## Overview

Albemarle County is reviewing personal wireless services facilities and Zoning Ordinance text to proactively plan for future wireless infrastructure. The project includes an infrastructure assessment, creation of an inventory catalog, propagation mapping, regulatory review, and ordinance text recommendations. The work is being performed by CityScape Consultants and the Berkley Group with guidance by County staff, the Planning Commission, and the County Board of Supervisors with opportunities for input from stakeholders and citizens.

## Agenda

The June 13th meeting will focus on reviewing the infrastructure and mapping analysis with discussion of potential text amendments.
The following agenda is provided as an outline for discussion:

1. Introduction of Staff & Project – 5 minutes
2. Overview of Wireless Technology – 5 minutes
3. Review of County Personal Wireless Services – 20 minutes
    a. Wireless Infrastructure & Mapping
    b. Review of Current Policy & Regulations
4. Recommendations – 10 minutes
5. Discussion – 30 minutes
6. Next Steps – 5 minutes

## Wireless Overview

The current evolution of personal wireless technology is benchmarked by the underlying network platforms and referenced as first, second, third, fourth and fifth generations of wireless deployment (1G, 2G, 3G, 4G and 5G respectively). First and second generations provided the initial launch of personal wireless services. Third generation improved data transfer with the addition of multimedia messaging services, simple applications and games. Fourth generation substantially increased connection speeds which revolutionized wireless handsets and included new interactive services incorporating broadband technology enabled applications like global positioning services (i.e., Google Maps, Waze Navigation etc.), banking, weather, educational, public safety services, games, video and music streaming and more. This platform continues to evolve as the industry transitions into full 5G technology. The concept of 5G and beyond is to use existing bandwidth and new radio spectrum to enable more simultaneous reuse of the same channels and improve data speeds by using advanced antenna systems and other to-be-invented processes.

To achieve complete coverage throughout the County each facility must be close enough to handoff to the other. Ultimately these services are determined by the individual service providers (AT&T, Dish, T-Mobile, US Cellular and Verizon) and their business models. These are private companies, and the County does NOT control the timing or location where facilities will be proposed. As providers submit applications, appropriate locations and designs will be determined on a case-by-case basis, following the established public policies. The County, as a public entity, can work to foster a public-private partnership to provide this much needed public resource, but ultimately is not responsible for proposing, situating, designing or building new personal wireless service facilities.

## Wireless Network Coverage

There are different types of radio systems using different frequency bands. FM radio is at the lower end of the wireless spectrum in the VHF band but has the advantage of being able to overcome terrain and foliage losses better than UHF and the lower microwave bands where consumer wireless service is licensed.

Wireless service providers use licensed frequency bands to transmit and receive signals to and from users of the network. First and second generation wireless providers operated in either low band 800 megahertz (MHz) or in the high band 1800 MHz frequencies. During the evolution to 3G, service providers merged and/or purchased additional spectrum from the FCC and began operating in both low and high frequency bands. The Advance of 4G LTE (Long Term Evolution) service had evolved to providers operating in and expanded low-band range between 600 to 900 megahertz (MHz) and the mid-band (formerly referenced as high band) is now inclusive of 1700 to 2600 MHz. 5G service necessitates the need for high-band frequencies above 6,000 MHz (aka 6 gigahertz (GHz)) which provides significant increases in data capacity over the low and mid-band frequencies but at a cost of considerable signal loss when trying to penetrate through buildings and trees. As a rule of thumb, the higher the frequency, the shorter the transmitting range due to the signal having to scatter and bend around obstacles such as hills, buildings and foliage. For this reason, a number of the service providers now own spectrum in all three (low, mid, high) frequency bands

Since the advent of 1G service providers have traditionally designed wireless networks to provide wireless coverage to large areas of land within defined service areas. To accomplish this, wireless service provider's first choice of deployed infrastructure was to construct macro towers at heights for antenna to transmit cell coverage over a several mile radius around the site. These facilities require a strong structure to support large antennas with heavy copper coaxial cables connecting the antenna to the ground equipment. To maximize efficiency of the network design, the antenna must be mounted on heights above ridgelines, ambient tree heights and rooftops for optimal signal connections throughout the designated coverage areas.

With nearly all Americans owning a mobile phone, wireless communication plays a key role in keeping Americans safe during emergencies and natural disasters like hurricanes, wildfires, snow and ice storms, flooding and tornadoes. As wireless data usage continues to escalate, consumers require more speed and high data-rate transfers that often exceed existing network capability. This is what the industry refers to as network capacity. Wireless capacity is the *amount* of wireless traffic (amount of bandwidth being used simultaneously by way of voice calls, and data usage) that a service provider's network can handle at any given time within a specific location.

There are several methods to address this demand. One is by connecting radios to existing antennas, another by adding new macro wireless facilities between existing towers and base stations and a third is by deploying small wireless facilities.

Small wireless facility technology uses broadband infrastructure with smaller antennas that operate at less power than the traditional macro facilities which are mounted on shorter in height structures. Small wireless facilities have a smaller coverage footprint (~500' radius as opposed to several miles) and are typically placed between macro facility sites to be used to "fill in" areas that need greater network capacity. Small wireless facilities can be attached to buildings and rooftops and onto utility poles, traffic signals or free-standing structures in public rights-of-way. These sites are routinely deployed in areas with large concentrations of network subscribers or in and around venues and geographic areas not conducive for macro facilities.

The wireless industry is currently upgrading existing 4G equipment to evolve into the next generation 5G infrastructure. The planned 5G standard is intended for true high-speed data meaning download speeds well in excess of today's typical wireless data speeds of 10 megabits per second.

## Existing Wireless Locations

The Study Area of the analysis is defined as the County's jurisdictional boundary plus a one-mile perimeter. Included are all known antenna locations providing wireless services into the County. All existing wireless facilities have been assessed, studied, cataloged into a wireless inventory (*Attachment A*), and used as the baseline in CityScape's mapping and analysis.

From the assessment process it was discovered there are a total of 180 existing towers and base stations, three approved but not built facilities and one proposed and under review inside the County; and existing five within the 1-mile perimeter. The 189 facilities in the study area categorized as follows:

- 164 Towers, 25 Base Stations
- 147 Macro Wireless, 4 Macro/Public Safety, 3 Public Safety, 17 Broadcast, 18 Other Antenna Types, 0 Small Wireless Facilities
- 161 Private Property, 14 Public Property, 14 Utility Easement, 0 Public Right-of-Way
- 80 Non-Concealed, 109 With Concealment Elements (7 Concealed, 102 Semi-Concealed)

## Predicted Propagation Mapping

Propagation mapping is a process that illustrates predicted coverage from individual antenna sites. Illustrating the wireless network service area coverage based on propagation signal strength modeling is of value when trying to determine the gaps in wireless coverages.

Signal strength, in this exercise, is a term used to describe the level and operability of a wireless device. The stronger the signal between the elevated antenna and the cell phone the more likely the device and all the built-in features will work as expected.

A reduced signal causes unsatisfactory service, results in slow download or upload speeds and can cause dropped calls. The distance between the elevated antennas and the physical location of the person using the wireless device is one factor determining signal strength. Other factors affecting signal strength are any natural or man-made obstructions such as location of buildings, type of building materials and vegetation that comes between the antenna and devices.

Predicted propagation coverage maps were created utilizing the existing personal wireless facilities to identify wireless coverage gaps throughout the County. Not all providers are on all facilities and no single service provider has coverage county-wide.

## Findings

### TERRAIN AND VEGETATION

Heavily wooded regions with mature tree canopies along with hillsides in areas of the County create terrain and foliage obstacles.

## LOCATION AND HEIGHT

The definition of a treetop facility and the development standard for a new monopole limits the height of new tower to being no more than 10' higher than the tallest tree within a 25-foot radius of the proposed tower. Since leaves, trees and land mass absorb and scatter wireless signals these natural features in the landscape are creating signal loss and limiting the coverage area from the elevated antenna.

The majority of existing infrastructure is along major corridors, which provides coverages to those highways and roadways and to the properties parallel those passageways. Many of these towers are setback over 200' from the roadway which reduces the visibility of the antenna from the corridors but also reduces the distance the signal transmits along these roadways necessitating more facilities closer together to provide continuous coverages.

## POPULATION DENSITY

Wireless service providers want to deploy as close to their subscriber base as possible which is why major highways and thoroughfares and higher population density areas are ideal locations for infrastructure. The majority of Albemarle County is rural residential with population density less than 350 people per square mile. The wireless deployment pattern throughout the County is currently within the higher density census blocks and along major transportation corridors servicing the greatest number of people which makes those sites the most economical. The propagation pattern from treetop facilities significantly reduces the coverage areas and is problematic because more treetop facilities are needed to cover the lower population areas. Large numbers of treetop facilities in those areas do not fit the economic business model of the wireless industry.

## ANTENNAS AND ASSOCIATED EQUIPMENT DEVELOPMENT REQUIREMENTS

Most providers own spectrum in low, mid and high band frequencies and deploy multiple antennas to accommodate the bands. Each provider typically needs a minimum of six antennas per site. Treetop facilities are limited to three antenna per array resulting in mostly single tenant poles because 1) the development standard limits the array to three antenna therefore providers need to use two different mounting elevations for the required six antennas; or 2) providers are using one array for antennas and the second array for radios.

The dimensions for a monopole are limited to a maximum of 30" at the bottom and 18" at the top requiring a tapered pole. The tapered top has less steel at the top and limits the weight and wind loads of the structure. Each frequency band requires a minimum of one cable; often two to each antenna. More cables are required as providers expand operation into low, mid, and high bands but the number of lines are limited because the allowable interior space diminishes towards the top of the monopole limiting the number of lines that can physically fit inside.

The size of each antenna is limited to 1,400 square inches and the back of the antenna cannot extend more than 18" out from the structure on which it is mounting. New 5G antennas are larger and one commonly used antenna is 1,420 square inches. Also, some of the new 5G antennas require the radio to be attached to the back (if not integrated into the antenna), thereby occupying an even larger space. The antennas with the integrated radio units will likely exceed the 18" standard from the pole.

## AVOIDANCE AREAS

Albemarle County's total land area is 725.979 square miles. Wireless facilities are discouraged from being installed in the following Avoidance Areas: Agricultural Forestral Districts; Historic Districts; Mountain Protection Areas; and within 200 feet of Scenic Highways and Bi-ways. The Avoidance Areas collectively cover 48.38 percent of the County as follows:

- Agricultural Forest Districts 100.039 Sq. Mi. (13.77%)
- Historic Districts: 216.125 Sq. Mi. (29.77%)
- Mountain Protection Areas: 130.094 Sq. Mi. (17.91%)
- Scenic Byways
- Total Avoidance Area: 351/251 Sq. Mi. (48.38%)

Of the 140 personal wireless service facilities (PWSFs) in the County's jurisdiction, 65 PWSFs (46.43%) are located within at least one Avoidance Areas as listed below:

- 3 in Agricultural Forest Districts
- 2 in Agricultural Forest and Historic Districts:
- 17 in Historic Districts
- 21 in Historic Districts and Mountain Protection Areas
- 22 in Mountain Protection Areas

## Recommendations to Improve Coverage

If the County seeks to improve wireless coverage under the existing development policies, then CityScape estimates it will take a minimum of 125 tree top poles per provider to cover most of the County, equating to approximately 625 total poles needed collectively for all providers. The network design for that many poles will be difficult to build out due to the number of properties needed throughout the County as well as it makes for an exorbitant economic model for that many new poles. This type of build will surpass what the industry can budget resulting in less infrastructure for lower density rural areas.

### EXISTING SITES

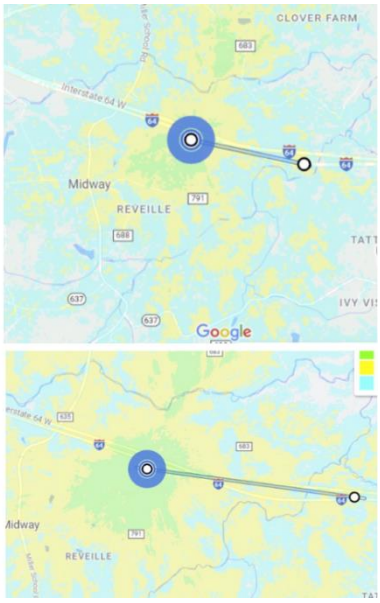
To maximize efficiency from existing towers CityScape suggests the possibility of allowing tower heights to increase from 10' to 30' above the tallest treetop (within 25' of the tower) and to allow standoff mounts for antennas and radios. The image below illustrates how this increase in height can increase coverage distance along a roadway by over 40% and the overall coverage area around the tower by 90%.


Increasing Height Scenario

Upper Right:
A59 at 100' (its current height) and achieved 0.9 miles of usable in-car coverage

Lower Right:
A59 at 130' and improved the coverage to over 1.3 miles from the site

Results:
An increase in coverage distance of over 40% and an increase in coverage area of over 90%.



### FUTURE SITES

To improve network functionality from future sites, CityScape suggests consideration of the following:

- Allow new towers to be constructed 30' above treetops to promote greater coverage and to allow for collocations
- Not require new towers to be screened by treetops
- Modify Sections 5.1.40.
    - b.2.(a) (b) & (c) "Antennas and Associated Equipment"
        - Number of Antenna
        - Size of Antenna
        - Antenna Projections
    - b.9 "Diameter of Monopole"
    - b.10 "Height of Monopole"
    - Design All New Public Safety Sites for PWSF collocations
    - Allow towers in Avoidance Areas in Tier II that are not Federal lands
    - Allow towers and base stations outside of treetop areas
    - Allow completely concealed towers that meet prescribed design standards as Tier II regardless of height relative to treetops.

### QUESTIONS FOR PLANNING COMMISSION CONSIDERATION AND DISCUSSION

- Does the County desire to improve network coverage and capacity? If yes, then:

    1. Do you agree that Historic Districts, or Ag Forest Districts or Mountain Protection Areas should be eliminated as avoidance areas to expand the areas where Tier II applications may be made?
    2. Do you agree that the standards for number of arrays, antenna size and standoff should be increased?
    3. Do you agree that the dimensions for width of towers should be increased?
    4. Do you agree that the Tier II standard should be increased from 10 feet to some other height (20-30 feet) above the reference tree?
    5. Do you agree that the distance from the reference tree should be increased?
    6. Do you agree that a tower meeting concealment standard (for example designed as a tree) should be allowed as a Tier II tower regardless of distance to a reference tree.

## Next Steps

Cityscape and the Berkley Group will draft text amendments as directed through discussion. An open house will be scheduled to present findings and text recommendations.