CityScape Consultants, Inc.

Helping Local Government Solve Wireless Telecommunications Issues

Telecommunications Master Plan

September 17, 2007

County of Louisa, Virginia

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Acknowledgements

CityScape would like to thank the following participants for their input into this project:
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Special thanks to all who provided information as requested and to those of you who read/reviewed the document for input and corrections.

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Preface

Purpose of this plan

In recent years, the County of Louisa (the "County") has experienced wireless telecommunication infrastructure growth. Such growth requires additional elevated wireless antennas and base station ground equipment. In accordance with Federal Communications Commission (FCC) guidelines, the County has developed a wireless telecommunications ordinance to regulate new antenna-support structure construction.

In conjunction with the ordinance development process, the County is developing a Wireless Telecommunications Master Plan (the "Master Plan") to analyze current demand for wireless telecommunications services within the County, and to establish guidelines for growth 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 the land use planning strategies with the industry-accepted radio frequency (RF) engineering standards to create an illustrative planning tool that complements zoning regulations. The Master Plan offers strategies to reduce tower infrastructure by improving efforts to morph wireless deployments from various service providers, thereby minimizing tower proliferation by increasing shared sites.

The Master Plan includes the following:

- An inventory of existing antenna-supporting structures and buildings upon which wireless antennas are currently mounted.
- Analysis of reasonably anticipated wireless facility growth over the next ten years.
- Engineering analysis of potential coverage based on County-regulated height restrictions and other locations and design criteria.
- Recommendations for managing the development of wireless structures for the next ten years.

CityScape Consnltants, Inc.

CityScape Consultants, Inc. is a land use planning, legal and radio frequency engineering consulting firm located in Boca Raton, Florida and Raleigh, North Carolina. 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.

Many communities are concerned about the proliferation of telecommunications tower build-outs from the standpoint of aesthetics, time involved in the review and fair deployment of these facilities, public safety issues, and the legal implications of upholding both the public and private interests involved. Most communities are dealing with tower growth in an ad hoc manner, which is the most expensive and perilous way to manage expansions to existing wireless telecommunications networks.

Implementation of a Master Plan simplifies and economizes the process. The Master Plan offers numerous benefits to the local government and its citizens, as well as the carriers who participate.

A comprehensive Master Plan includes:

- Review and revision (if necessary) of existing ordinances and code to encourage all present and future wireless service providers to participate in a Master Plan by working with CityScape to ascertain their current and future service needs;
- Development of a comprehensive telecommunications network for the local government;
- Minimizing the total number of telecommunications towers and/or sites within the local government;
- Ensuring the local government's compliance with the Telecommunications Act of 1996 (as amended); and
- Correlation of industry data together with the local government's publicly owned sites to develop a Master Plan for wireless telecommunications facilities.

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, 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.

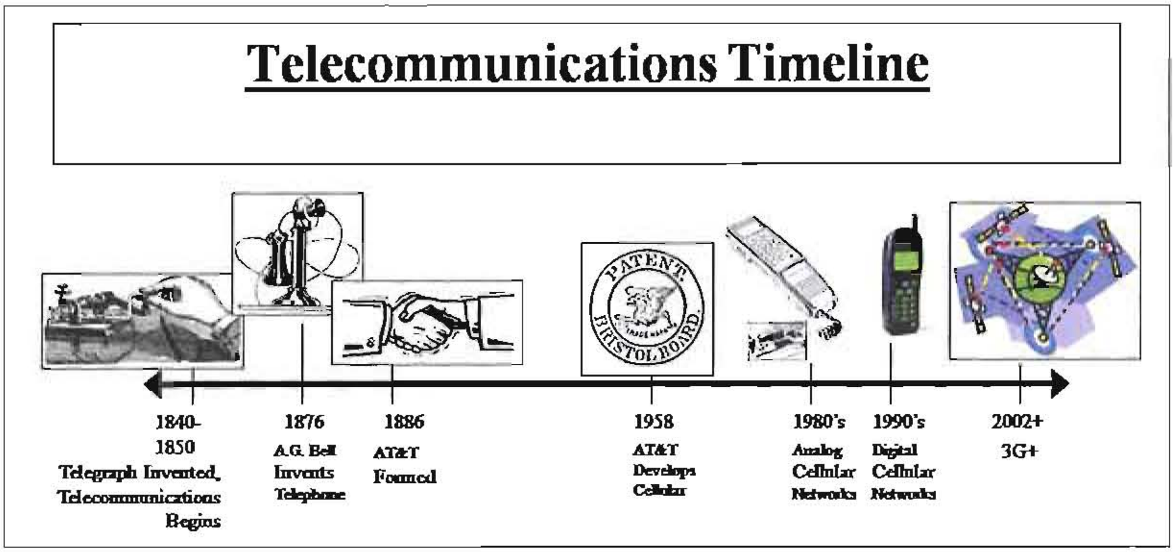


Figure 1: Telecommunication Timeline

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.

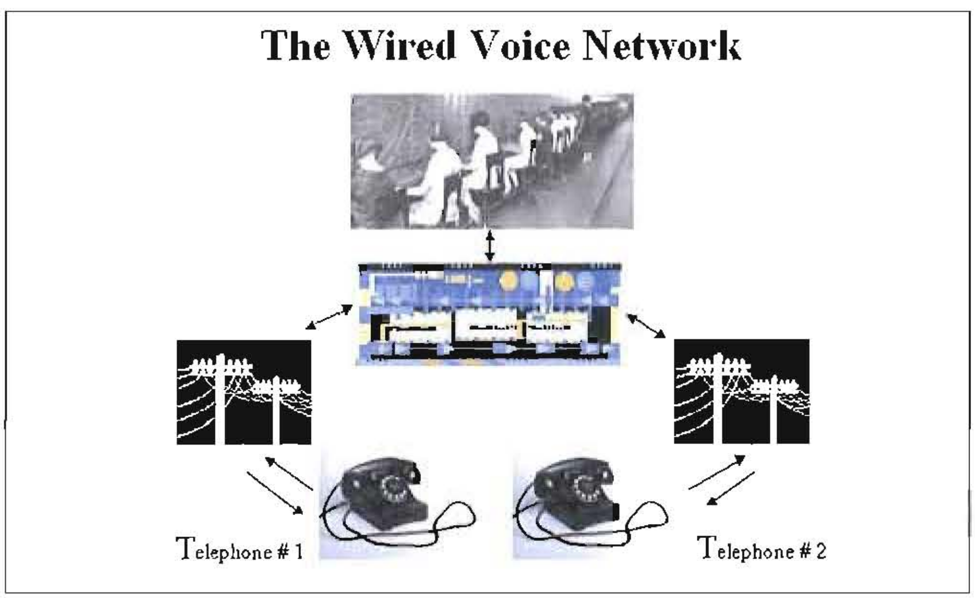


Figure 2: Wired Voice Network Systems

Wireless telephone networks

Wireless telephone networks operate utilizing wireless frequencies similar to radio and television stations. To design the wireless networks, radio frequency 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 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 structure; 2) antenna or antenna array; 3) feed lines; and 4) an electronic base station.

Antenna support structures

A variety of structures can be used as an antenna support structure, 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 structures can also be camouflaged in some circumstances to visually blend-in with the surrounding area. Figure 3 provides examples of several antenna support structures. The flagpole and light standard are camouflaged 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 camouflaged lattice tower. The antennas are hidden above the bells and behind the artwork at the top of the structure.

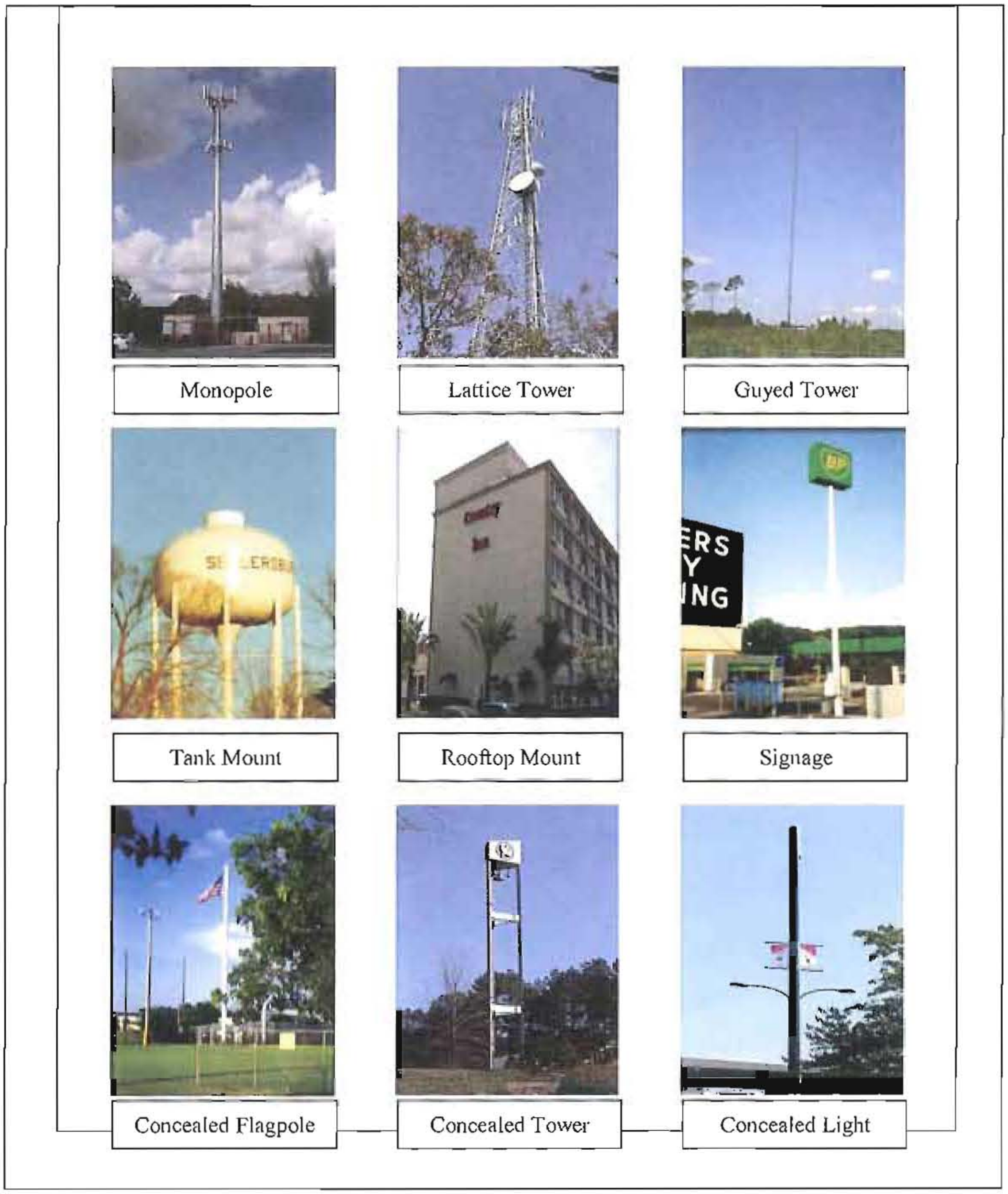
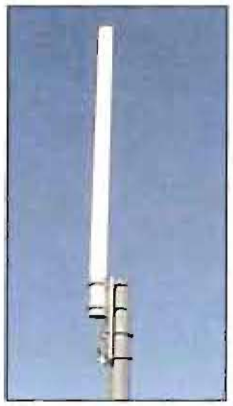


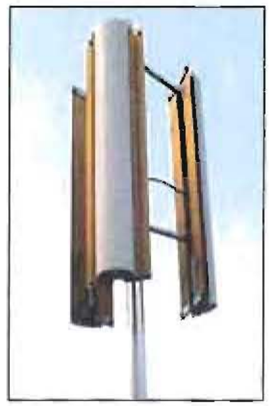
Figure 3: Examples of Base Stations

Antennas and antenna arrays

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

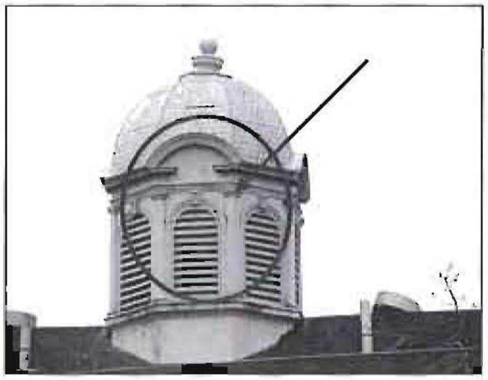


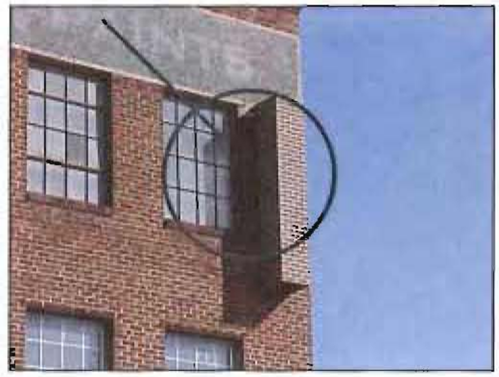
Omni-Directional
Whip Type Antenna



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.

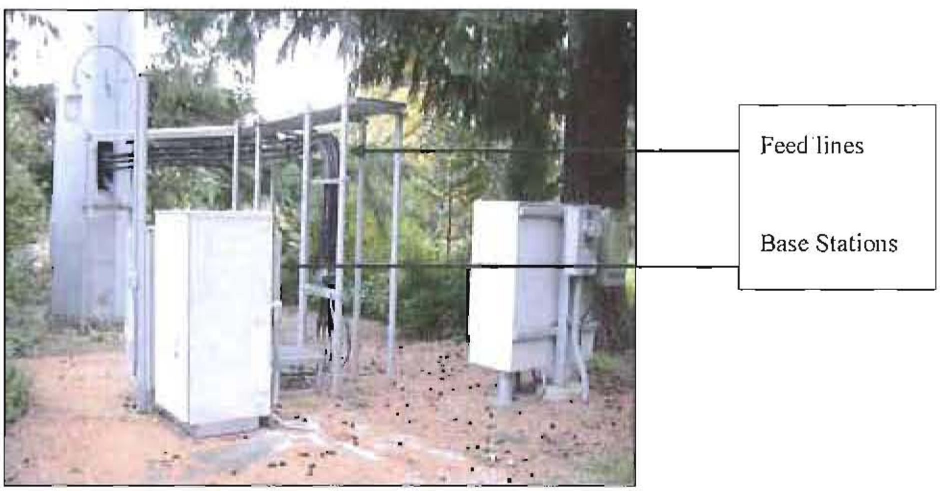




Feed lines and electronic base stations

Feed lines are the 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 stations shown in the photograph are typical models 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 during instances of power failure.

Wireless coverage and antenna mounting elevation considerations

Wireless telecommunication networks are comprised of elevated antenna arrays attached to a base station that transmit and receive radio signals allowing wireless telephone handsets to operate satisfactorily. Figure 4 illustrates the wireless telephone network.

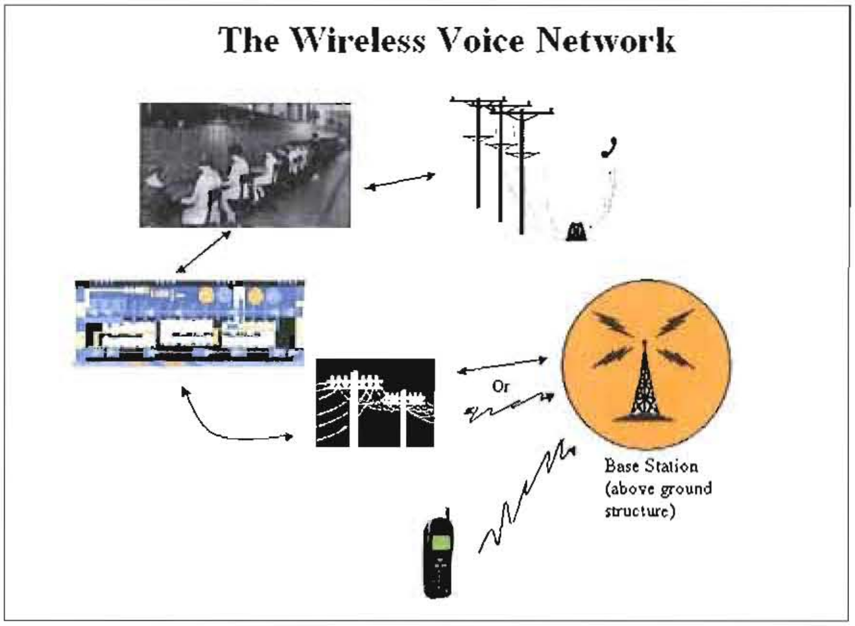


Figure 4: Wireless Voice Network

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 antenna array successfully relays or hands-off the radio signal to another 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 colocation, which could theoretically decrease the number of additional towers and antennas required in an area. The extent to which height may increase colocation opportunities must be verified by an RF engineering review on a case-by-case basis. High 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 level on a facility are more desirable for some terrain and in some rural areas, but in many cases, the wireless providers seek to limit the height in more populous areas.

In wireless system evolution, a wireless provider initially built fewer base stations with relatively tall antenna-supporting structures to maximize the network coverage footprint. These initial 1G, 800 MHz and 900 MHz systems sought to broadcast coverage to large geographic areas with minimal infrastructure. Typically, these tall towers were spaced four to eight miles apart.

By nature, the 1900 MHz frequency band is higher than the 800 MHz band and cannot transmit a signal an equal distance. For the same coverage, these 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 no more than 240 calls (different providers prefer different numbers, 1,000 is an average). This process is referred to as network capacity. As population and 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 be asked to leave a message without hearing the phone ring on the receiving end of the call.

As the wireless network reaches design network capacity, it causes the coverage 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 they press the call send button on the wireless handset.

Wireless providers

In 1983, the 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 like Cellular One. There were many initial problems and growth was slow. Most wireless providers preferred tall towers in the range of 300 to 500 feet to service large areas. There was also a preference for analog services to reach farther, without much concern for static. 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 produced over $23 billion for the U. S. Department of Treasury.

Wireless infrastructure and local zoning

The location of antennas used for transmitting radio signals and wireless data is critical to attaining an optimum functioning wireless telecommunications network. With the deployment of 1G there were only two competing wireless cellular providers, however with the deployment of 2G, and six competing PCS 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 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 colocation.

This industry change could have benefited local governments who adopted new tower ordinances requiring colocation 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 (the "Act") 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 FCC has rules and regulations for human exposure to electromagnetic radiation. Electromagnetic radiation should not be confused with ionizing radiation.

Ionizing radiation is radiation that has sufficient energy to remove electrons from atoms. 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.

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.

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 30 minutes, the standard permits a level of 2.0 $mW/cm^{2,}$ for up to 15 minutes, as long as this is followed by a 15 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.

In general, single provider installations on towers will be categorically excluded. Multiple provider colocations 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 far below the calculated values.

If the site truly 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.

Steps one can take to minimize RF exposure from cell phones:

- Reduce talk time;
- Place more distance between one's 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 stated "[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 wireless

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 3G products once network upgrades were completed. The upgrades for 3G 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 2007 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 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 15 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 for text messaging will create a system capacity demand for providers.

Third generation handsets 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. Most handsets now have built-in camera and video camera features, and certain handsets offer Microsoft Word 5.0. Figure 5 illustrates the Nokia N93 and Samsung Blackjack handsets as examples of the 3G handset capabilities.

Nokia N93 3G Wireless Phone

- Phone number storage
- Speaker phone
- Conference calling
- Voice messaging
- Voice recorder
- Multiple ring tones
- Downloadable ring tones
- 3.2 Mega pixel camera with 3x zoom
- Built-In flash
- Video camera
- Multimedia messaging that can combine text message, image or video, and audio
- TV output
- Digital music player
- Prints pictures directly from camera onto compatible printers
- 50 MB internal memory
- 128 MB expandable memory
- Much, much more...

(www.nokia.com)

Samsung Blackjack (SGH-i607) 3G Wireless Phone

- Phone number storage
- Speaker phone, hold and mute options
- Conference calling
- Voice messaging
- Multiple ring tones
- Downloadable ring tones
- 1.3 Mega pixel camera/camcorder
- Like a "mini computer"
- Windows 5.0
- Word, Excel,and Outlook
- Download working file documents
- Check e-mail from Yahoo, MSN, Google, or AOL
- Digital music player
- 64 MB RAM
- 128 MB ROM
- Much, much more...

(www.samsung.com)

Figure 5: 3G Wireless Phone and Related Services

Future wireless generations

While at last the United States is starting to experience firsthand the handset features of 3G, other parts of the world are being introduced to 4G. Proving to early skeptics that while the deployment of wireless services in the United States have slowed down, the 3G services will continue to evolve and be sold here and abroad. The article below explains the type of wireless services now being promoted in Asia, which will eventually be promoted in the United States.

> "At a Telecom Asia exhibition in Hong Kong in 2004, Samsung showed for the first time its M400 handset. Based on Pocket PC 2002 Phone Edition, the device runs on CDMA 2000 1x EvDO (Evolution Data Only) networks, which are in commercial service in South Korea and offer data transmission at speeds of up to 2.4M bps. Features of the phone, which is based on an Intel Corp. XScale processor running at 400MHz, include a display capable of showing 65,000 colors, voice recognition and a text-to-speech engine, a TV tuner and GPS (Global Positioning System)". (ITworld.com 12/26/02, Samsung's i330 Palm OS Cell Phone Debuts. Martyn Williams, IDG News Service, Tokyo Bureau).

This same technology was introduced in the United States in January of 2006 at the Consumer Electronics Show in Las Vegas.

In Japan the DoCoMo D903iTV wireless phone by Foma has a built-in digital television and can record up to 160 minutes of viewing time. The television has access to all of Japan's top TV channels and serves as the remote control for certain television models. The phone acts as a mobile credit card and has a built-in GPS service not only to find where one's going but also to locate the missing handset if lost. This 3G phone offers all the familiar features and includes international roaming.

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 licensees of satellite services such as XM Radio and satellite telephone services have petitioned the FCC to allow additional deployment of land-based supplemental transmission relay stations for the ability to compete more aggressively with existing ground-base services. 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. XM Radio has been successful in getting ground-base supplemental transmitters, and has become 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 (ESMR)

Enhanced Specialized Mobile Radio (ESMR) systems are two way radios systems (similar to walkie-talkies) whereby two or more handsets are linked together by a single repeater. 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. 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 by the 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 18 months. Thus, this phase out period is more than ample time to migrate the remaining analog users 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.

Chapter 2 Wireless Technical Issues

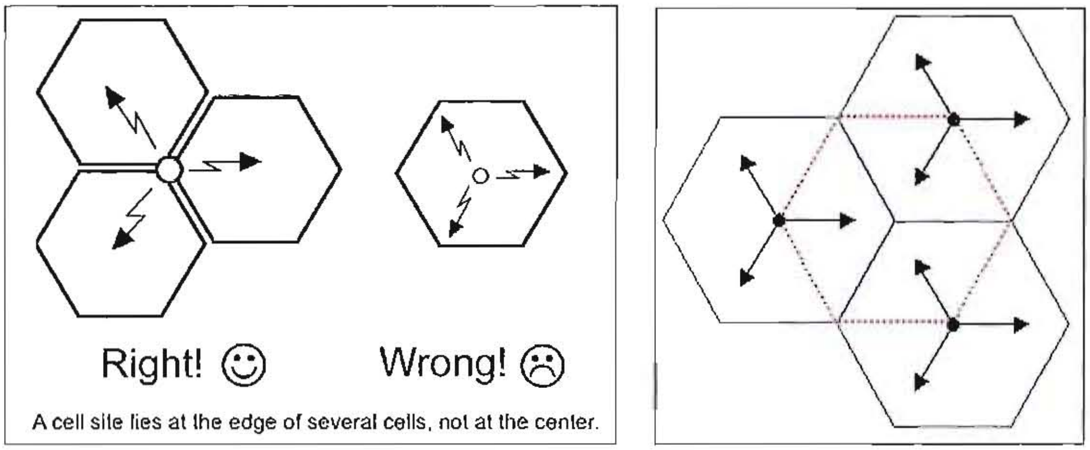
Brief overview

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. 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. However, each facility has network capacity limitations that are becoming more apparent in some of the older, 800 MHz cellular operators such as Cingular (formerly BellSouth Mobility and AT&T Wireless Services), Verizon, and Nextel. 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 heights 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 mutual 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 6, 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 6: 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 Tables 1 and 2 below. 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 20 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 1: 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 2: 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 20 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 colocation, which could theoretically decrease the number of additional towers and antennas required in an area. The extent to which height may increase colocation opportunities must be verified by an RF engineering review on a case-by-case basis. Where there is high customer telephone usage or terrain concerns, the build-out plans for some areas may require very low antenna location heights, especially in densely populated areas. Antennas located at a higher level on a facility are more attractive in some rural areas, but in many cases, the wireless providers seek to limit the height in more populous areas. Thus, wireless providers may need differing heights on a single tower, reducing the potential for interference, both between the same provider and 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 such 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. 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.

Chapter 3 Master Plan Engineering Analysis

Plan design process

This Master Plan evaluates the County for future wireless facility deployments. This 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-supporting structures and buildings, and evaluating designated public lands as potential sites for wireless facilities.
- Designing an engineered search radii template and applying it over the boundary of the County to evaluate existing build-out conditions.
- Providing an engineering analysis of existing coverage based on the inventory and regulatory height restrictions in the County.

Basic coverage predictions and wireless coverage handoff

At the onset of this project CityScape was asked to illustrate the greatest coverage to the entire County with the fewest total number of towers. 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 to demonstrate how many base station locations it would require for one provider to provide complete coverage countywide. Based on recently approved tower heights through the Conditional Use Permit approval process CityScape has chose to use 200 feet for the initial theoretical Master Plan maps.

According to the Okumura-Hata propagation path loss formula coverage for 800 MHz tables in Chapter 2, a reasonable coverage area for an antenna mounted at 200 feet for cellular deployment on flat terrain is 4.8 miles. Figure 7 illustrates how the use of nine locations within the County could provide coverage to the entire geographic area. These sites represent a theoretical build-out for antennas mounted at the 200-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 smaller circles shown within the larger circles represent the limits of the search area for locating the tower. Although nine cells cover the vast majority of the County for one provider, this does not include the concept of capacity or terrain concerns.

Referring to the "COST-231" formula for 1900 MHz coverage tables in Chapter 2, a reasonable coverage area for an antenna mounted at 200 feet for a PCS site on flat terrain is 2.72 miles. Figure 8 demonstrates that it would take approximately 36 facilities to cover the same geographic area as in Figure 7. These sites represent a theoretical build-out of antenna mounted at the 200-foot elevation at equal dispersion for one PCS provider; again with no consideration of terrain, demographic, or zoning variables.

THEORETICAL COVERAGE FOR 800MHz at 200 FEET

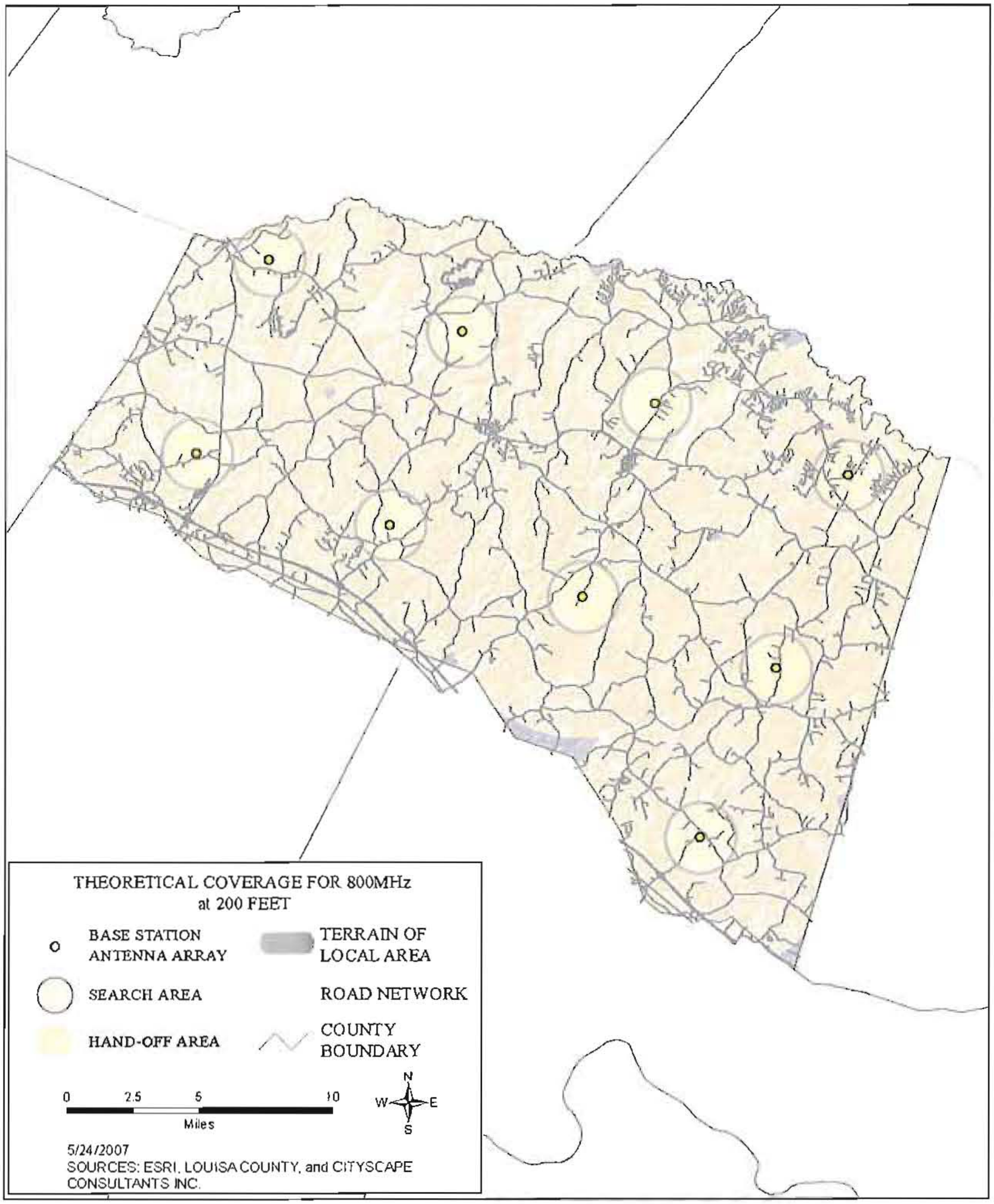


Figure 7: RMS 800 MHz Handoff and Search Areas at 200' Antenna Elevations

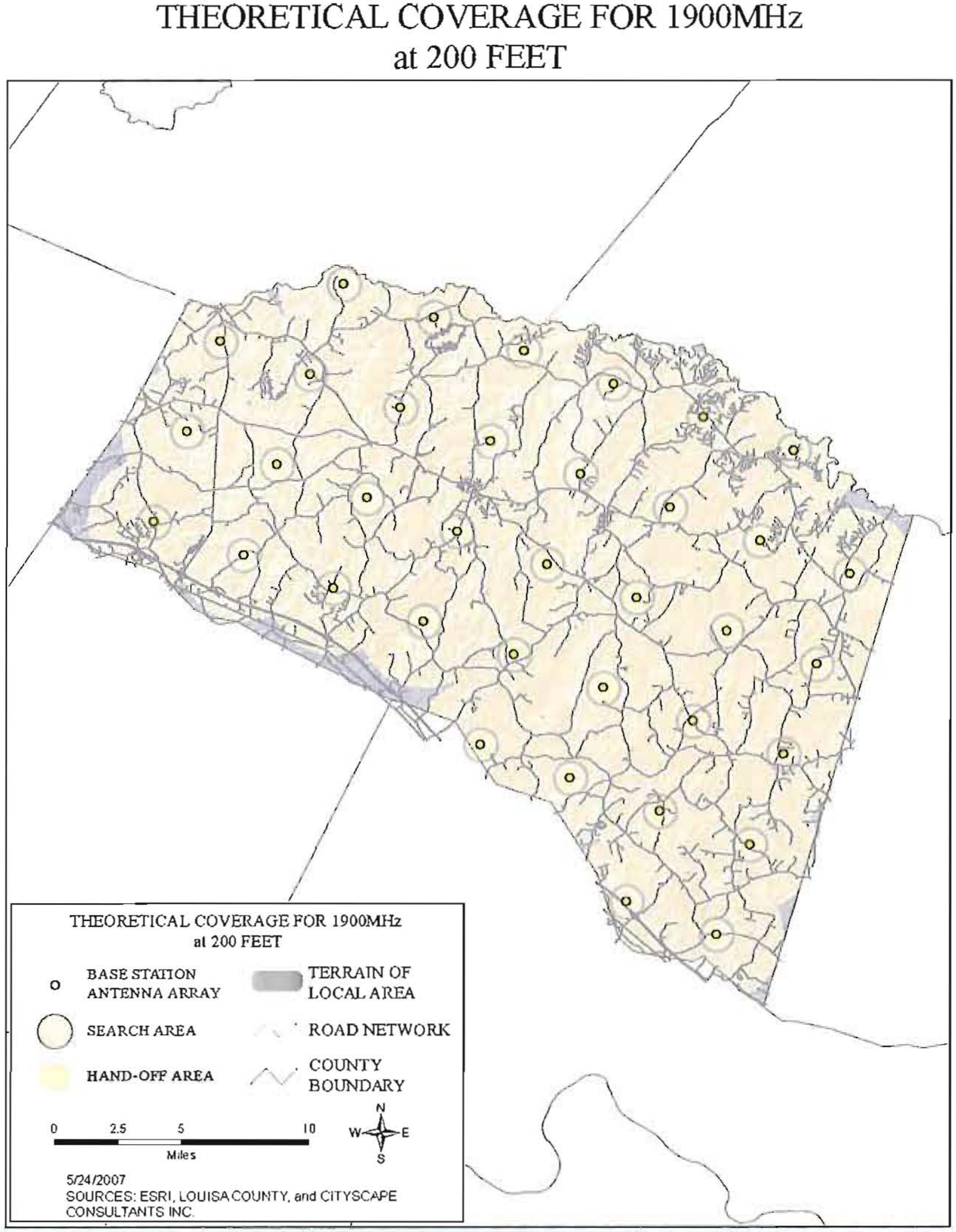


Figure 8: RMS 1900 MHz Handoff and Search Areas at 200' Antenna Elevations

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 is the most dramatic. Radio frequency propagation is similar to line-of-sight technology. Therefore, on flat terrain service areas, the coverage network forms 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 sufficient topographical variation to provide significant gaps in coverage.

Using the same random antenna locations identified in Figures 7 and 8, Figures 9 and 10 illustrate how wireless service coverage areas become distorted when the topographic variables are added to the propagation formulas. The areas in gray illustrate geographic areas that would need an additional antenna to improve coverage objectives.

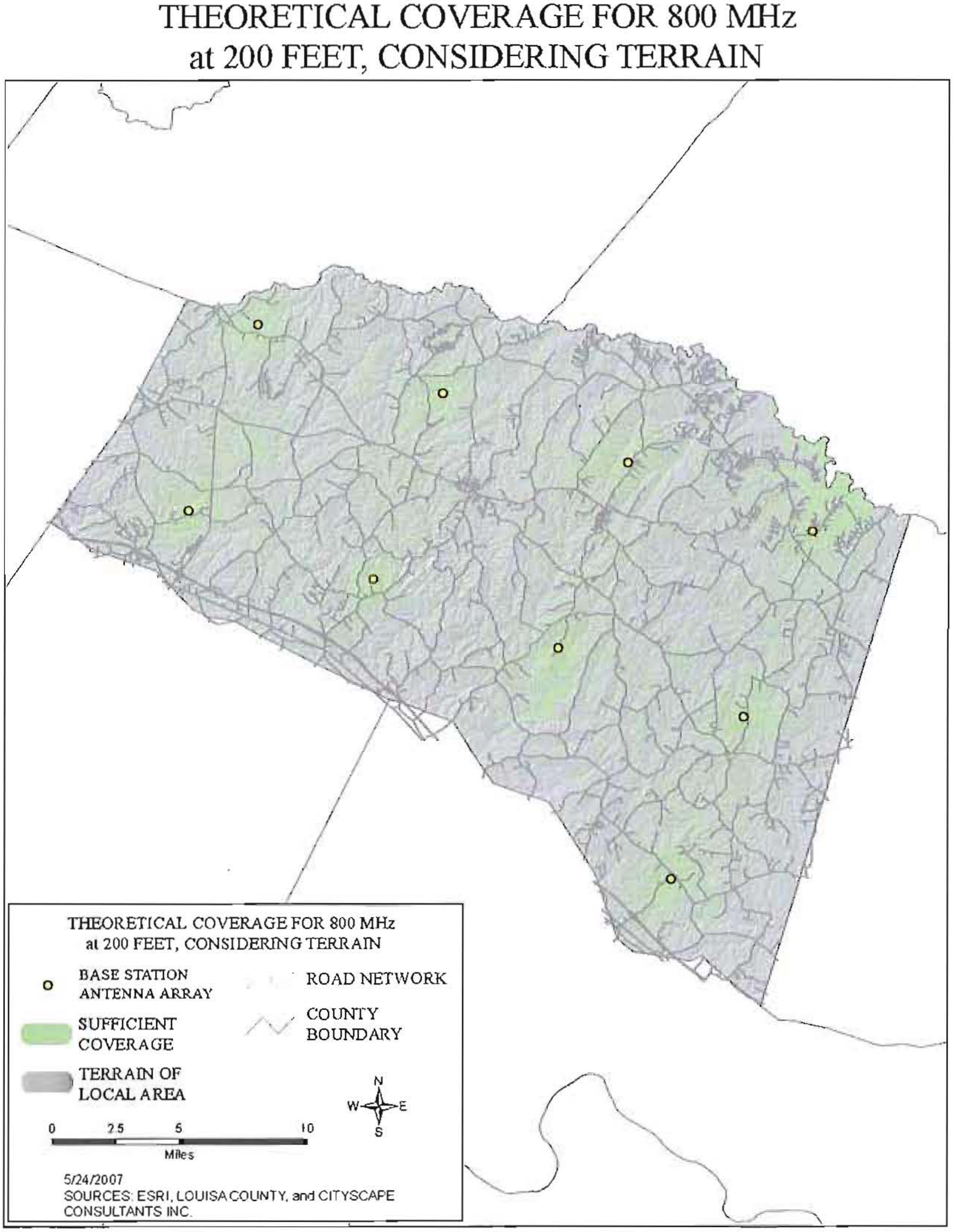


Figure 9: RMS 800 MHz Handoff at 200' Antenna Elevations with Terrain

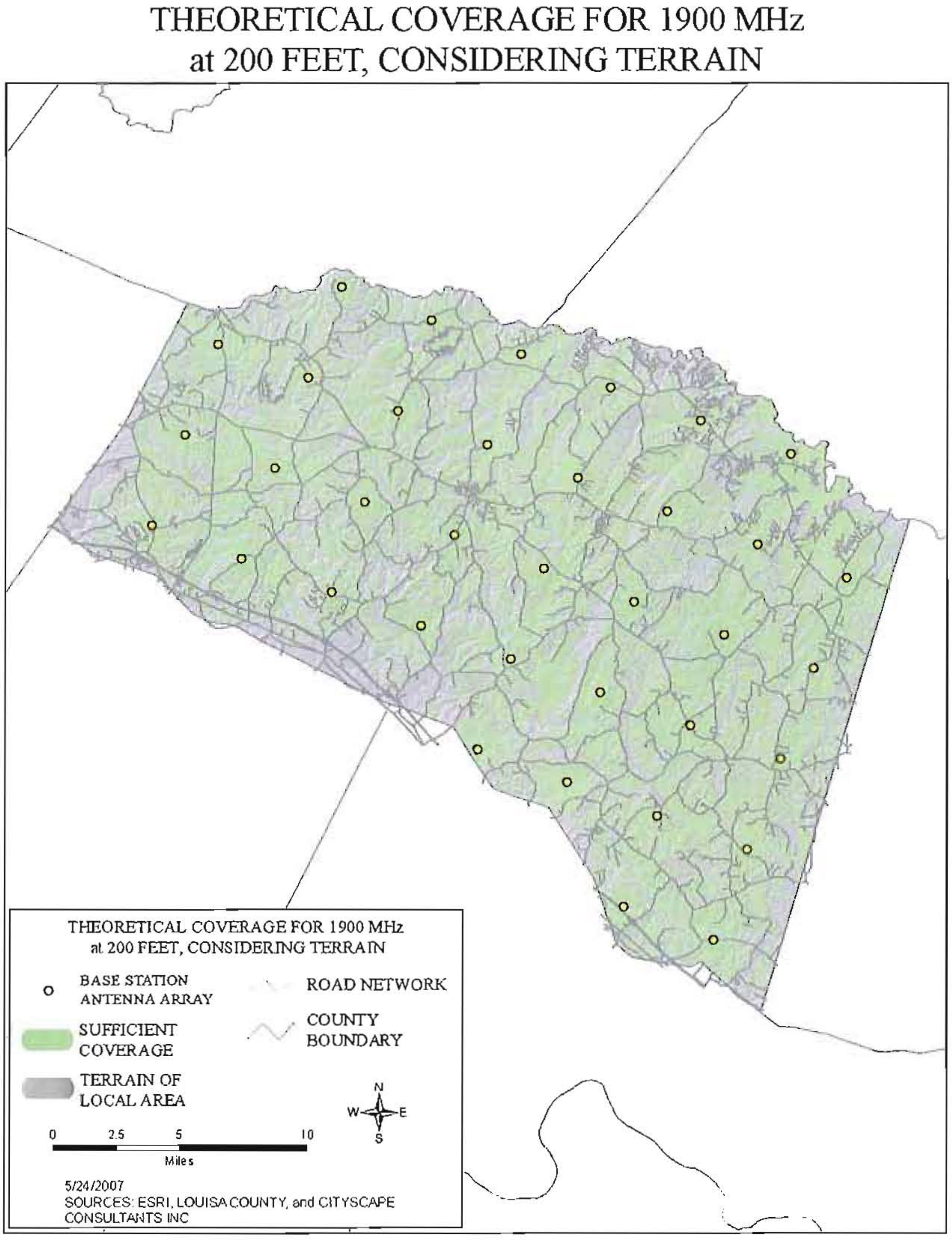


Figure 10: RMS 1900 MHz Handoff at 200' Antenna Elevations with Terrain

Existing antenna locations

Mapping the existing antenna sites creates the base map and a starting point from which observations and analysis are derived concerning current wireless deployment trends and projected future deployments for the County. CityScape performed an assessment of the existing antenna locations in and around the County to identify the following: 1) the location of existing telecommunications facilities currently located in the County; and 2) the availability of existing structures potentially for future colocations. This assessment was achieved through actual site visits to each of the WCFs provided to CityScape by the County, the tower owners, and the FCC database. CityScape has identified 46 existing and proposed antenna locations in and around the County. All these sites are a necessary part of the deployment infrastructure for the County. Figure 11 identifies all the known and proposed antenna locations throughout the County. Known antenna locations are identified by an orange dot and proposed locations are identified in a yellow dot.

The present deployment pattern illustrates approximately 21 towers located parallel to Interstate 64 and seven towers parallel to Highway 33. Many of these towers are located in pairs with the antenna arrays clustered closely together at the top indicating a need for as much height as possible by the providers. This pattern of deployment is consistent with other deployment patterns around the United States as providers seek to develop their networks for customers utilizing their wireless handsets while traveling in their vehicles.

KNOWN EXISTING AND PROPOSED ANTENNA LOCATIONS AS OF SEPTEMBER 17, 2007

LOUISA COUNTY, VIRGINIA

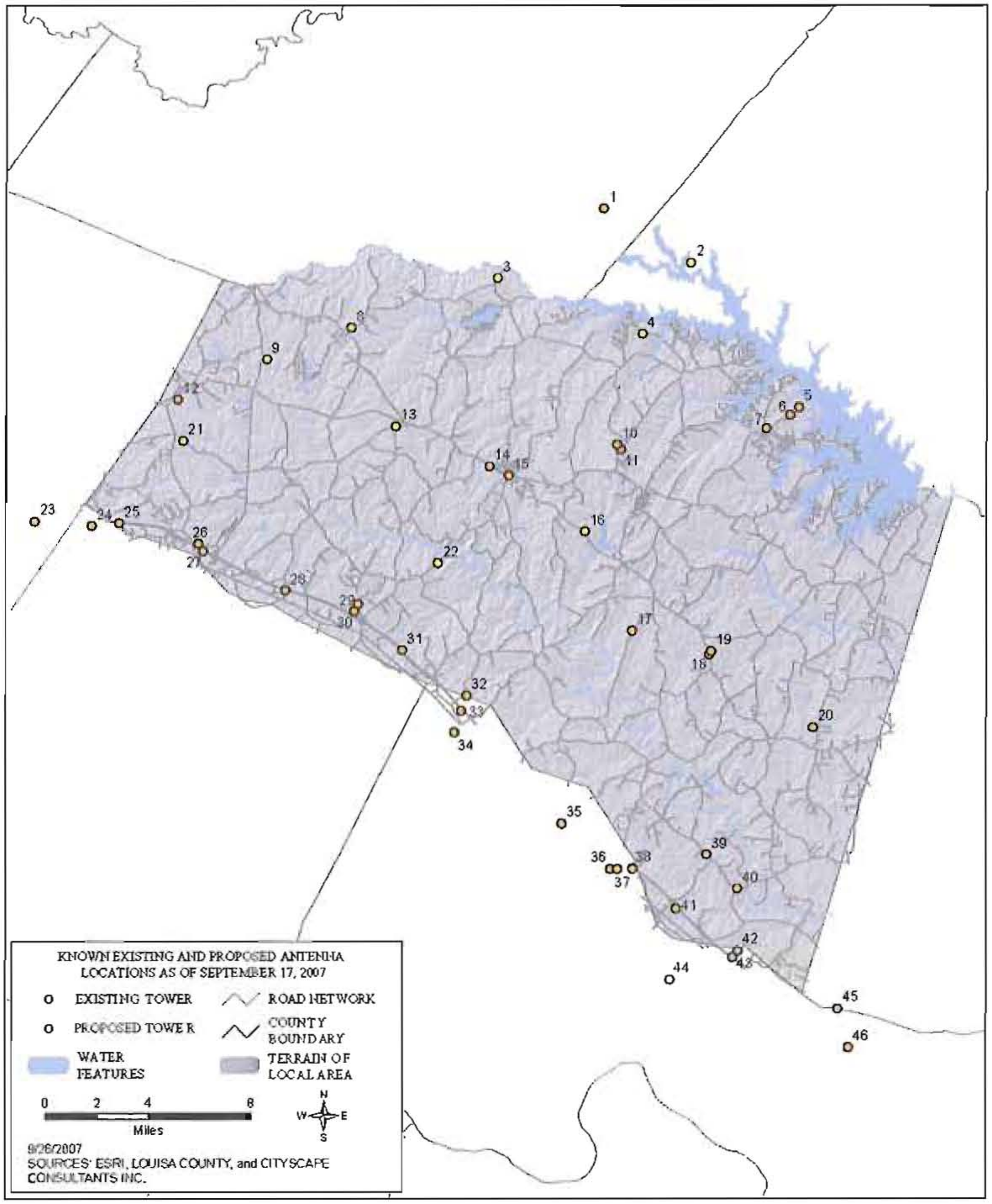


Figure 11: Existing Antenna Locations

Heights of support structures are known for all of the known antenna locations. Of these 46 antenna support structures the largest percent are less than 200' in height. The tables and bar graph below provides the height ranges of the known antenna support structures.

Number of Known Support Structure Heights	Height of Support Structure	Percentage of Support Structures in Given Height Range
5	>126'<155'	12%
2	>156'<176'	4%
21	>177'<200'	46%
9	>201'<299'	19%
9	>300'<400'	19%

Table 3: Known Antenna Mounting Elevations

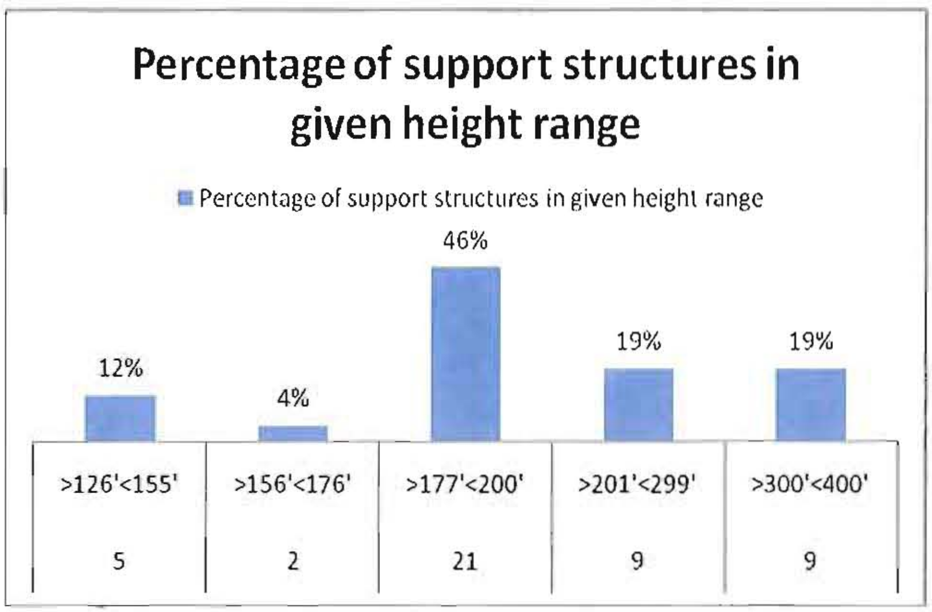


Table 4: Bar Graph of Known Antenna Support Structure Elevations

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 areas of the County are potentially underserved or have no service. CityScape theorizes how existing sites might be used by the wireless industry through a second series of RMS maps shown in Figures 12 through 15.

For example, CityScape asks the following questions: "If all existing antenna locations were developed with an antenna array and base station for the same wireless provider operating in the 800 and 1900 MHz frequencies would there be any gaps in coverage? Or are there ample sites to provide complete coverage to the entire County for this same theoretical provider?"

Figure 12 demonstrates in theory the coverage for a single provider operating in the 800 MHz frequency with its antenna mounted at the top of each tower. Geographic areas with good wireless coverage are shown in yellow. Generally the entire County is shown to have ample 800 MHz coverage in this scenario. Only the far eastern boundaries of the County are shown to have no coverage.

Figure 13 demonstrates in theory the coverage for a single provider operating in the 1900 MHz frequency with its antenna mounted at the top of each tower. Geographic areas with good wireless coverage are shown in yellow. However, significant shades of gray appear indicating marginal and no service areas. In this scenario only the Towns of Mineral and Louisa; the I-64 corridor; most of the Highway 33 corridor; the intersection of Highway 33, Highway 22 and Highway 522; and most of Lake Anna are shown to have greater than marginal service. The rest of the County is shown to have little or no coverage.

COVERAGE FOR A SINGLE 800 MHz PROVIDER

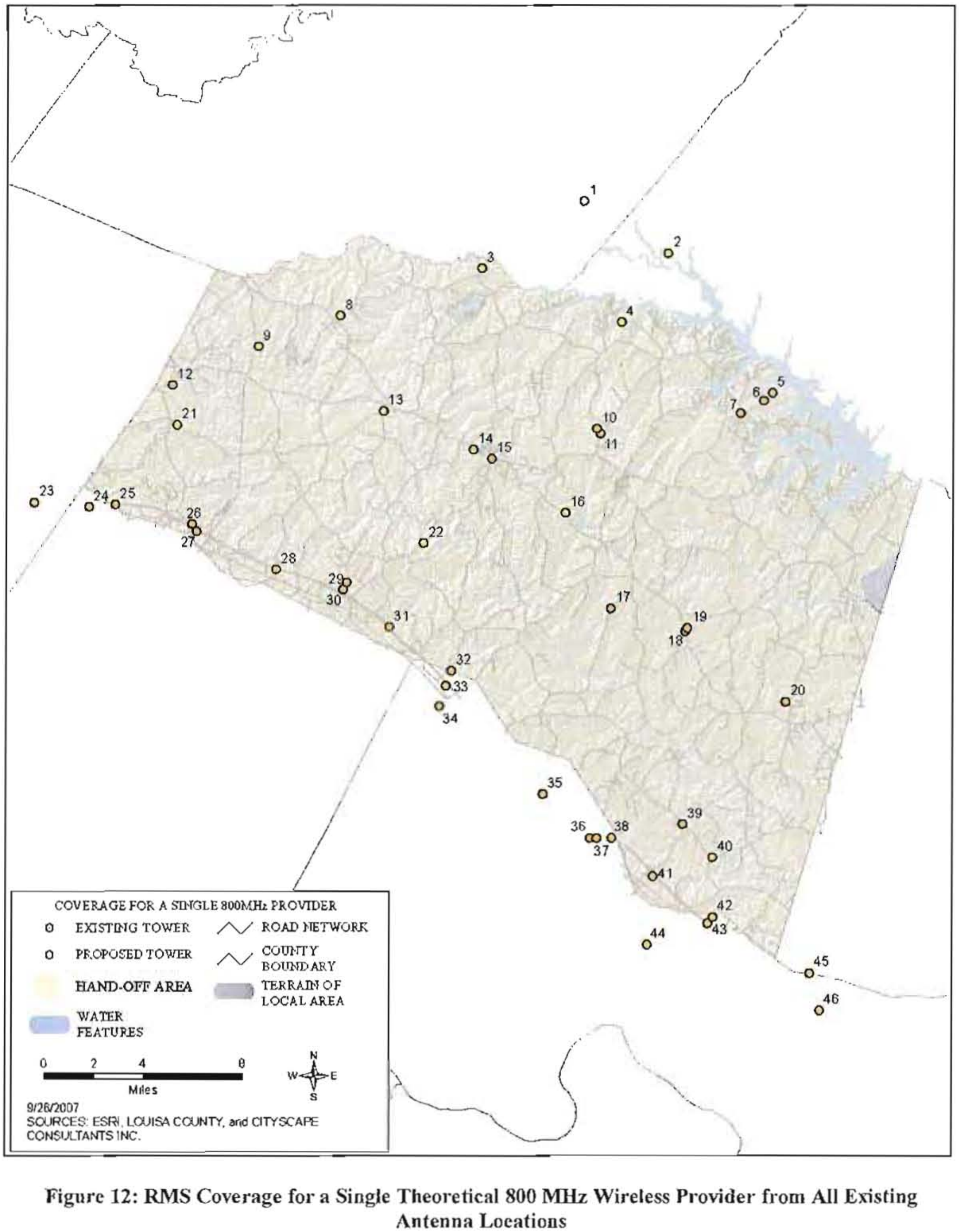


Figure 12: RMS Coverage for a Single Theoretical 800 MHz Wireless Provider from All Existing Antenna Locations

COVERAGE FOR A SINGLE 1900 MHz PROVIDER

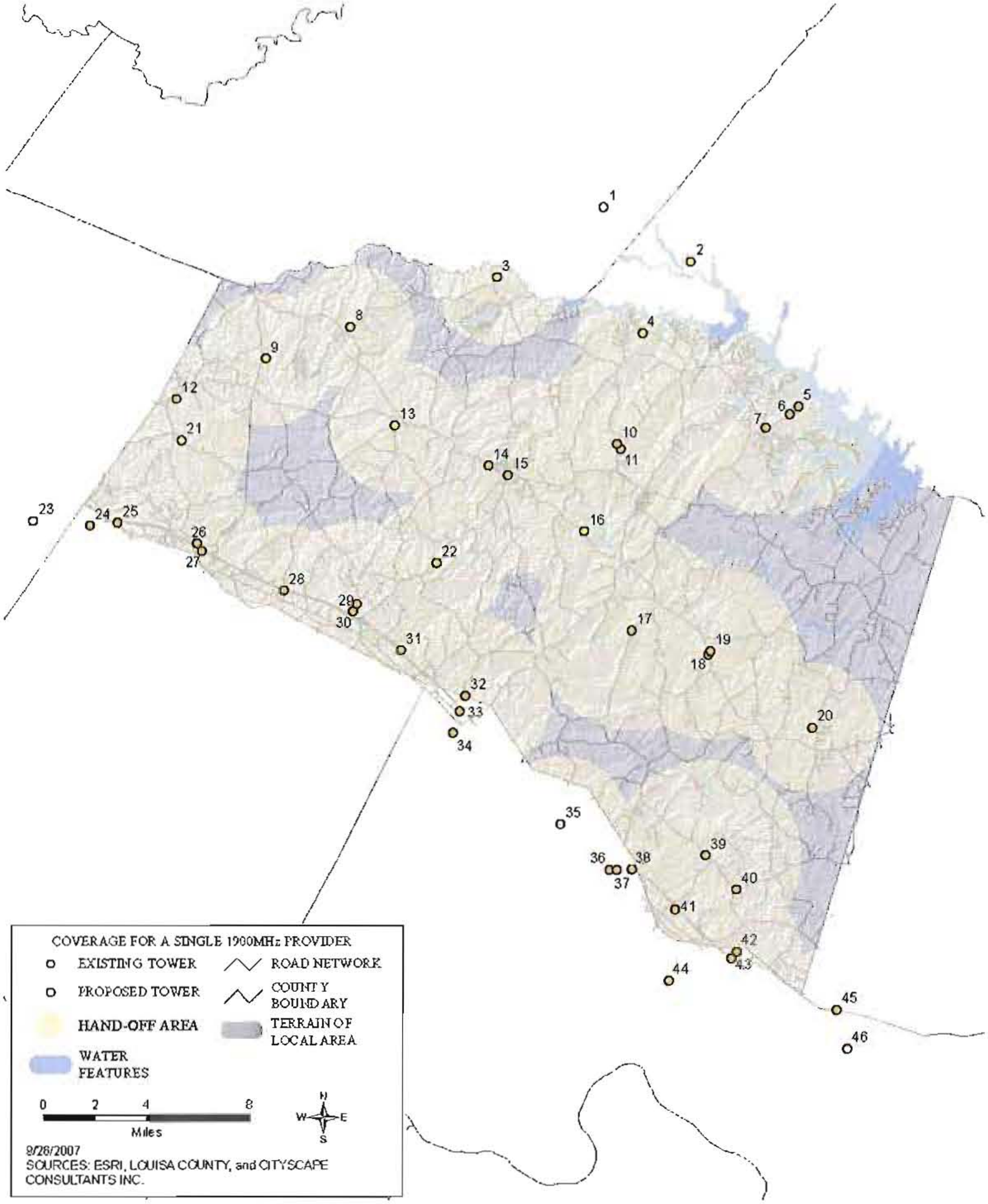


Figure 13: RMS Coverage for a Single Theoretical 1900 MHz Wireless Provider from All Existing Antenna Locations

Topographic variables

Radio Frequency propagation is loosely based on line-of-sight technology. 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 is most dramatic in foothills and mountainous areas. On flat terrain, the coverage network forms a circular pattern over the service areas. In the foothills, such as the County, the line-of-sight reach will be altered by the varying terrain conditions. The higher and lower ground elevations create a distorted coverage pattern over the service area.

Using the same existing antenna locations identified in Figures 12 and 13, Figures 14 and 15 illustrate how wireless service coverage areas become distorted and diminished when the topographic variable is added to the RMS formula. Geographic areas with good wireless coverage are shown in green. The areas in gray illustrate service areas that could use immediate improvements.

COVERAGE FOR A SINGLE 800 MHz PROVIDER

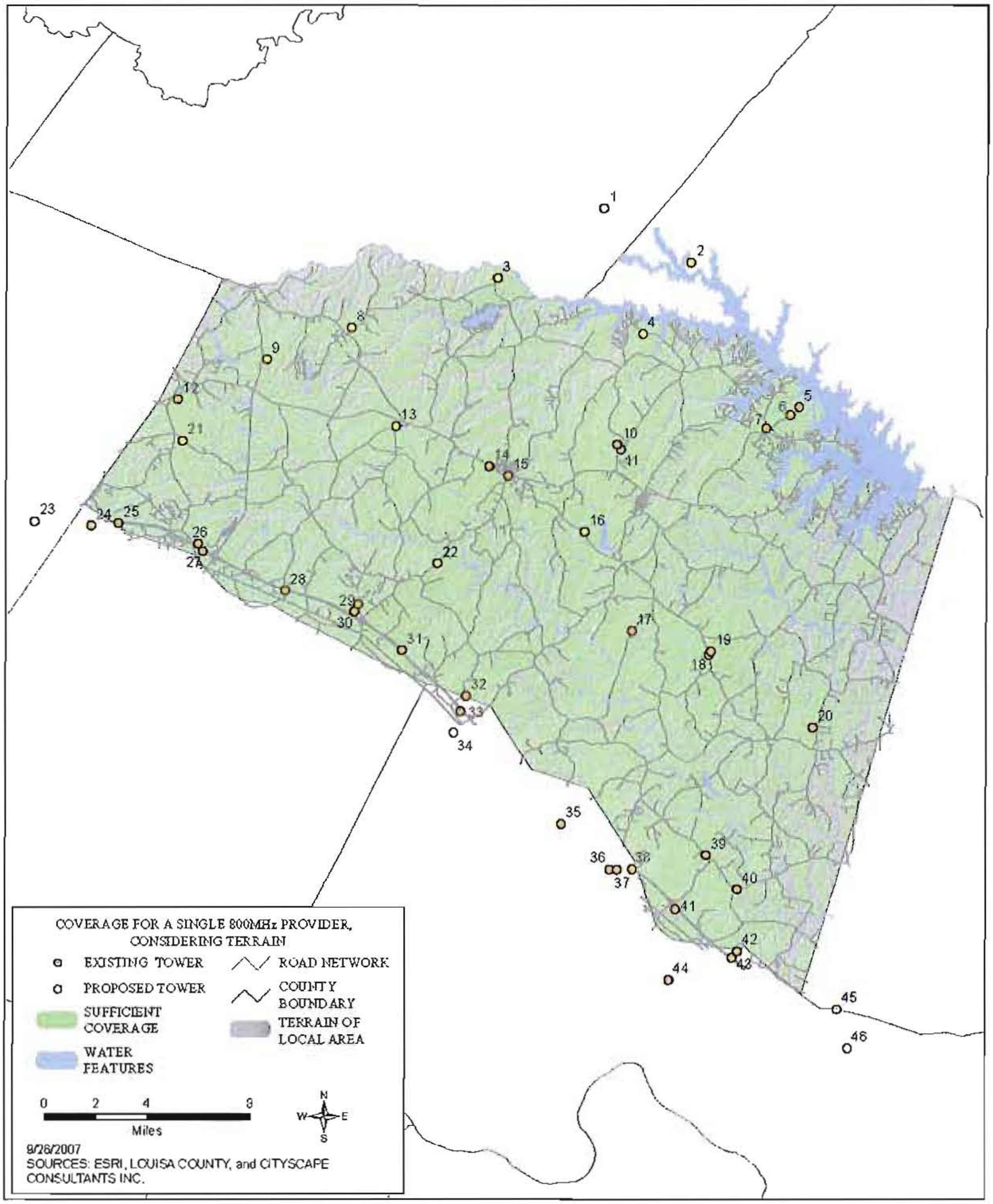


Figure 14: RMS Coverage for a Single Theoretical 800 MHz Wireless Provider from All Existing Antenna Locations with Terrain

COVERAGE FOR A SINGLE 1900 MHz PROVIDER

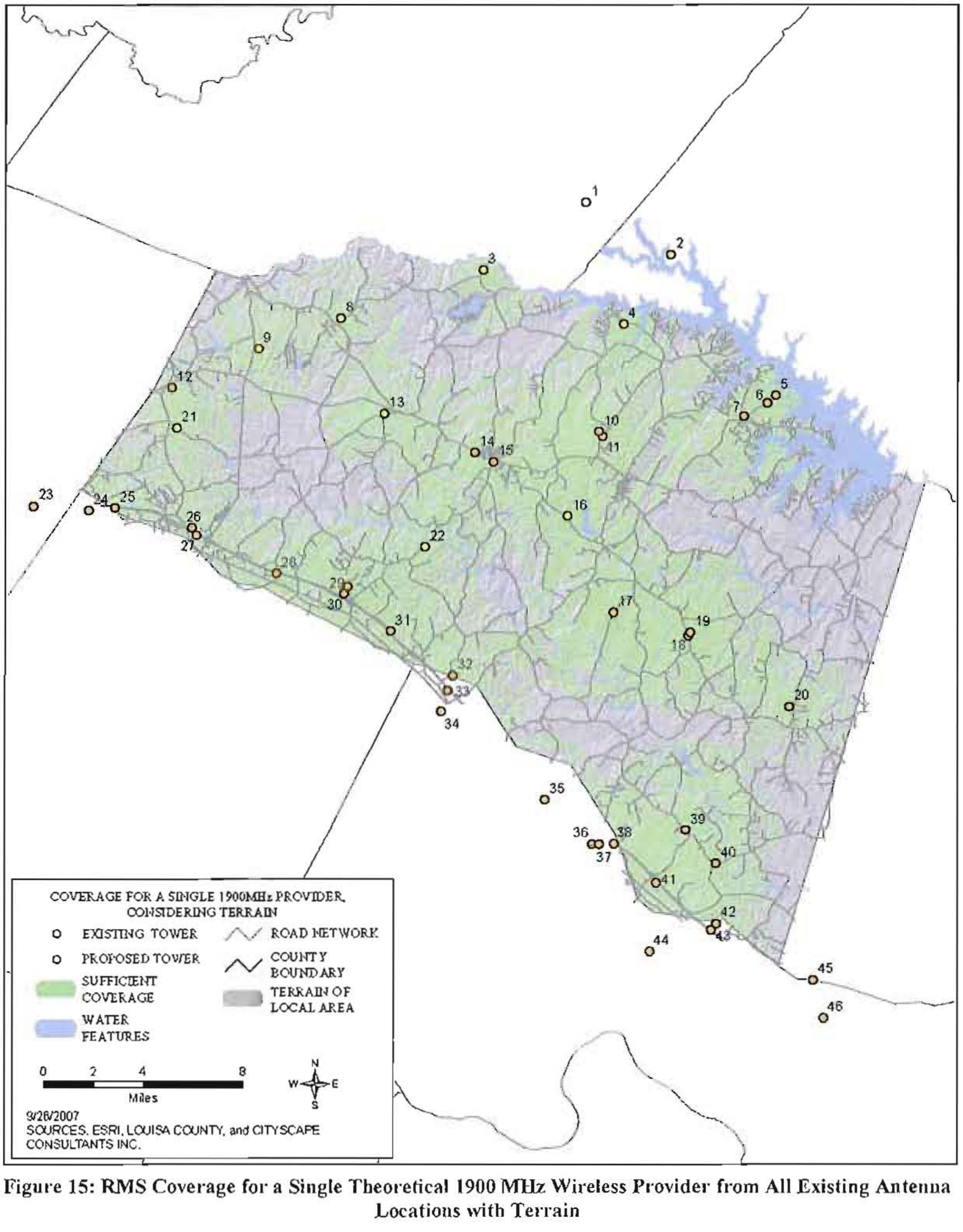


Figure 15: RMS Coverage for a Single Theoretical 1900 MHz Wireless Provider from All Existing Antenna Locations with Terrain

Analysis of RMS mapping and deployment patterns

The deployment patterns demonstrate that about 50 percent of the County has marginal or no coverage areas. One reason for this could be the low population density of the County and the industry design to develop surrounding higher populated areas. The 2005 US Census estimates the population of the County to be 30,020; equating to an average of 51.6 people per square mile. Providers prioritize their markets based on subscriber market share and generally put their resources in areas where the demand is greatest and the return of their investment meets their business plan. The Interstate 64 corridor and other main transportation routes provide a concentration of wireless subscribers to justify a need for infrastructure which is the reason for the proliferation of facilities along these pathways. Similarly, the concentration of population density in the Towns of Louisa and Mineral justify a need for wireless facilities in these geographic areas too.

The average mounting heights of the existing antennas is indicative of first phase deployment patterns where providers strive to meet coverage objectives; rather than network capacity objectives. Most of the County is still in phase one of wireless deployment, with the exception of the I-64 corridor where the network is more advanced to meet customer demands.

Demographic variables

The industry

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 described as Major 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 "Richmond-Norfolk" MTA (a.k.a. MTA 23) and the "Richmond-Petersburg" BTA (a.k.a. BTA 374).

Presently throughout the County there are three providers operating in the blocks of cellular services allocated in the 800 MHz band: AT&T (Cingular), Alltel, and Verizon. There are four blocks of Personal Communications Services (PCS) operating in the 1900 MHz band: AT&T (Cingular), Sprint, T-Mobile, and Ntelos for Verizon. Additionally an existing Enhanced Specialized Mobile Radio (ESMR) provider is also in the 800 MHz band (Nextel). These seven service providers all require uninterrupted and continuous handoff service throughout the County. In the near future, there is likelihood that additional services in the 700, 2500 and 5400 MHz bands will follow similar requirements.

Of the 46 towers in and around the County only two of them are owned by one of the wireless providers; the remaining 44 towers are owned and managed primarily by tower builders. American Tower Corporation (ATC), Crown Castle Incorporated (CCI), and Community Wireless Structures (CWS) collectively own the majority of the towers (31 total).

Tower Owners	Number of Towers
American Tower Corporation	8
Crown Castle Incorporated	14
Community Wireless Structures	9
Other	15
Total	46

Table 5: Primary Tower Owner Stakeholders

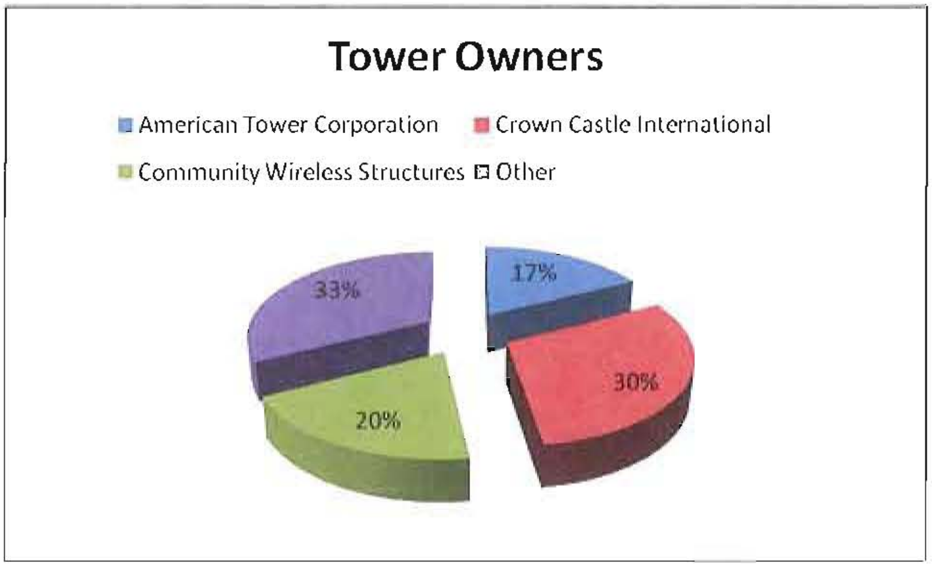


Table 6: Pie Chart of Primary Tower Owner Stakeholders

The 15 towers owned by others are listed in the table below which includes the two wireless providers previously mentioned.

Other Tower Owners	Number of Towers
National Communication Towers	1
VA Electric & Power	2
Piedmont Communications	1
Rappahannock Electric Cooperative	1
MCI Communications	1
Richmond 20 MHz, LLC	1
RCTC Wholesale (Alltel)	3
Manakin Towers	1
Department of State Police	1
Verizon	1
SBA	1
Sprint	1
Total	15

Table 7: Other Tower Owner Stakeholders

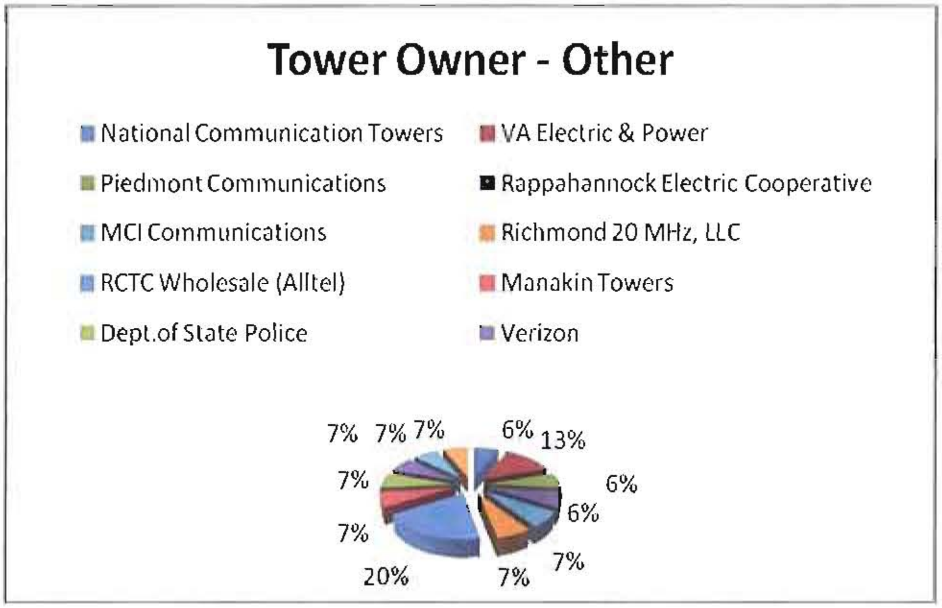


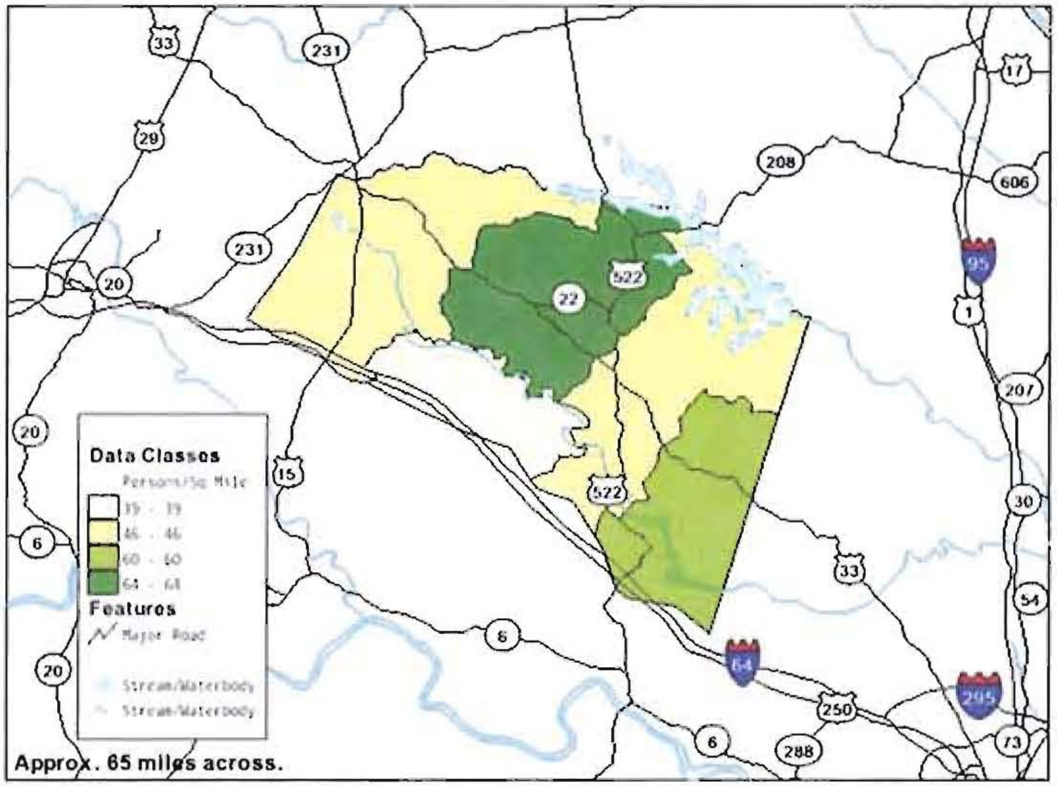
Table 8: Pie Chart of Other Tower Owner Stakeholders

The majority of the tower types are lattice and monopole type construction. Sixty percent of towers built by "others" and 50 percent of towers owned by ATC are lattice style construction. CCI owns an equal number of lattice and monopole type poles (36%), and 78 percent of towers owned by CWS are monopoles. Thus, of the 46 towers assessed; 19 are lattice, 18 are monopoles, and 9 are guy wire type facilities.

Louisa County

Louisa County is located in the central northeast portion of Virginia, north of Interstate 64, west of the City of Charlottesville, and east of the City of Richmond. The County encompasses roughly 514 square miles or 328,960 acres (Comprehensive Plan). The US Census estimates the 2000 population for the County at 25,627; and the Louisa County Comprehensive Plan estimated a slightly higher population of around 27,277.

Figure 16 illustrates the distribution of population countywide. The deep shade of green identifies the greatest population concentration in the County; with the lighter shade of green being the next most populated area of the County. Pale shades identify low population profiles. It is logical the greatest population density is in and around the Towns of Louisa and Mineral. The second largest population grouping in the southeast quadrant of the County north of Interstate 64 is surprising given the rural character of this geographic area. The lowest population density in the central southern part of the county is typical of commercial and business land uses.



Source US Census

Figure 16: Demographics

Figure 17 is a side by side comparison between the population densities shown in Figure 16 and the theoretical coverage from the existing antenna locations as shown in Figure 15. Again, the deep shade of green in Figure 16 identifies the greatest population concentration in the County; with the lighter shade of green being the next most populated area of the County. Pale shades identify low population profiles.

The map on the right illustrates the theoretical coverage from existing known antenna locations throughout the County. The map combines topographic and demographic variable; the areas in gray show minimal or no wireless service coverage. This mapping exercise demonstrates a future need for wireless telecommunications facility sites throughout the County especially parallel to all major highways; within linear geographic areas between the highways; and in the most populated areas of the County, especially in the eastern half of the County. The geographic area where future wireless infrastructure is needed is generally zoned Agricultural (A1) and Agricultural (A2); and towers are presently permitted through the approval of a Conditional Use Permit in both of these districts.

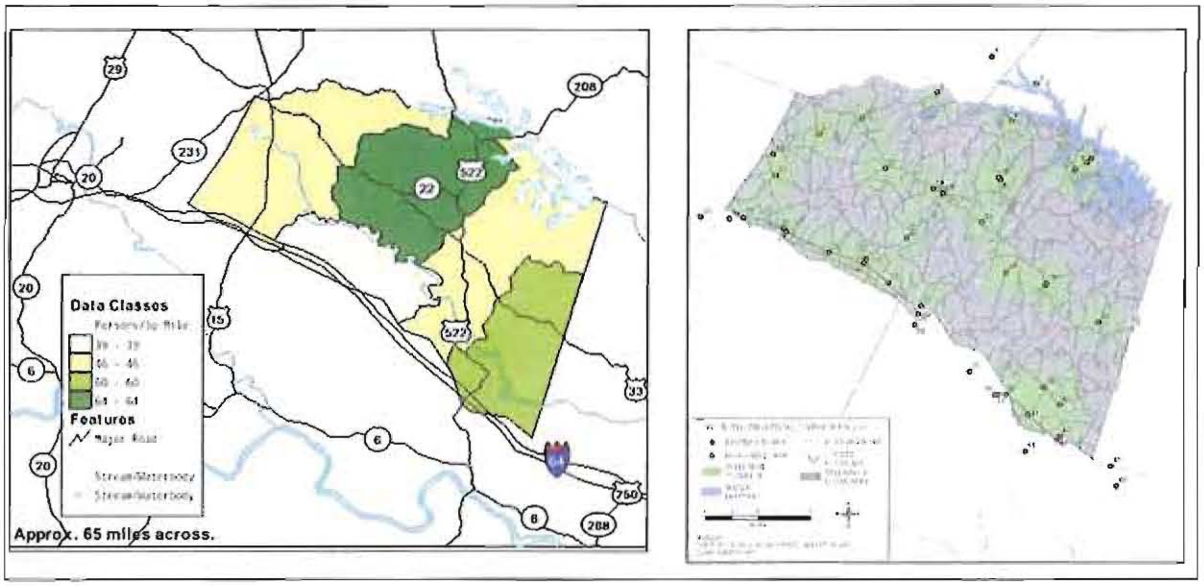


Figure 17: Demographic and Coverage Comparisons

Wireless demographic analysis

CityScape research shows contradictory information regarding the County population trends and the current cell phone penetration rates within the County. Based on the US Census Data, the Virginia Employment Commission estimates the County population will increase to approximately 34,918 (Comprehensive Plan) by year 2020. However, building permits for the County indicates the 2007 population to be around 36,171; presently exceeding the 2020 projection by 1,253 persons. Using staff's research as the basis for 2020 projections estimates a population of around 61,064; provided the level of building and growth are maintained at the present rate.

The wireless telecommunications market factors indicate a penetration rate of about 60 percent; yet recently released federal penetration rates indicate a level of around 77 percent. CityScape selected to use 68 percent (a number between these two projections) as the present penetration rate for the County, with an additional 15 percent transient rate.

Considering constant increase projections to 2020, the population is expected to reach approximately 61,064. Using this population increase and expected increases in subscriber minutes, it is fair to assume a proposed market penetration rate increase to 90 percent by 2020. Additionally, a transient figure of 15 percent for estimating capacity overloads is included. Based on this method, the County should anticipate growth that will result to about 70,224 wireless subscribers by 2020. However, by 2020 it is predicted the average number of subscribers processed by a base station will drop from 1,000 to 1,500 simultaneous calls to between 500 and 750 simultaneous calls.

As a result of the present growth models and the current wireless market penetration rate, the County region can expect an increase from 46 antenna locations to approximately 112 antenna locations by 2020, depending on local connectivity and the rate of wireless network evolution from 3G to 5G. 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 sties and around seven colocations per year over the next ten years.

Figures 18 illustrates anticipated coverage voids over the next 10 years as wireless phone subscriber rates increase and more broadband is needed to accommodate added handset features. The new sites will be necessary in the areas shown in gray to meet network planning objectives. This projection is for one wireless provider and assumes this provider has an antenna array at each site shown on the map.

PROJECTED THEORETICAL COVERAGE FOR 2020

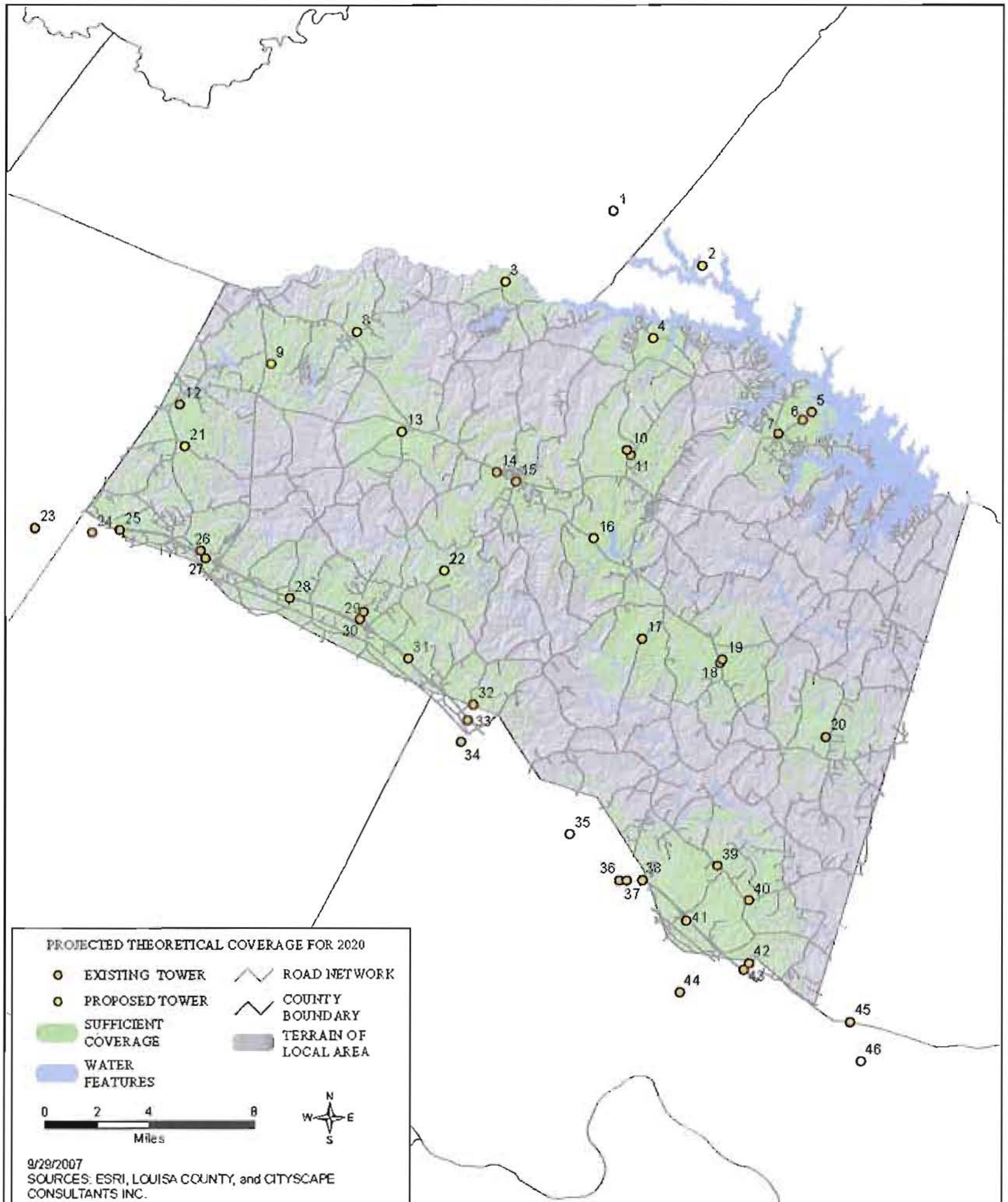


Figure 18: Demographic and Coverage Comparisons

Louisa County's public policy on wireless teleeommunications prior to September 2007

CityScape has reviewed the Louisa County Zoning Definitions and Article IX, entitled, "Telecommunications Regulations", Section 89-481 through Section 86-494 of the County's Ordinance. CityScape has identified several areas of concern.

First, Section 86-482. (d), "Existing structures and towers" indicates the addition of an antenna onto an existing structure shall only be permitted provided:

> "...said antenna shall not add more than 20 feet in height to said structure or tower and provided, however, that such specific permitted use shall not include the placement of additional buildings or other supporting equipment used in connection with said antenna...."

As mentioned previously, each elevated antenna array must have supporting ancillary equipment such as feed lines and ground equipment to make the antenna function.

A second concern pertains to Section 86-489, "Setbacks and separation". Requirement three states:

> "the distance from the base of all towers to the property boundary of the parcel upon which the tower is located shall be 110 percent of the height of the tower."

CityScape has determined the average height of towers in and around the County is around 200 feet. Approximately 110 percent of this height would require a 220-foot setback from all property boundaries; equating to a minimum lot size of 1.11 acres. This minimum lot standard is likely available throughout the undeveloped geographic areas of the County; but that may not be the case in geographic areas zoned predominantly for business parks or residential purposes. If this minimum lot size is non-existent then this specific zoning standard could be viewed as a barrier to entry by the industry. Logistically this requirement forces the tower towards the interior of the property away from existing perimeter tree lines and making it more visible to the public.

Lastly, Section 86-492, "Local government areas" requires:

> "Owners of towers shall provide the county colocation opportunities without compensation as a community benefit to improve radio communication for county departments and emergency services."

CityScape recommends similar language to be included in lease agreements between wireless providers and tower owners when the proposed infrastructure is to be installed on county-owned land. Requiring county access on a new tower to be erected on privately-held land could be viewed as an unfair request by the County. CityScape recommends the deletion or re-wording of this standard and using it only on county-owned assets.

Wireless workshop surveys

CityScape presented a wireless workshop at which elected officials, County staff, and the citizenry were given the opportunity to learn about wireless deployment practices and share their vision of future land use policies related to this industry. Based on the survey results, CityScape determined that concealment is the most preferable type of wireless infrastructure and that non-concealed support structures are only deemed acceptable in commercial or industrial districts. While this is a viable option, it will be challenging to develop concealment techniques that offer a blended appearance to the local landscape relative to scale. Because most of the County is in phase one of wireless deployment, antenna mounting heights will need to be in the 190-foot elevations; lower mounting heights will only become a viable option to the industry in areas with a dense subscriber population; and this profile is uncharacteristic for most of the unincorporated areas of the County.

Throughout the Country, there is an acceptance to use power line distribution poles and support structures to support new antenna arrays provided; 1) the power company is agreeable, and 2) the use of the rights-of-way for these purposes is permissible by the local government. This scenario provides a great option for meeting network objectives given the tall heights of the cross-country distribution poles that traverse the County.

Survey participants indicate a preference for new tower constructions to be of the monopole type support structure, and that new antenna support structure heights be limited to less than 200 feet; thereby reducing the requirement for night lighting. Industry manufacturers make monopoles up to 250 feet and about one third of the existing infrastructure in the County already meets this description.

Colocation was voted as the most preferable option for wireless infrastructure deployment. This is advisable provided existing elevated structures are available on which to colocate. A visual survey of existing towers indicates ample space for additional antenna arrays.

There remains a strong desire to maintain the character and aesthetics of the County skyline and at ground level pedestrian views. In some situations it is preferable to design ground equipment facilities to compliment the surrounding architecture. This goal is attainable through land use standards to specifically address the visual appearance of the ground space.

A number of survey participants are expressing frustration with the present lack of network coverage and are encouraging the continued deployment of wireless infrastructure. Their radio frequency propagation maps clearly illustrate areas of concern. Developing a wireless telecommunications friendly ordinance that bridges citizenry concerns with industry needs will promote an orderly future deployment pattern.

Use of county-owned property

The County has indicated an interest in utilizing public lands for future wireless telecommunications infrastructure.

Legal opinion

CityScape has been asked to determine the propriety of using County property for private wireless telecommunications facilities. Use of public property is rooted in the enabling text of the federal legislation that revolutionized the wireless communications industry, the Federal Telecommunications Act of 1996 (the Act).

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 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.

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

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 and a telecommunications attorney, 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.

CityScape conducted a preliminary review of county-owned property and identified 14 County-owned properties that could be suitable for new tower locations. These sites have been mapped and evaluated for use in meeting future network objectives. Table 9 lists these properties, Figure 20 identifies the location of these sites, and Figure 19 illustrates how an antenna mounted at 199 feet at these locations can help meet network objectives. Theoretical coverage from the County-owned properties is shown in red.

Map Reference	County-owned Property	Site Location	Tax Map Parcel Number
A	Bowlers Mill Lake	Northwest of Reservoir – Rt. 704	8-19
B	Bowlers Mill Lake	Southeast of Reservoir – Rt. 603	8-19
C	Shooting Range	West of Louisa Town – Rt. 730	25-30
D	Industrial Air Park	East of Louisa Town - Rt. 22	41-195
E	Water Authority	Air Park – Rt. 780	41-201
F – H *	Land Fill Area	South East of Mineral Town – Rt.700 (Mica Road)	59-112 and 59-112B
I	Park	Bumpass Area – Rt. 601	76-14A
J	Vacant	South of Pendleton - Rt. 522	59-11-2A
K	Vacant	Within Reedy Creek Subdivision	67-28A
L	Zion Crossroads Water Tower	Zion Crossroads – Rt. 15	51-48A
M	Old Louisa Dump Site	North of I-64 - Rt. 208	67-5A
N	Recycling Center	South of Louisa Town – Rt. 208	55-8A
*Only one tower will be necessary for County-owned properties F through H.			

Table 9: List of County-owned Lands

Louisa County Government Property

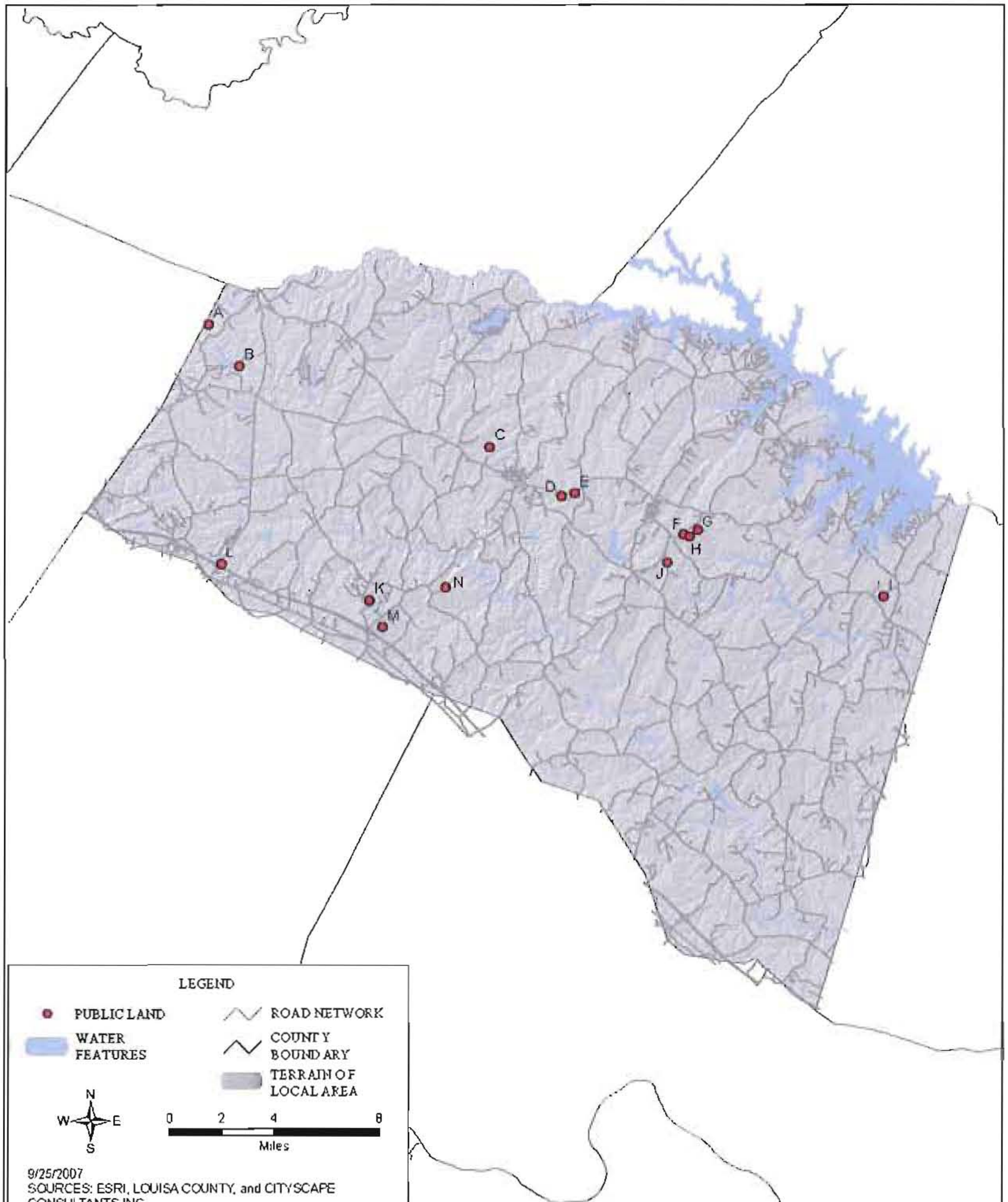


Figure 19: County-owned Lands

PROJECTED THEORETICAL COVERAGE FOR 2020 INCLUDING COUNTY-OWNED LAND

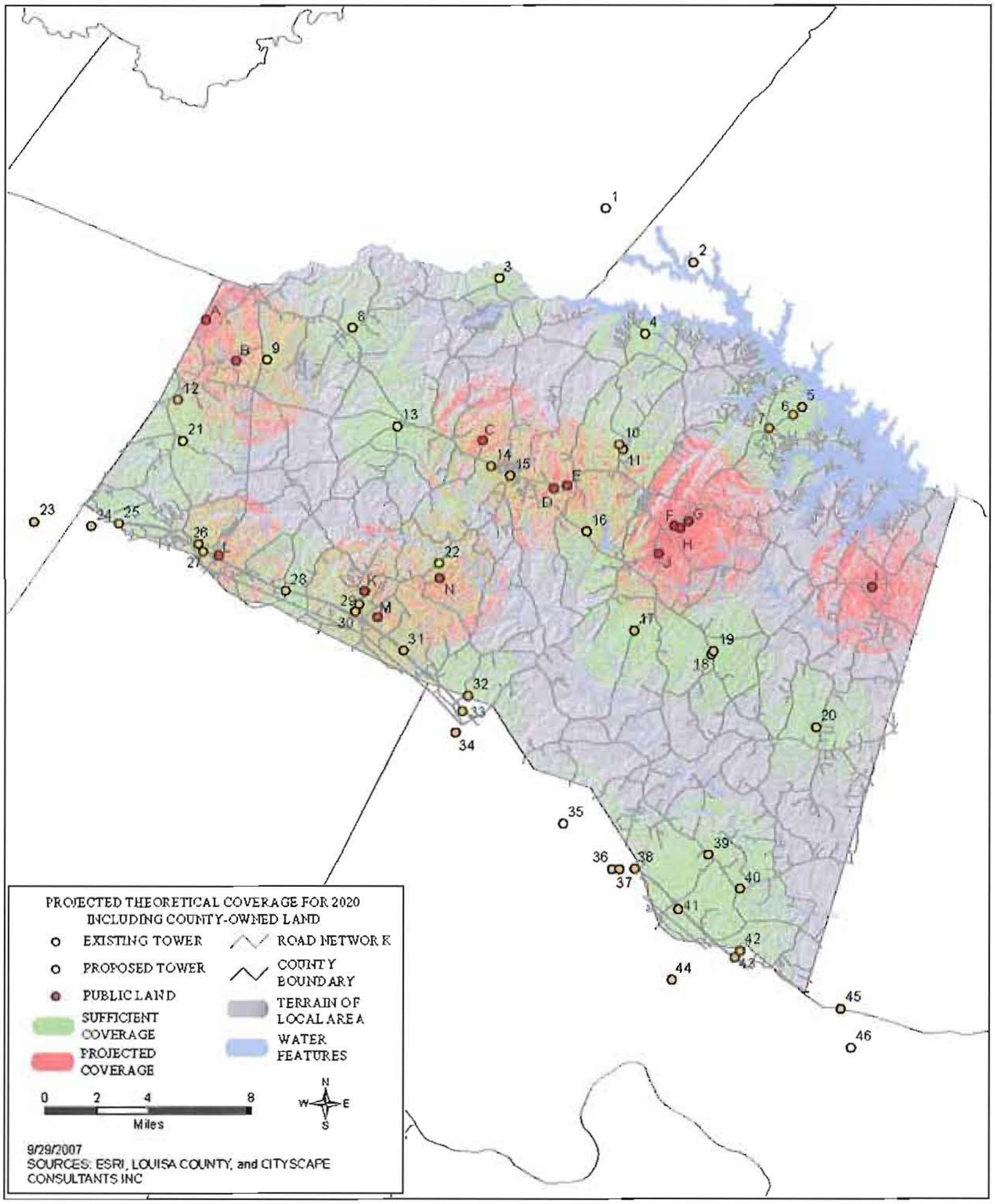


Figure 20: Theoretical Coverage from County-owned Lands

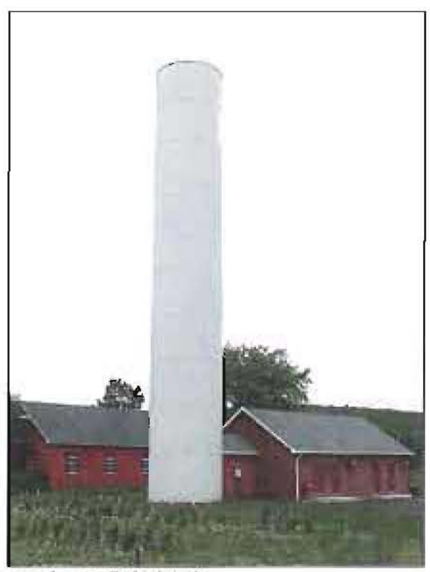
Proposed policy changes

Ordinance revisions are intended to limit the visibility of new wireless telecommunications support structures on the landscape, reduce the number of new antenna support structures, and utilize publicly-owned lands for the purposes of wireless infrastructure deployment. It addresses concerns over tower proliferation, and includes strategies to control future growth of the wireless telecommunications industry throughout the County.

To encourage the use of existing elevated structures, CityScape recommends adding new words and definitions consistent with the wireless telecommunications industry to the existing Ordinance; and adding a hierarchy of preferable infrastructure options to address the visual and locational preferences of future network installations. The siting hierarchy establishes the preferred type of facilities to be located in the community. The order of preferred installs is first for a concealed attached antenna. If these are not an option, then colocation or combining would be the second preference, followed by a non-concealed attached antenna. If a new tower needs to be constructed, then tower owners are directed to first consider the mitigation of an existing facility (improvements to allow for more colocations); for example structural improvements to allow for more colocation on and existing facility. If this is not an option, then the Ordinance places the first preference on a concealed facility over a non-concealed tower.

Based on the surveys, an example of the siting preferences in the hierarchy would be to allow concealed antennas attached to existing elevated structures and new concealed towers and monopoles less than 200 feet; as opposed to lattice and guy towers in excess of 200 feet. The proposed text allows new towers in residential districts up to 125 feet; provided they are concealed, including, but not limited to the concealed towers shown in the pictures below.

(Courtesy Community Wireless Structures)



(Courtesy Stealth Concealment Solutions)

Chapter 4 Inventory

Purpose of the inventory

In order to determine suitability of existing wireless communications facilities in the County for future colocation or combining, and with the intention of limiting additional antenna-supporting structure construction to the extent possible, CityScape created an inventory catalogue of sites.

Procedure

CityScape conducted an assessment of existing antenna locations and selected County-owned property within the County. The data for the assessment was obtained from a number of sources including actual permits obtained from the County for wireless infrastructure, site visits, research of registered site locations and direct information from existing wireless service providers and tower owners active in the County.

Inventory catalogue

Pictures of existing antennas mounted on towers, water tanks, and selected County-owned property are included in the inventory catalogue. The site locations of these sites are located on Figure 21. Existing tower locations are identified by an orange dot, proposed new tower locations as of May 21, 2007 are identified by a yellow dot, and all County-owned land is identified by a red dot.

Structural evaluation

Based on a visual inspection of antennas already on existing antenna supporting structures, CityScape has made a judgment as to whether the support structure is likely to physically accommodate more antennas. The number of estimated colocations is referenced as future capacity and is included in the inventory. This is based on visual observations only. In this consideration, more antennas mean additional wireless antenna platform(s) consisting of several antennas and requiring several lines of heavy coaxial cable. Prior to mounting new antennas, the structure must be examined and analyzed by a structural engineer for its ability to support the proposed addition. New tower infrastructure on County-owned land is subject to Conditional Use Permit approval prior to new tower construction.

Site photographs

Photographs of found sites are included in this inventory. The identification number in the inventory corresponds to the site's identification on Figure 21, and the pictures of each site follow Figure 21.

KNOWN EXISTING AND PROPOSED ANTENNA LOCATIONS AS OF SEPTEMBER 17, 2007 WITH PUBLIC LANDS

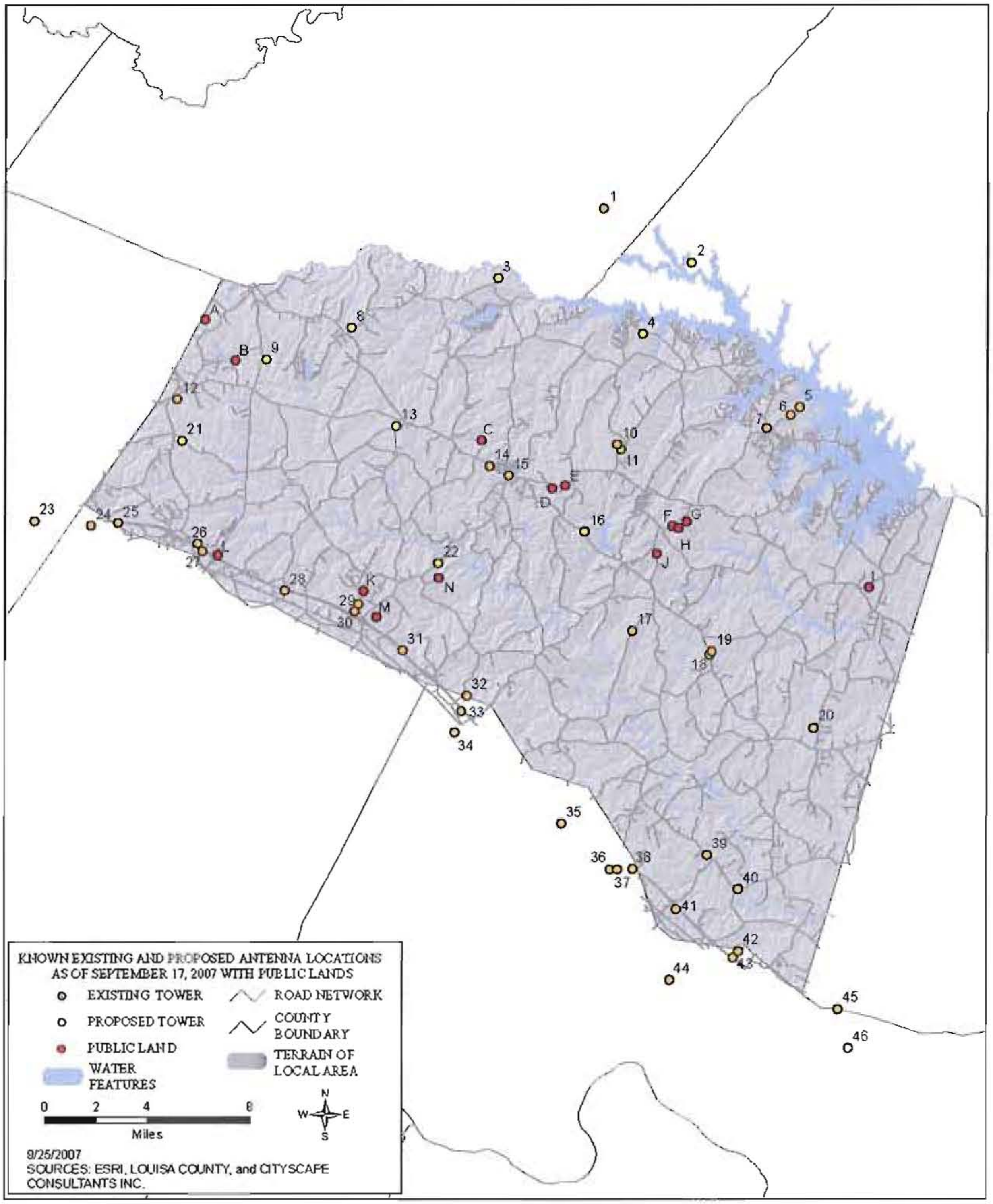


Figure 21: Existing, Proposed, and Potential Tower Locations

Known Inventory-1 as of September 17, 2007

SITE LOCATION

Site Number 1
17169 Zachary Taylor Hwy.
Latitude: 38-10-17.5 N
Longitude: -77-56-07.5 W

Type: Lattice 250'
Future Capacity: 2

SITE LOCATION
PROPOSED
Site Number 2
Hickory Cut (Spotsylvania County)
Latitude: N
Longitude: W

Type: Monopole 195'
Future Capacity: 4

SITE LOCATION
PROPOSED
Site Number 3*
Union Avenue Extension
Latitude: 38-07-55.16 N
Longitude: -78-0-40.48 W

Type: Monopole 199'
Future Capacity: 4

SITE LOCATION
Under Construction
Site Number 4*
7149 Zachary Taylor Hwy.
Latitude: 38-06-02.5 N
Longitude: -77-54-27.8 W

Type: Lattice 199
Future Capacity: 4

SITE LOCATION

Site Number 5
End of Route 700
Latitude: 38-03-32 N
Longitude: -77-47-47 W

Type: Lattice 240'
Future Capacity: 4

SITE LOCATION

Site Number 6
4429 Johnson Rd.
Route 700
Latitude: 38-03-17 N
Longitude: -77-48-10 W

Type: Guy 387'
Future Capacity: 4

SITE LOCATION

Site Number 7
Route 700
Latitude: 38-02-50.52 N
Longitude: 77-49-11.32 W

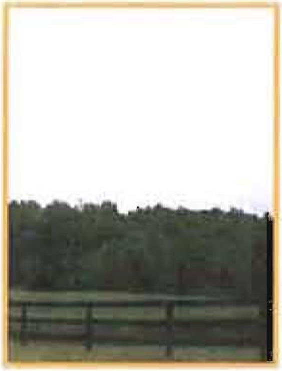
Type: Guyed 309'
Future Capacity: 2

SITE LOCATION
PROPOSED
Site Number 8*
Doctors Rd.
Latitude: 38-06-18.6 N
Longitude: -78-06-56.6 W

Type: Monopole 175'
Future Capacity: 4

EXISTING TOWER BUILDING LAND WATERTANK
* Photo Complements of CWS

Known Inventory-2 as of September 17, 2007



SITE LOCATION
Proposed
Site Number 9
Hound Dog Rd.
Latitude: 38-05-15.6 N
Longitude: -78-10-34.2 W

Type: Monopole 199'
Future Capacity: 4

SITE LOCATION

Site Number 10
977 Chopping Rd.
Latitude: 38-2-14 N
Longitude: -77-55-26 W

Type: Guy 348'
Future Capacity: 2

SITE LOCATION

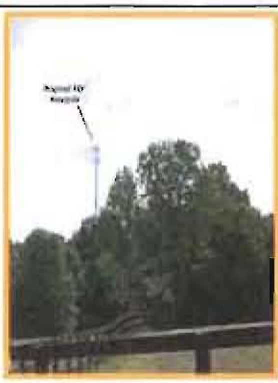
Site Number 11
1101 Chopping Rd.
Latitude: 38-2-19 N
Longitude: -77-55-25 W

Type: Guy 320'
Future Capacity: 3

SITE LOCATION

Site Number 12
Route 22
Latitude: 38-03-55 N
Longitude: -78-14-24 W

Type: Guy 140'
Future Capacity: 1



SITE LOCATION
PROPOSED
Site Number 13*
8903 Poindexter Rd.
Latitude: 38-02-59.5 N
Longitude: -78-05-3.1 W

Type: Monopole 199'
Future Capacity: 4

SITE LOCATION

Site Number 14
194 McDonald St.
Latitude: 38-01-37.5 N
Longitude: -78-01-03.9 W

Type: Lattice 286'
Future Capacity: 4

SITE LOCATION

Site Number 15
196 McDonald St.
Latitude: 38-01-18.1 N
Longitude: -78-0-14.6 W

Type: Lattice 394'
Future Capacity: 3

SITE LOCATION
PROPOSED
Site Number 16*
Highway 33
Latitude: 37-59-23.6 N
Longitude: -77-56-58.86 W

Type: Monopole 199'
Future Capacity: 6

EXISTING TOWER BUILDING LAND WATERTANK
* Photo Complements of CWS

Known Inventory-3 as of September 17, 2007

SITE LOCATION

Site Number 17
3921 Indian Creek Rd.
Latitude: 37-56-1.97 N
Longitude: -77-54-58.3 W

Type: Lattice 395'
Future Capacity: 4

SITE LOCATION

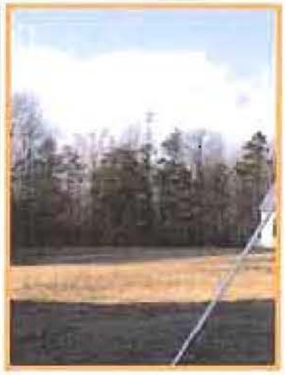
Site Number 18
9656 Jefferson Hwy.
Latitude: 37-55-13.1 N
Longitude: 77-51-42 W

Type: Lattice 165'
Future Capacity: 0

SITE LOCATION

Site Number 19
9661 Jefferson Hwy.
Latitude: 37-55-19.7 N
Longitude:77-51-36.5 W

Type: Lattice 325'
Future Capacity:



SITE LOCATION

Site Number 20
909 Bethany Church Rd.
Latitude: 37-52-47.5 N
Longitude: -77.47-16.6 W

Type: Monopole 190'
Future Capacity: 2

SITE LOCATION
PROPOSED
Site Number 21*

Latitude: 38-02-31.8 N
Longitude: - 78-14-10.9 W

Type: Monopole 199'
Future Capacity: 4

SITE LOCATION
PROPOSED
Site Number 22*
Route 208
Latitude: 37-58-21.5 N
Longitude: -78-03-17 W

Type: Monopole 199'
Future Capacity: 4

SITE LOCATION

Site Number 23
Route 250
Latitude: 37-59-49.3 N
Longitude: -78-20-30.8 W

Type: Lattice 152'
Future Capacity: 1

SITE LOCATION

Site Number 24
Near State Rds. 250 & 799
Latitude: 37-59-40 N
Longitude: -78-18-05 W

Type: Monopole 125'
Future Capacity: 2

EXISTING TOWER BUILDING LAND WATERTANK
*Photo Complements of CWS

Known Inventory-4 as of September 17, 2007

SITE LOCATION

Site Number 25
Cedar Ridge Rd.
Latitude: 37-59-45 N
Longitude: -78-16-55.1 W

Type: Monopole 194'
Future Capacity: 2

SITE LOCATION

Site Number 26
1022 Zion Rd.
Latitude: 38-59-03 N
Longitude: -78-13-32.03 W

Type: Lattice 197'
Future Capacity: 1

SITE LOCATION

Site Number 27
306 Zion Rd.
Latitude: 37-58-47.3 N
Longitude: -78.13.19.7 W

Type: Monopole 194'
Future Capacity: 3

SITE LOCATION

Site Number 28
310 Rock Quarry Rd.
Latitude: 37-57-27.67 N
Longitude: -78.09.48.54 W

Type: Monopole 194'
Future Capacity: 3

SITE LOCATION

Site Number 29
488 Lands End Rd.
Latitude: 37-56-59.29 N
Longitude: -78-06-41.45 W

Type: Guy 299'
Future Capacity: 2

SITE LOCATION

Site Number 30
465 Lands End Rd.
Latitude: 37-56-54 N
Longitude: -78-06-44 W

Type: Lattice 208'
Future Capacity: 0

SITE LOCATION

Site Number 31
892 Hasher Ln.
Latitude: 37-55-25.6 N
Longitude: -78-04-46.5 W

Type: Monopole 194'
Future Capacity: 3

SITE LOCATION

Site Number 32
5893 Perrish Rd.
Latitude: 37-53-53 N
Longitude: -78-02-04 W

Type: Guy 300'
Future Capacity: 4

■EXISTING TOWER ■BUILDING ■LAND ■WATERTANK

Known Inventory-5 as of September 17, 2007

SITE LOCATION

Site Number 33
5620 Three Chop Rd.
Latitude: 37-53-22.1 N
Longitude: -78.02.18.8 W

Type: Lattice 209'
Future Capacity: 2

SITE LOCATION

Site Number 34
Off Shannon Hill Rd.
Latitude: 37-52-39.2 N
Longitude: -78.02/36.7 W

Type: Lattice 152'
Future Capacity: 2

SITE LOCATION

Site Number 35
Cabin Rd.
Latitude: 37-49-32.8 N
Longitude: -77-57-26.9 W

Type: Monopole 207'
Future Capacity: 2

SITE LOCATION

Site Number 35
4440 Old Fredericksburg Rd.
Latitude: 37-47-59.4 N
Longitude: -77-55-39.1 W

Type: Lattice 199'
Future Capacity: 2

SITE LOCATION

Site Number 37
3763 Three Chopt Rd.
Latitude: 37-48-0.39 N
Longitude: -77.55.39.04 W

Type: Lattice 199'
Future Capacity: 4

SITE LOCATION

Site Number 38
3763 Three Chopt Rd.
Latitude: 37-48-0.39 N
Longitude: -77.55.39.04 W

Type: Guy 196'
Future Capacity: 1

SITE LOCATION

Site Number 39
3707 Cross Country Rd.
Latitude: 37-48-28 N
Longitude: -77-51-51 W

Type: Lattice 370'
Future Capacity: 4

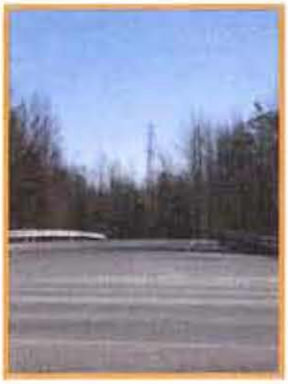
SITE LOCATION

Site Number 40
3218 Holly Grove Dr.
Latitude: 37-47-18.4 N
Longitude: -77-50-32.4 W

Type: Guy 140'
Future Capacity: 1

EXISTING TOWER BUILDING LAND WATERTANK

Known Inventory-6 as of September 17, 2007



SITE LOCATION

Site Number 41
822 Cross Country Rd.
Latitude: 37-46-37.6 N
Longitude: -77-53-06 W

Type: Lattice 210'
Future Capacity: 1

SITE LOCATION

Site Number 42
2412 Goodluck Ln.
Latitude: 37-45-0.85 N
Longitude: -77-50-44.7 W

Type: Monopole 185'
Future Capacity: 2

SITE LOCATION

Site Number 43
2425 Goodluck Ln.
Latitude: 37-45-00 N
Longitude: -77-50-45.8 W

Type: Monopole 199'
Future Capacity: 3

SITE LOCATION

Site Number 44
2501 Sandy Hook Rd.
Latitude: 37-44-15.6 N
Longitude: -77-53-27.3 W

Type: Monopole 195'
Future Capacity: 3

SITE LOCATION

Site Number 45
1601 State Route 617
Latitude: 37-43-14.23 N
Longitude: -77.46.17.31 W

Type: Lattice 187'
Future Capacity: 2

SITE LOCATION

Site Number 46
1990 Triplet Ln.
Latitude: 37-41-55.3 N
Longitude: -77-45-51.0 W

Type: Lattice 263'
Future Capacity: 4

EXISTING TOWER BUILDING LAND WATERTANK

Potential County-owned Inventory-7 as of September 17, 2007

SITE LOCATION

Site Letter A
Rt. 704
Bowlers Mill Lake
Northwest of reservoir
Tax Map Parcel #: 8-19

Potential Use: 199' Monopole

SITE LOCATION

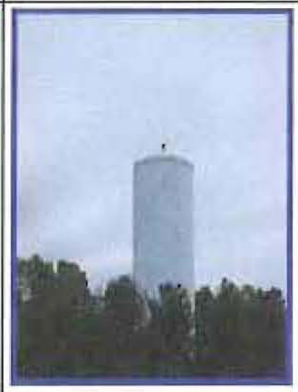
Site Letter B
Rt. 603
Bowlers Mill Lake
Southeast of reservoir
Tax Map Parcel #:

Potential Use: 300' Guy

SITE LOCATION

Site Letter C
Rt. 730
Shooting Range
West of Town of Louisa
Tax Map Parcel #: 25-30

Potential Use: 199' Monopole



SITE LOCATION

Site Letter D
Rt. 22
Industrial Air Park
Tax Map Parcel #: 41-195

Potential Use: Colocation

SITE LOCATION

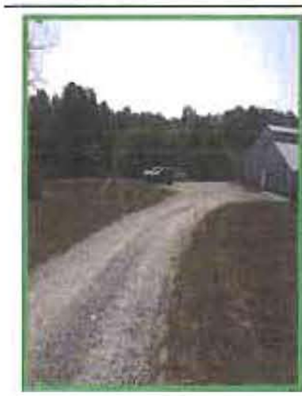
Site Letter E
Rt. 780
Water Authority
East of Louisa Town on Rt. 22
Tax Map Parcel #: 41-201

Potential Use: 199' Monopole

SITE LOCATION

Site Letter F
Rt. 700 (Mica Rd.)
Land fill Area
Southeast of Town of Mineral
Tax Map Parcel #: 59-112B

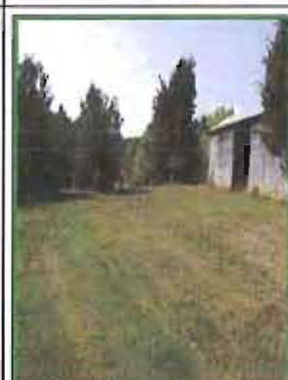
Potential Use: 199' Monopole



SITE LOCATION

Site Letter G
Rt. 700 (Mica Rd.)
Land fill Area
Southeast of Town of Mineral
Tax Map Parcel #: 59-112

Potential Use: 300' Guy



SITE LOCATION

Site Letter H
Rt. 700 (Mica Rd.)
Land fill Area
Southeast of Town of Mineral
Tax Map Parcel #: 59-112

Potential Use: 199' Monopole

EXISTING TOWER BUILDING LAND WATERTANK

Potential County-owned Inventory-8 as of September 17, 2007

SITE LOCATION

Site Letter I
Rt. 601
Park
Bumpass Area
Tax Map Parcel #: 76-14

Potential Use: 199' Monopole

SITE LOCATION

Site Letter J
Rt. 22
Vacant Land
South of Pendleton
Tax Map Parcel #: 59-11-2A

Potential Use: 199' Monopole

SITE LOCATION

Site Letter K
Vacant
Reedy Creek Subdivision
Tax Map Parcel #: 67-28A

Potential Use: 199' Monopole

SITE LOCATION

Site Letter L
Rt. 15
Zion Crossroads
Tax Map Parcel #: 61-48A

Potential Use: Colocation

SITE LOCATION

Site Letter M
Rt. 208
Old Louisa Dump
North of I-64
Tax Map Parcel: 67-5-A

Potential Use: 199' Monopole

SITE LOCATION

Site Letter N
Rt. 208
Recycling Center
South of Louisa Town
Tax Map Parcel #: 55-8-A

Potential Use: 199' Monopole

EXISTING TOWER BUILDING LAND WATERTANK