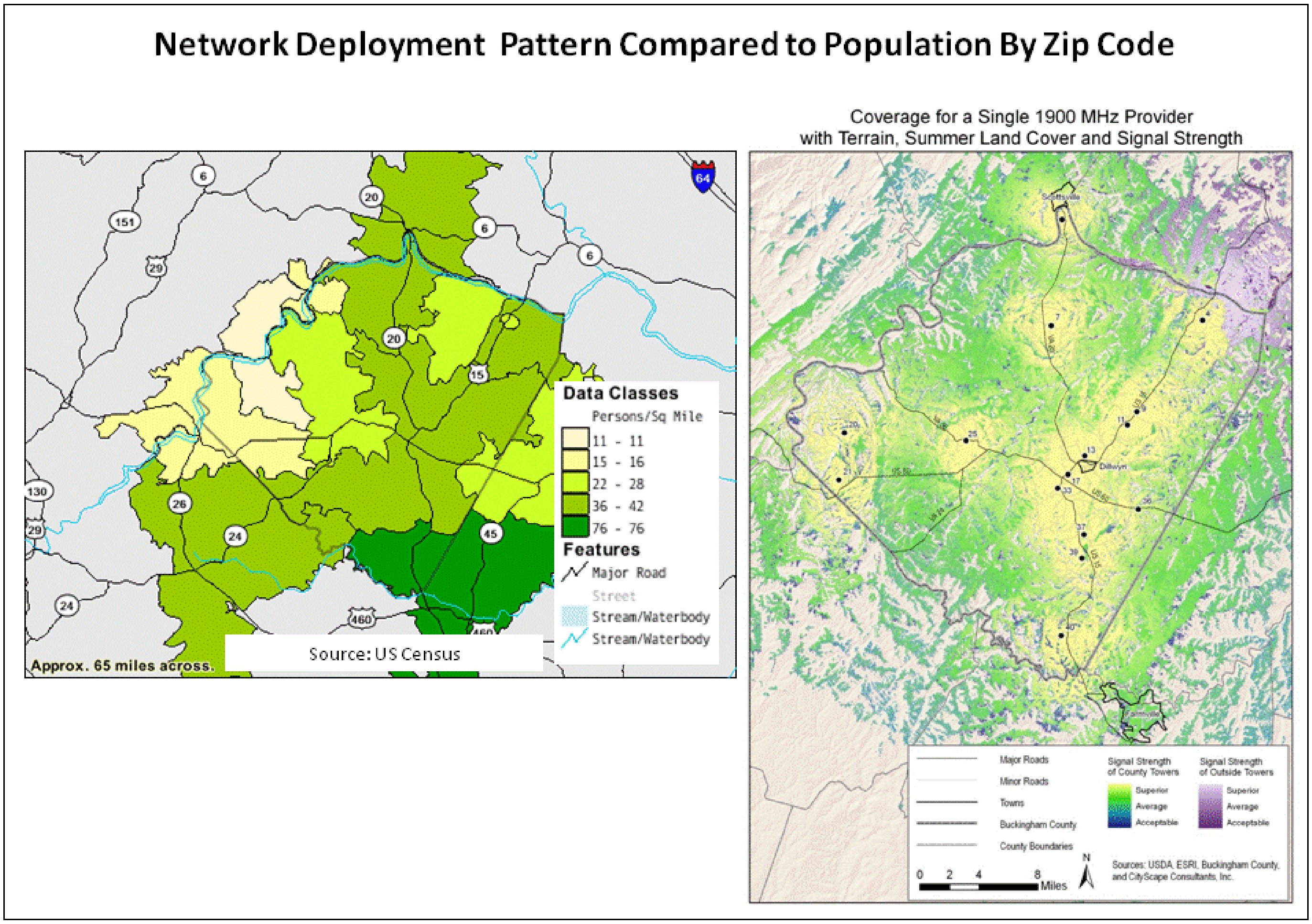


Figure 23: Population and Wireless Coverage Comparisons

Chapter 4 Zoning

Zoning Analysis

CityScape has reviewed the County's zoning regulations in comparison to the Tower Master Plan and provides the following observations.

First, Article 9, Section 5(4) indicates a set back from any property line to be one hundred and twenty percent (120%) of the total tower height. This means a tower that is 260 feet in height must have a minimum setback of 312' from all property lines, equating to a minimum lot size of 2.23 acres. On lots of record in commercial and in more densely populated areas, lots tend to be smaller. Finding a parcel in these type geographic areas that meet this standard may be difficult. The inventory map for geographic regions parallel the major transportation networks is incomplete and may partially be due to this zoning standard. If lots of sufficient sizes are not available for the industry then this requirement could present a barrier to entry. CityScape recommends the county study the lot and available parcels in this geographic area that would be sized and suitable for new towers and keep a listing of those sites for the industry to use a guide for future site locations.

Second, much discussion has occurred regarding the use of County-owned properties for the installation of wireless telecommunication facilities. The practice of installing infrastructure on publically-owned sites is common throughout the United States and is rooted in the enabling text of the federal legislation that revolutionized the wireless communications industry, the Telecommunications Act of 1996 (the Act).

Legal Opinion

The Act requires local governments to treat wireless telecommunications providers (who provide functionally equivalent services) equally and that those governments not enact regulations that hinder or prevent the development and provision of wireless services to consumers. Those provisions of Section 704 of the Act are well known, but lesser known sections provide that the federal government makes available property for wireless facilities stating in part:

> "(c) AVAILABILITY OF PROPERTY- Within 180 days of the enactment of this Act, the President or his designee shall prescribe procedures by which Federal departments and agencies may make available on a fair, reasonable, and nondiscriminatory basis, property, rights-of-way, and easements under their control for the placement of new telecommunications services that are dependent, in whole or in part, upon the utilization of Federal spectrum rights for the transmission or reception of such services. These procedures may establish a presumption that requests for the use of property, rights-of-way, and easements by duly authorized providers should be granted absent unavoidable direct conflict with the department or agency's mission, or the current or planned use of the property, rights-of-way, and easements in question. Reasonable fees may be charged to providers of such telecommunications services for use of property, rights-of-way, and easements. *The Commission shall provide technical support to*

> *States to encourage them to make property, rights-of-way, and easements under their jurisdiction available for such purposes"* (emphasis added).

Clearly, the congressional intent behind this language was to enable the utilization of Federal property for wireless services and to encourage state and local governments to make public property available for wireless purposes. The FCC interpreted the language in its *Wireless Siting Fact Sheet #1* (April 23, 1996)[1] to mean: "Federal agencies and departments will work directly with licensees to make federal property available for this purpose, and the FCC is directed to work with the states to find ways for states to accommodate licensees who wish to erect towers on state property, or use state easements and rights-of-way".

However, there is no federal telecommunications regulation prohibiting the extent to which a city, county, town or County desires to regulate the placement of wireless communications facilities to *favor* public property over private property. Indeed, based on the foregoing language, it would appear that Congress' intent is to encourage siting on public property. Of course, if the effect of such a provision were to prevent the implementation of wireless services (for example, by mandating that a provider had to construct on public property and there was no public property available in the geographic search ring for the proposed facility), then such regulation would have the effect of prohibiting wireless services and that could be a violation of the Act.

The opinions provided herein relate solely to federal law and FCC decisions and regulations specifically and do not relate to any applicable state or local regulation. Anthony T. Lepore, Esq., CityScape's Vice President, devotes his practice exclusively to telecommunications issues, is a member of the Florida and Massachusetts Bars and is admitted to practice before the Federal Communications Commission

Leasing public-owned lands assures the community the preference of concealment materials and technologies presently available to the industry. As public sites are developed, the infrastructure installed becomes the precedent of how future sites should be developed on private land. For example, many "tree towers" and "flag pole" towers are available to the industry. But there are other creative ideas for concealment towers; some are more aesthetically pleasing and more practical than other types. As the local government utilizes these products, these applications become the standard for future tower sites on both public and private land. As public land sites are considered and utilized for these purposes, staff gains invaluable knowledge on how wireless sites are constructed which will aid them in future site plan designs and evaluations on both public and private properties.

Leasing public lands for purposes of new wireless infrastructure can create new sources of public revenue. As new sites are developed on public land, the community generates lease revenue from that tower owner and tenant. Some communities are generating millions of dollars over the term of multiple contracts just from leasing public facilities to the wireless service providers. This revenue is created without bonds or raising taxes.

[1] http://wireless.fcc.gov/siting/fact1.html

Developing a Siting Alternative Hierarchy is one way to encourage the use of County-owned and publicly-owned property as locations for new wireless telecommunications infrastructure. If the County intends on this scenario coming to fruition then it would behoove the County to target specific public sites for leasing purposes and to add them to the propagation analysis of the Master Plan to determine the effectiveness of the sites for future wireless infrastructure.

CityScape has reviewed the County database of potentially available county-owned lands and has identified fourteen sites that match the future service geographic areas illustrated in Figure 24. The potential coverage from new infrastructure from the county-owned parcels is illustrated in orange. These figures are based on the 260-foot antenna mounting elevation. The addition of the County-owned property offers a significant improvement to the existing wireless network. The coverage comparison is illustrated in Figure 25.

Figure 26 offers a second view of network coverage from the identified County-owned properties with the antenna mounting elevation of 199'. Towers build less than 200' in elevation do not have to have lighting standards unless they are in close proximity to a flight path. The lower elevation offers an opportunity to be less conspicuous. The disadvantage to the lower mounting elevation is the likelihood that collocation opportunities would possibly be limited given the topographic variations throughout the County.

The county would need to study each of these identified County-owned sites to determine the viability of utilizing each parcel for future wireless telecommunications infrastructure. Figure 27 provides the County's lease revenue potential if six of the twenty-five properties are utilized for future wireless communications infrastructure.

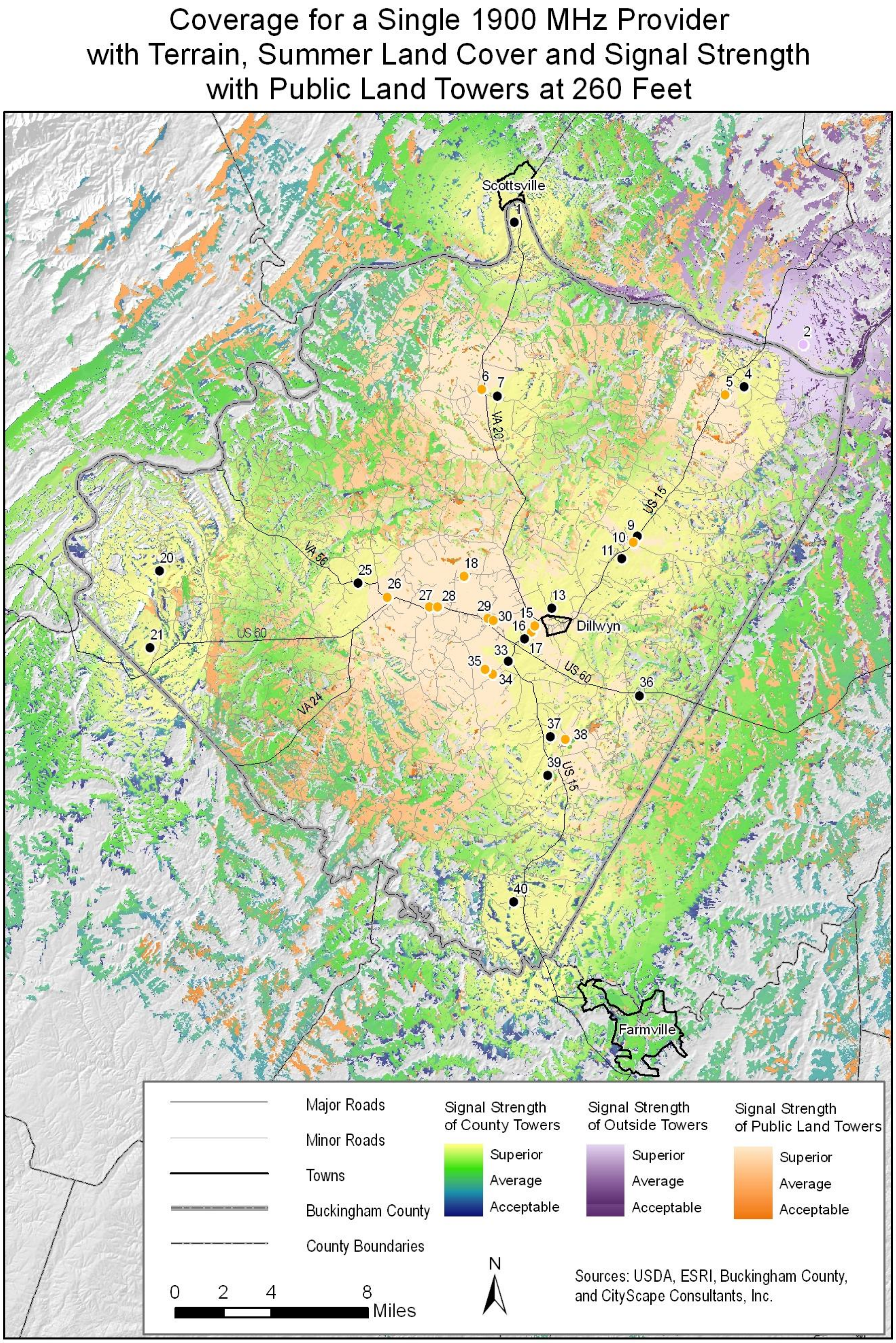


Figure 24: **Potential County-owned parcels for new wireless infrastructure infill sites with 260' towers**

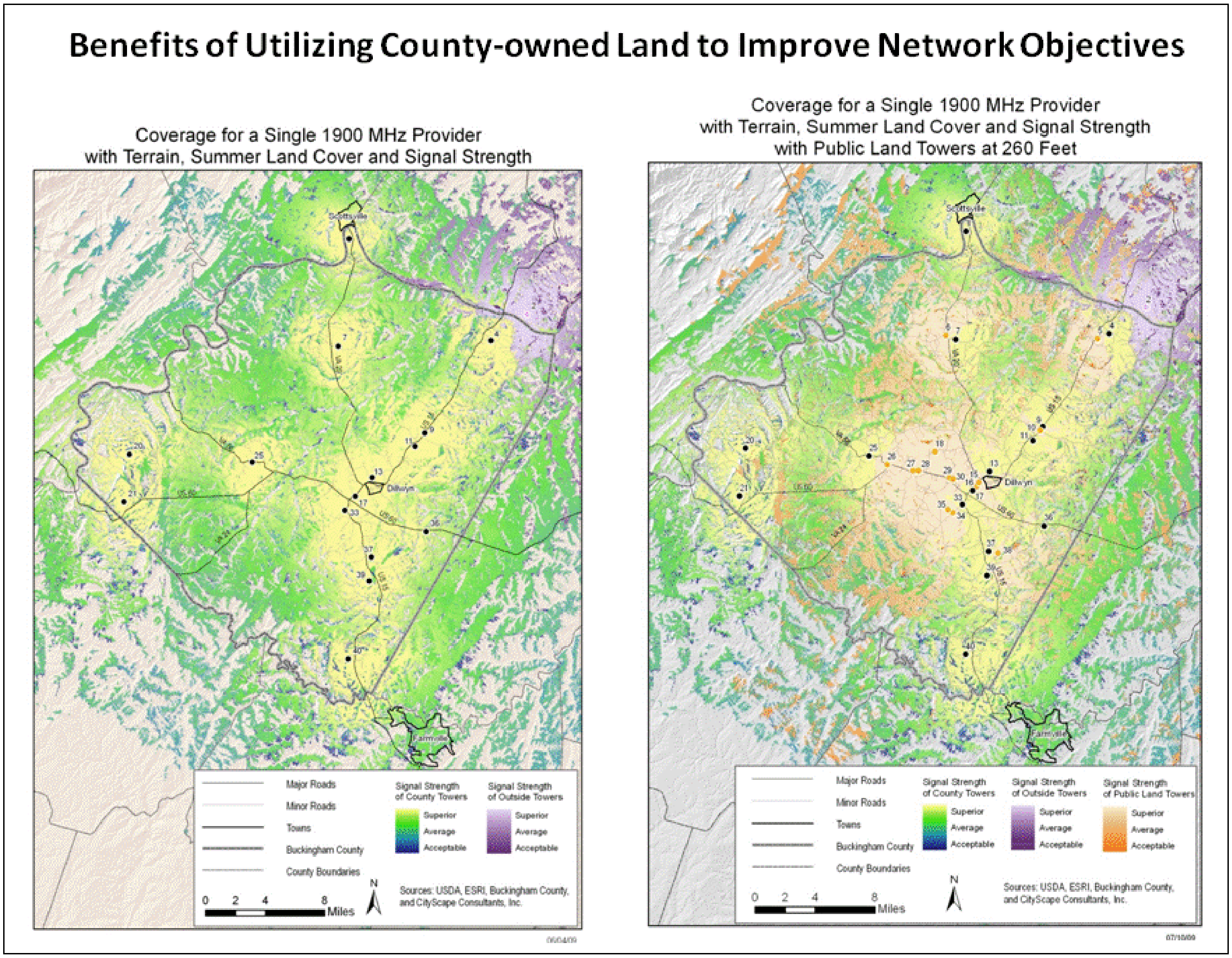


Figure 25: **Comparison of existing and potential of wireless infrastructure infill sites with 260' towers**

Coverage for a Single 1900 MHz Provider
with Terrain, Summer Land Cover and Signal Strength
with Public Land Towers at 199 Feet

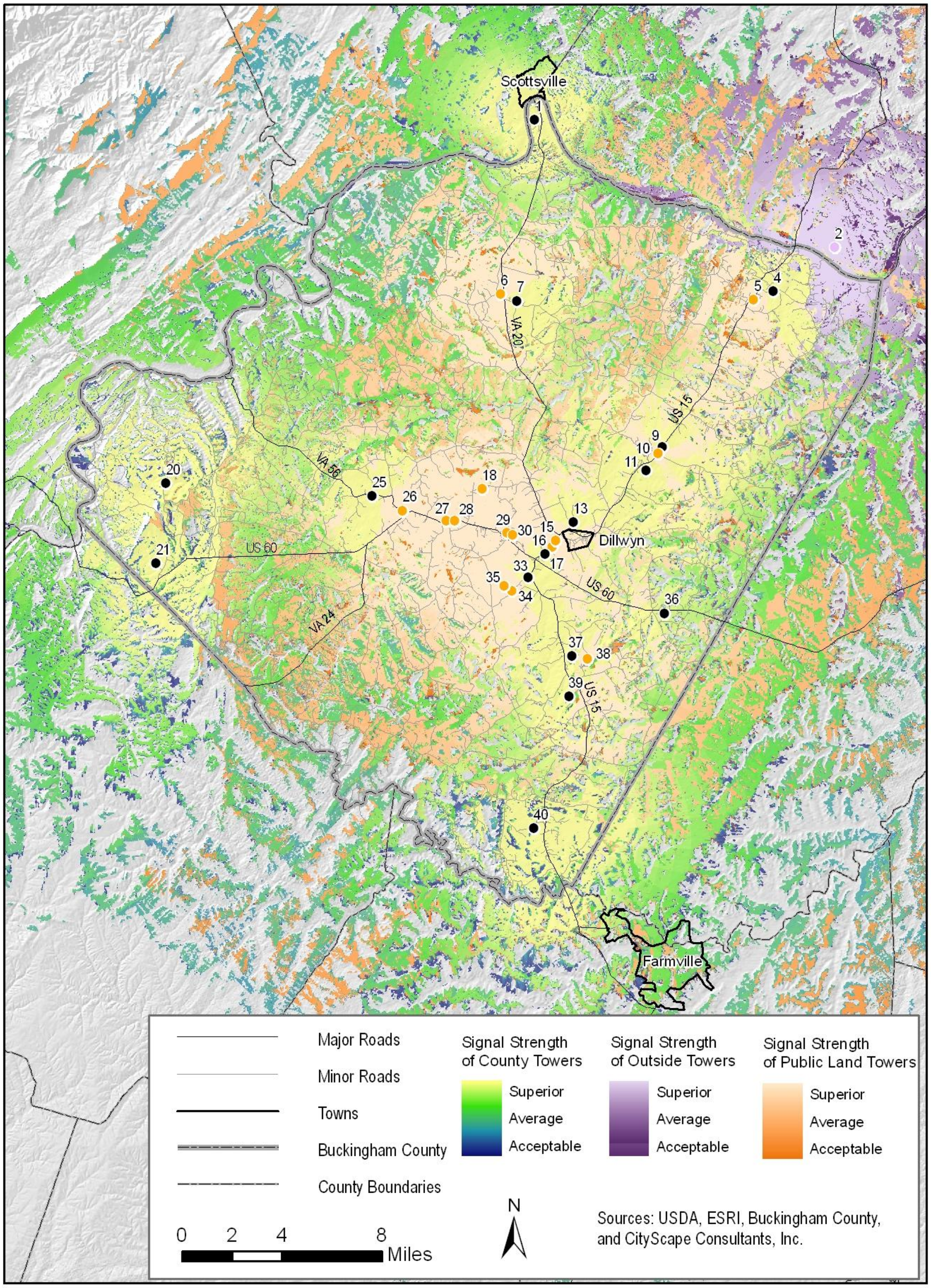


Figure 26: **Potential County-owned parcels for new wireless infrastructure infill sites with 199' towers**

Average Pote

For Buckin

	Initial 5-Year Term					
	Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	
BUCKINGHAM COUNTY						
Tower 1						
Tenant 1 - Tower 1	21,600	22,248	22,915	23,603	24,311	
Tenant 2 - Tower 1	21,600	22,248	22,915	23,603	24,311	
Tenant 3 - Tower 1	21,600	22,248	22,915	23,603	24,311	
Tower 2 (3 tenants)	64,800	66,744	68,746	70,809	72,933	
Tower 3 (3 tenants)	64,800	66,744	68,746	70,809	72,933	
Tower 4 (3 tenants)	64,800	66,744	68,746	70,809	72,933	
Tower 5 (3 tenants)	64,800	66,744	68,746	70,809	72,933	
Tower 6 (3 tenants)	64,800	66,744	68,746	70,809	72,933	
Total	388,800	400,464	412,478	424,852	437,598	2
TOTAL GROSS	**388,800**	**400,464**	**412,478**	**424,852**	**437,598**	**2**

Population and wireless network planning

Up to this point the Master Plan has focused on existing wireless base station coverage, however current network coverage is only one aspect of wireless service. The primary objective of the first phase of network development is to create coverage over a large service area. When network coverage is achieved wireless service providers begin to monitor the number of calls. Once the number of simultaneous calls reaches a predetermined maximum number, and the facility cannot support the subscriber base, the wireless network exceeds the capacity design of the system. Exceeding network capacity equates to overloading the network which results in dropped calls, rapid busy signals, and the inability to make calls. To overcome problems caused by over-capacity challenges, additional antenna and base stations are required.

Recently released federal penetration rates for the United States indicate a level of around 77 percent. Cell phone service is projected to increase to about 80 percent by 2010. "According to the County Comprehensive Plan, in 2010 the population is projected to be 18,177 and in 2020 the population is a projected 21,514" (Buckingham Office of Economic Development).

Because of the growth in number of cell phone users along with an increase in talk-time minutes, it is predicted the average number of subscribers processed by a single base station will drop from a range currently of 1,750 to 2,500 simultaneous calls to between 750 and 1,250 simultaneous calls in 2020.

Future tower site projections

As a result of the present growth models and the current wireless market penetration rate, and the rate of wireless network evolution from 3G to 5G, CityScape's prediction for future antenna deployment is based on network growth from the existing antenna locations. Currently in and immediately around the unincorporated areas of the County there are 28 potential antenna locations. Each year in the future the number of new facilities will vary. Subscriber demand on the network will control future deployments.

To effectively and efficiently provide network coverage county-wide over the next ten years CityScape anticipates it will require about 14 - 15 new support facilities to provide a comprehensive network to fill in the service coverage gaps. Yearly increases cannot be anticipated to be evenly increased as customer demand on the network will control future deployments. As a rule of thumb the County could anticipate an average of five new tower sites and around seven colocations per year over the next ten years.

Two projects are offered for the 2020 estimations. Figure 28 is based on new tower heights at 260 feet to allow for maximum collocation opportunities and the reduction of multiple towers within the same geographic search areas. This model would require 14 additional sites. Figure 29 is based on new tower heights at 199 feet. The pink dots and shading represent the general areas that these new antenna locations will need to be placed to complete network coverage.

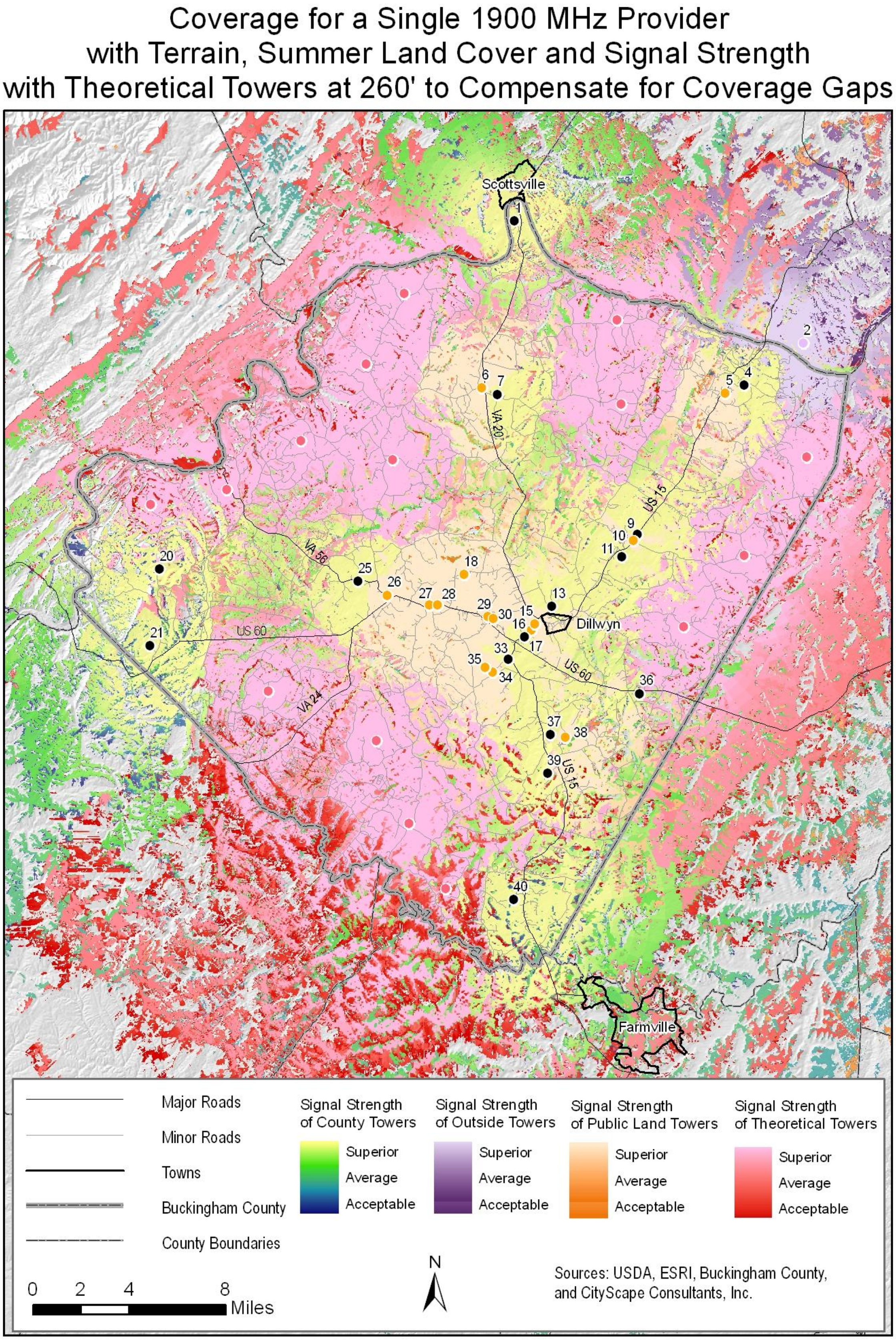


Figure 28: Projected new infrastructure infill sites at 260'

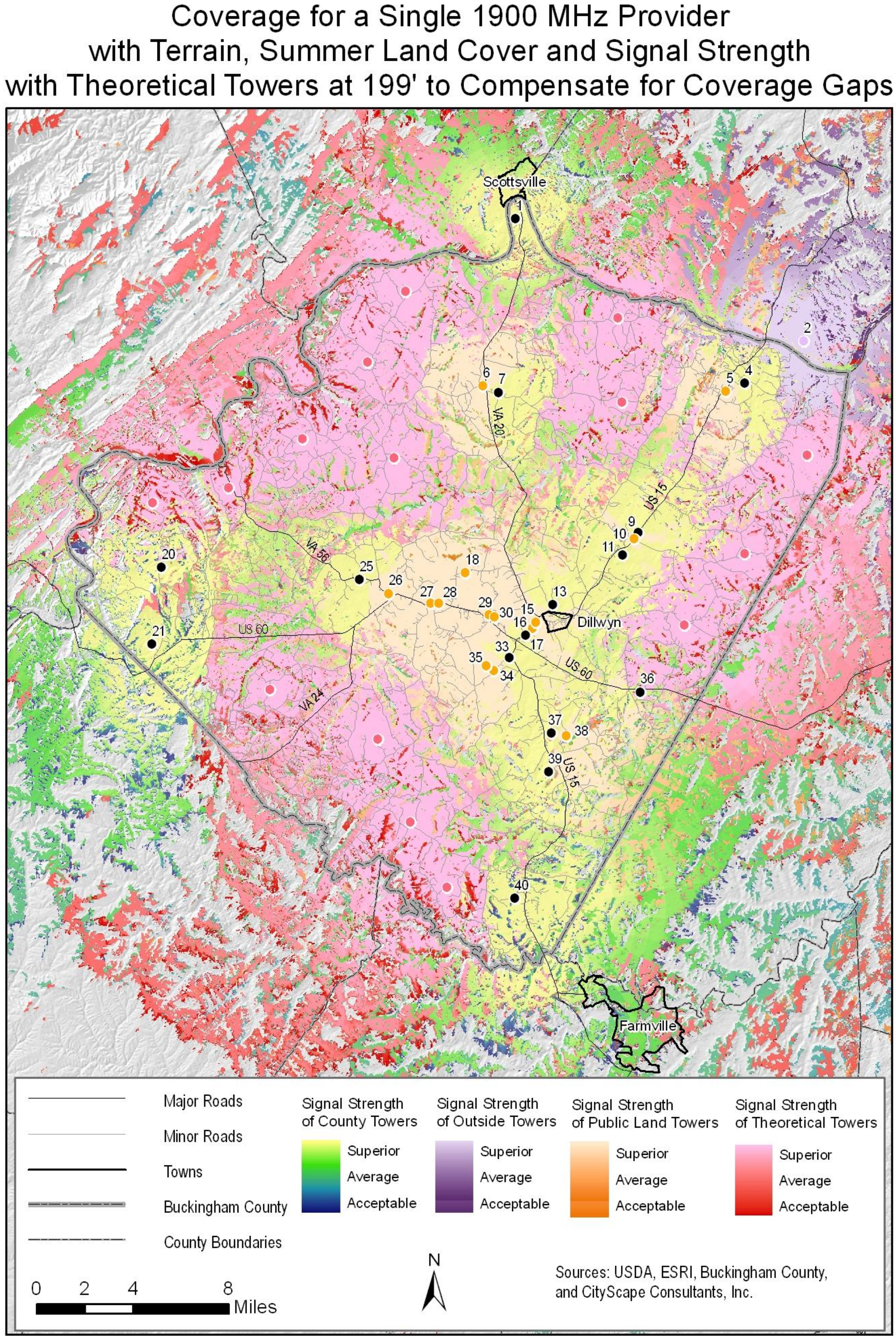


Figure 29: Projected new infrastructure infill sites at 199'

Chapter 5 Inventory

Purpose of the inventory

Procedure

CityScape conducted an assessment of the existing antenna locations throughout the Buckingham County by driving to all locations. Data for the assessments was obtained from a number of sources including actual permits obtained from the County for wireless infrastructure, research of FCC registered site locations, information from existing wireless service providers and tower owners active in the County, and through actual site visits to each location.

Inventory catalogue existing antenna(s) and towers

Pictures of existing antennas mounted on towers, rooftops, utility poles, and water tanks are included in the inventory catalogue. Existing antenna site locations are identified numerically on Figures 27. Existing towers other than broadcast sites are identified by a black dot. Towers approved for construction but not built at the time of the site assessments in March 2009 are identified as an orange dot. Known sites under consideration are identified with a brown dot. Blue dots identify antenna mounted on water tanks and pink dots symbolize antenna and towers just outside the County's jurisdiction. Red dots identify towers with equipment for emergency services, and green dots locate County-owned land for use a potential future wireless communication facilities.

Structural evaluation

Based on a visual inspection of antenna arrays already on existing antenna support facilities, CityScape has made a judgment as to whether each support structure is likely to physically accommodate more antennas. The number of estimated collocations is referenced as future antenna collocation possibilities. The suggested collocation is based on visual observations only. In this consideration, adding antennas equates to adding another wireless antenna platform consisting of several antennas and associated heavy coaxial cable. Prior to mounting new antennas and related equipment, the structure must be examined and analyzed by a structural engineer for its ability to support the proposed addition.

Site photographs

Photographs of all found sites are included in this inventory. The identification number in the catalogue corresponds to the antenna(s) identification on Figure 30.

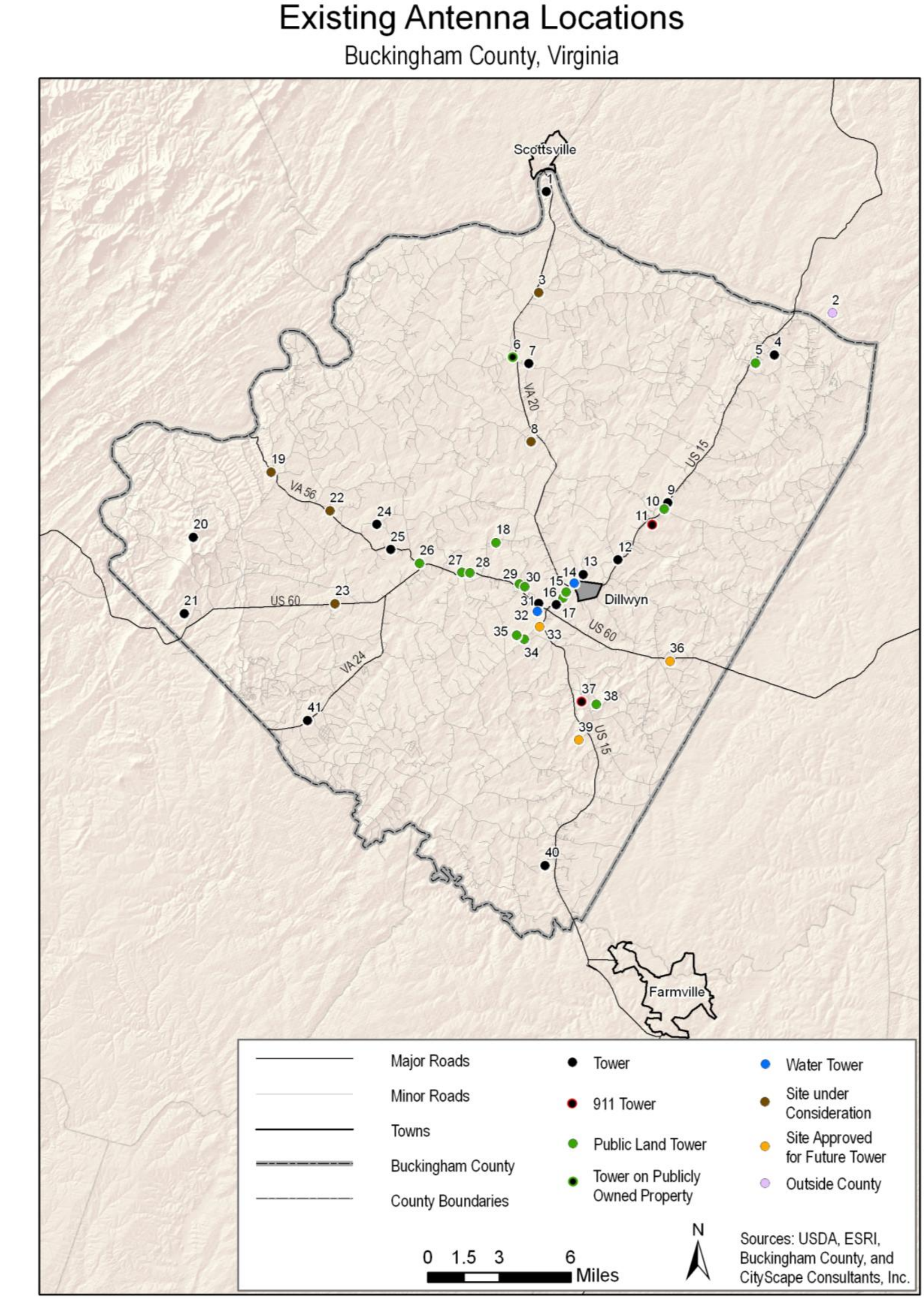


Figure 30: Existing Antenna Locations Overall Map

Inventory-1

SITE LOCATION
Site Number 1
FCC #: 1023035
U.S. Cellular Corporation
2385 Woodburn Road
Scottsville, VA
Latitude: 37-47-00 N
Longitude: -78-29-32 W

Height: 400'
Type: Guyed
Future Capacity: 0

SITE LOCATION
Site Number 2
FCC #: 1016964
VA Electric & Power
.3 miles off SR 656
Bremo Bluff
Latitude: 37-42-34 N
Longitude: -78-16-24 W

Height: 325'
Type: Guyed
Future Capacity: 1

Proposed Site

SITE LOCATION
Site Number 3
FCC #:
Verizon
13664 S. Constitution Rte.
Centenary
Latitude: 37-43-18 N
Longitude: -78-29-52 W

Proposed Height: 260'
Type:
Future Capacity:

SITE LOCATION
Site Number 4
FCC #:1246554
Communication
Enhancement, LLC
U.S. Route 672
Arvonia, VA
Latitude: 37-41-01 N
Longitude: -78-19-04 W

Height: 265'
Type: Guyed
Future Capacity: 4

SITE LOCATION
Site Number 5
Buckingham County
Household Waste &
Recycling Center
29420 N. James Madison
Highway
Latitude: 37-40-44 N
Longitude: -78-19-56 W

Possible Height: 125'
Possible Type: Monopole
Future Capacity: 6

SITE LOCATION
Site Number 6
Buckingham County
Household Waste &
Recycling Center
Route 20 & 655

Latitude: 37-40-57 N
Longitude: -78-31.2 W

Height: 60'
Type: Wooden Pole
Future Capacity: 0

SITE LOCATION
Site Number 7
FCC #: 1264650
Vision Ventures, LLS
355 Sharron Church Road
Centenary
Latitude: 37-40-43 N
Longitude: -78-30-19 W

Height: 300'
Type: Guyed
Future Capacity: 5

Proposed Site

SITE LOCATION
Site Number 8
FCC #:
Verizon
Route 659

Latitude: 37-37-52 N
Longitude: -78-30-13 W

Proposed Height: 260'
Type:
Future Capacity:

■EXISTING TOWER ■PROPOSED TOWER ■WATERTANK ■LAND

Inventory-2

SITE LOCATION
Site Number 9
FCC #: 1005510
AT&T Corporation
Route 15
Dillwyn
Latitude: 37-35-38 N
Longitude: -78-23-55 W

Height: 264'
Type: Lattice
Future Capacity: 6

SITE LOCATION
Site Number 10
Buckingham County
Household Waste
720 Plank Road

Latitude: 37-35-25 N
Longitude: - 78-24-8 W

Possible Height: 199'
Possible Type: Monopole
Future Capacity: 6

SITE LOCATION
Site Number 11
FCC #: 1017501
American Tower Corporation
21370 N. James Highway
Dillwyn
Latitude: 37-34-50 N
Longitude: -78-24-39 W

Height: 180'
Type: Lattice
Future Capacity: 3

SITE LOCATION
Site Number 12
FCC #:

Latitude: 37-33-33 N
Longitude: -78-26-15 W

Height:
Type: Guy
Future Capacity: 0

SITE LOCATION
Site Number 13
FCC #: 1016826
U.S. Cellular Corporation
SR 688 & 650
Dillwyn
Latitude: 37-33-01 N
Longitude: -78-27-50 W

Height: 400'
Type: Guyed
Future Capacity: 1

SITE LOCATION
Site Number 14
FCC #:
Buckingham County
52 Dillwyn Primary Road
Dillwyn
Latitude: 37-32-42 N
Longitude: -78-28-14 W

Height: 130'
Type: Concealed antenna attachments
Future Capacity: 6

SITE LOCATION
Site Number 15
Buckingham County
Household Waste &
Recycling Center

Latitude: 37-32-23 N
Longitude: -78-28-37 W

Possible Height: 125'
Possible Type: Concealed WCF
Future Capacity: 6

SITE LOCATION
Site Number 16
FCC #:
Buckingham County Rescue Squad
29420 N. James Madison Highway
Latitude: 37-32-14 N
Longitude: -78-28-42 W

Height:
Type:
Future Capacity: 6

■EXISTING TOWER ■PROPOSED TOWER ■WATERTANK ■LAND

Inventory-3

SITE LOCATION
Site Number 17
FCC #:
15176 N. James Madison Hwy
Dillwyn
Latitude: 37-31-55 N
Longitude: -78-29-4 W

Height:
Type: Monopole
Future Capacity: 4

SITE LOCATION
Site Number 18
FCC #:
Water Treatment Plant
1788 Troublesome Creek Road (Additional land available across street)
Latitude: 37-34-11 N
Longitude: -78-31-50 W

Possible Height: 199'
Possible Type: Monopole
Future Capacity: 4 –6

Proposed Site

SITE LOCATION
Site Number 19
Verizon
24145 James River Road

Latitude: 37-36045 N
Longitude: -78-42-8 W

Proposed Height: 260'
Type:
Future Capacity:

SITE LOCATION
Site Number 20
FCC #: 1017548
Alltel Communications
3484 Spears Mountain Road

Latitude: 37-34-21 N
Longitude: -78-45-41 W

Height: 180'
Type: Lattice
Future Capacity: 4

SITE LOCATION
Site Number 21
FCC #: 1024073
U.S. Cellular Corporation
2 miles east of Gladstone

Latitude: 37-31-35 N
Longitude: -78-46-6 W

Height: 255'
Type: Lattice
Future Capacity: 4

Proposed Site

SITE LOCATION
Site Number 22
FCC #:
Verizon
Route 56

Latitude: 37-35-20 N
Longitude: -78-39-25 W

Proposed Height: 260'
Type:
Future Capacity:

Proposed Site

SITE LOCATION
Site Number 23
FCC #:
Verizon

Latitude: 37-31-56 N
Longitude: -78-39-11 W

Proposed Height: 260'
Type:
Future Capacity:

SITE LOCATION
Site Number 24
FCC # 1019704
WKGM Inc.
Highway 640
Dillwyn
Latitude: 37-34-51 N
Longitude: -78-37-17 W

Height: 350'
Type: Guyed
Future Capacity: 0

■EXISTING TOWER ■PROPOSED TOWER ■WATERTANK ■LAND

Inventory-4

SITE LOCATION
Site Number 25
FCC #: 1241927
Alltel Communications
Route 56
Buckingham
Latitude: 37-33-55 N
Longitude: -78-36-39 W

Height: 300'
Type: Guyed
Future Capacity: 3

SITE LOCATION
Site Number 26
Buckingham County
Household Waste &
Recycling Center
16836 W. James Anderson
Highway
Latitude: 37-33-25 N
Longitude: -78-35-19 W

Possible Height: 199'
Possible Type: Monopole
Future Capacity: 6

SITE LOCATION
Site Number 27
Buckingham County
County Courthouse
13043 W. James Anderson
Highway
Buckingham
Latitude: 37-33-5 N
Longitude: -78-33-23 W

Possible Height: 125'
Possible Type: Concealed
Future Capacity: 6

SITE LOCATION
Site Number 28
Buckingham County
Administration Offices
13360 W. James Anderson
Highway
Buckingham
Latitude: 37-33-5 N
Longitude: -78-33-1 W

Height:
Type:
Future Capacity: 6

SITE LOCATION
Site Number 29
Buckingham County
Section 137, Parcel 121A

Latitude: 37-32-29 N
Longitude: -78-30-28 W

Possible Height: 125'
Possible Type: Concealed
Future Capacity: 6

SITE LOCATION
Site Number 30
Buckingham County
Robertson—99-25, Parcel
89

Latitude: 37-32-25 N
Longitude: -78-30-20 W

Possible Height: 125'
Possible Type: Concealed
Future Capacity: 6

SITE LOCATION
Site Number 31
FCC #: 1017860
VA Dept. of State Police
U.S. Route 60 & Highway 15
Sprouses Corner
Latitude: 37-31-51 N
Longitude: -78-29-47 W

Height: 250'
Type: Lattice
Future Capacity: 0

SITE LOCATION
Site Number 32
FCC #:
Buckingham County
U.S. Route 60 & Highway 15
Sprouses Corner
Latitude: 37-31-43 N
Longitude: -78-29-51 W

Height: 147'
Type: Concealed antenna attachments
Future Capacity: 4-6

■EXISTING TOWER ■PROPOSED TOWER ■WATERTANK ■LAND

Inventory-5

At the time of the assessment this site had not been constructed. Photo is forthcoming.

SITE LOCATION
Site Number 33
FCC #: 1248385
National communication Towers
SR 460 & Route 15
Latitude: 37-31-07 N
Longitude: -78-29-50 W

Proposed Height: 250'
Type:
Future Capacity:

SITE LOCATION
Site Number 34
Buckingham County
Animal Shelter
9659 Andersonville Road

Latitude: 37-30-39 N
Longitude: -78-30-32 W

Possible Height: 199'
Possible Type: Monopole
Future Capacity: 6

SITE LOCATION
Site Number 35
Buckingham County
Old Landfill
Off Andersonville Road

Latitude: 37-30-49 N
Longitude: -78-30-54 W

Possible Height: 199'
Possible Type: Monopole
Future Capacity: 6

At the time of the assessment this site had not been constructed. Photo is forthcoming.

SITE LOCATION
Site Number 36
FCC #: 1248384
National Communication Towers
SR 632 & Route 60
Latitude: 37-29-51 N
Longitude: -78-23-52 W

Proposed Height: 250'
Type:
Future Capacity:

SITE LOCATION
Site Number 37
FCC #: 1261379
Alltel Communications
15154 N James Madison Highway
Latitude: 37-31-55 N
Longitude: -78-29-03 W

Height: 197'
Type: Monopole
Future Capacity: 2

SITE LOCATION
Site Number 38
Buckingham County
Household Waste & Recycling Center

Latitude: 37-28-17 N
Longitude: -78-27-14 W

Possible Height: 199'
Possible Type: Concealed Monopole
Future Capacity: 4

At the time of the assessment this site had not been constructed. Photo is forthcoming.

SITE LOCATION
Site Number 39
FCC #: 1248386
National Communication Towers, LLC
646 Wise Ridge Road
Pleasant Valley
Latitude: 37-26-59 N
Longitude: -78-28-03 W

Proposed Height: 250'
Type:
Future Capacity:

SITE LOCATION
Site Number 40
FCC #: 1258496
National Communication Towers, LLC
Sheppards Road
Latitude: 37-22-24 N
Longitude: -78-29-35 W

Height: 195'
Type: Lattice
Future Capacity: 1

■EXISTING TOWER ■PROPOSED TOWER ■WATERTANK ■LAND

Inventory-6

SITE LOCATION
Site Number 41
FCC #:
Toga Volunteer Fire Dept.
Route 24

Latitude: 37-27-41 N
Longitude: -78-40-26 W

Height: 60'
Type: Wood pole
Future Capacity: 0

■EXISTING TOWER ■PROPOSED TOWER ■WATERTANK ■LAND

Appendix A

"A Local Government Official's Guide to Transmitting Antenna RF Emission Safety: Rules, Procedures, and Practical Guidance"

Appendix B

"Electromagnetic fields and public health; Base Stations and wireless technologies"