Powhatan County
Broadband Needs Assessment

Demographic analysis, bandwidth projections, and demand aggregation

Funded by the Virginia Department of Housing and Community Development and Powhatan County

Prepared for
Powhatan County, VA

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Overview

Introduction

Over the next thirty years, the businesses, residents, and institutions of Powhatan County will spend about $562 million for telecommunications services--in today's dollars, unadjusted for inflation and unadjusted for price increases. Some analysts believe that the average household bill for services delivered via broadband may double in the next ten years, which would make the thirty year projection easily reach one billion. Currently, virtually all of these funds leave the county without producing any jobs or business opportunities.

In a talk at a broadband conference in April (2008), FCC Commissioner Deborah Tate indicated that demand for bandwidth is doubling every two years, and that the FCC expects that the typical bandwidth needed by businesses and residents in 2015 (just four years) will exceed 50 megabits. Projections in Powhatan (data from Mediamark Research Inc.) estimate that 42% of workers in the county have Internet access at work.

Approximately 77% residents have Internet access at home, better than the national average (68%). About 87% of residents have any Internet access (including work and home). Only about 59% of Powhatan residents have any type of broadband connection. Some areas of Powhatan still have dial up as their only option, and DSL and wireless services cannot be upgraded affordably to support the FCC's expected bandwidth demands. About 15% of residents are still using dial-up to access the Internet.

Powhatan County's community and economic future is dependent upon the availability of affordable high speed broadband services--at the bandwidths that will be needed to conduct business in the future ("big" broadband), not at today's "little" broadband speeds. Businesses large and small are already heavy users of the Internet, and their bandwidth needs will increase dramatically as two business trends accelerate:

- Business travel costs are increasing rapidly as the cost of fossil fuel increases. Both the cost of ordinary commuting to the workplace is increasing as well as the cost of out of town business travel by air. Businesses are already investing heavily in HD quality business videoconferencing systems, and will make more use of them to reduce travel costs. These HD quality business videoconferencing systems require dramatic increases in bandwidth that are not affordable or in most cases even available in Powhatan today.
- More and more workers and business people are working from home, either on a part time or a full time basis. New work from home job opportunities are growing rapidly, but most of those jobs require a wired Internet and a wired phone connection to qualify. Many corporate and business employees will be seeking permission to work more from home (e.g. one or two days per week) to reduce travel costs. Some major

businesses in other parts of the U.S. are already actively planning to have 20% of their workforce work full time from home to reduce employee travel costs and office energy costs. Corporate employees working from home require high bandwidth services to be connected to the office network and to use corporate videoconferencing systems. These corporate network services will require 35-50 megabit connections within five years.

Powhatan County can take advantage of recently emerging business and residential growth in Virginia and in the Richmond area, but only if it has the right telecommunications infrastructure to support the needs of existing businesses and to attract new businesses. A vision for Powhatan's telecommunications infrastructure would include the goals below.

Vision for the Project

By 2015, every business in Powhatan County should have affordable access to high performance broadband infrastructure with as much bandwidth as needed to successfully compete with any other business located anywhere in global economy.

By 2016, every home in Powhatan should have affordable access to high performance broadband infrastructure with as much bandwidth as they need to manage their personal affairs, obtain access to world class tele-health and tele-medicine services, keep their homes safe, and have the same level and quality of access online goods and services as any other community anywhere in the world.

By 2013, Powhatan is attracting new businesses to the county and creating new jobs because the high performance, affordable broadband infrastructure lowers the cost of doing business.

By 2015, Powhatan County has a workforce that has the skills needed by high tech businesses. Workers are able to study and train from home using the advanced broadband infrastructure to attend classes, and many workers in the region work full time from home, using the regional broadband infrastructure to be connected to their corporate business systems.

Community investments in broadband infrastructure, with private sector service providers selling services like Internet, telephone, and TV service can have a beneficial effect on job creation and economic development. A high performance "digital road system" has the potential to keep investments modest, and this "digital road system" can be managed without unnecessarily burdensome maintenance requirements.

An open access business model keeps the County out of the business of selling telecom services, and the community-owned infrastructure would be leased to existing and new service providers, who in turn could use the modern infrastructure to deliver new and enhanced telecom and broadband services to businesses and residents.

By using this approach, the service providers interested in offering next generation broadband to businesses and residents will have a lower cost of doing business in the community. The County government will not and should not sell services. Instead, Powhatan will build a digital road system and make that digital road available to the private sector, just as governments today build roads and let the private sector use those roads to sell goods and services. There will be NO competition between government and the private sector, because local governments will not sell any services to the public.

The current broadband business model is broken

The current business model for selling broadband is an anachronism that evolved in the early nineties with the introduction of dial up Internet access. At that time, there was little more than email and a few text-based Web pages available on the Internet, and selling bandwidth "by the bucket" worked fine. For something like $20/month, subscribers got a "bucket of bandwidth" that was defined by some upper limit on that bandwidth, like 14,400 bits/second or 56,000 bits/second.

As the Web evolved to include video and audio, and as new services like telephone over the Internet (Voice over IP, or VoIP) became available, more bandwidth was needed to support these uses. Broadband was and still is sold by the "bucket," but the bucket is now larger, with the DSL bucket typically advertised as something like 1/2 megabit/second, and cable modem service typically promoted as 1-3 megabits/second. We are still buying bandwidth by the bucket.

This business model is fundamentally broken. There is no way to fix it. The broadband business model of selling bandwidth by the bucket is means ***providers make the most money if their customers do not use the service at all***. They make the least amount of money if customers like the service and use a lot of it. This approach is upside down from most other businesses. It leads to odd behavior by the service providers that causes them to punish or even disconnect customers that use too much of the service.

From an economic development perspective, this is disastrous. Local businesses should not be punished for using too much of an essential business service. An apt analogy would be if the Department of Transportation told a businesses that the tractor trailers they were using were "too big" and henceforth all deliveries had to be made by pick up truck. We know intuitively that this would make the business uncompetitive with businesses in other regions that had roads that supported tractor trailers.

The least desirable course of action is to make direct or indirect investments to support privately owned copper-based or low performance telecom infrastructure. As one example of what not to do, in other states, regional authorities and state governments have made direct cash payments to incumbent telecom providers to extend copper-based and wireless broadband services. This has two negative effects:

- By doing this, elected officials are picking winners and losers in the marketplace. The private firm that gets the cash payment "wins," and all

other companies "lose." It is poor policy for government officials to make such selections, and presumes that a handful of government officials can accurately predict that a single firm is likely to be able to provide all the business and residential telecom needs over a period of several years. The past twenty years of telecom deregulation and divestiture provide numerous examples of how difficult this is to do.

- Investing in the continued use of copper-based broadband infrastructure or only low performance wireless puts Powhatan County's businesses at a competitive disadvantage in the world economy. Copper infrastructure is slow, and many low cost wireless systems lack appropriate security and bandwidth for business use. Competitors in many other countries already have low cost access to high capacity fiber systems ($40-$50/month for 100 megabit fiber is common).

Investment Characteristics

Just as communities had to take on the task of building and maintaining roads in the early twentieth century, communities must now provide digital road systems as a matter of community and business survival. These digital road systems must be designed with certain characteristics:

Future oriented

Current usage patterns are not a good predictor of future broadband needs. Community-wide networks must be designed to scale gracefully to support future uses over the next thirty years.

Invest in systems that will meet future needs, not current demand.

Fiscally conservative

Vendor and system selection should be deferred until a community or region has conducted a thorough financial engineering exercise that predicts as accurately as possible system design and construction costs, sources and cost of funding, operational expenses, prices of services, and income and cash flow.

Identify a financially sustainable business model and an appropriate legal entity before picking systems or selecting vendors.

Fiber and wireless are both important

Both fiber and wireless infrastructure are needed to meet all business and residential needs. Fiber is needed to support the business and job applications that are already driving economic development in other communities. Wireless services are needed to provide the mobile access to services like the Web and voice telephony. Wireless fixed access can also be an important "bridge" technology in rural areas where it is important to move homes and businesses from dial-up and "little" broadband quickly.

Plan for and support both fiber and wireless networks.

Open access multi-services model

Community digital road systems should be managed in the same way physical road systems are managed. Community broadband investments should be available to any qualified private sector service provider, including incumbent providers, to deliver goods and services to customers. Companies that use the community-owned infrastructure will pay a fee to the network owner/operator (the community) in return for access to a high performance system connected to households and businesses.

Invest in open access networks to keep operational costs low and to maximize competition and choice.

Economic development focus

While technology design issues obviously have to be addressed appropriately, it is business needs that have to drive the design of these systems. Both the needs of businesses that will offer services and the businesses that will use those services to sell into the global market place have to be calculated carefully.

Investments should support long term economic development goals and objectives.

Economic Impact Analysis

Broadband is not a silver bullet for communities. Broadband investments need to be tied to a wider set of community and economic development strategies that help make communities engaging and interesting places to locate and run a business, and to make communities a vibrant and safe place to live. Communities that have made broadband investments without taking the time to identify a broader set of goals and expected outcomes have usually been disappointed when broadband investments have not had much of an impact.

Powhatan County should embark on a strategy to make regular investments in broadband infrastructure coupled with other key community and economic development projects. Key goals of such an effort would have the following set of characteristics.

- ***A long range plan to extend duct and dark fiber*** to most homes and businesses over a period of three to five years.
- Plan to install duct in alleys as they are renovated and improved.
- Install fiber and duct in the business areas of Powhatan to increase the attractiveness and value of those areas.
- Provide fiber to buildings in the town center, especially buildings with office space, which could draw more businesses and entrepreneurs.

The financial analysis below demonstrates 30 year expenditures for routine and normal telecom services for businesses, residents, schools, and institutions for Powhatan County. Over the next three decades, about $562 million dollars will be spent on telecom services. This is a very conservative estimate that does not take into account the ever expanding demand for new kinds of services. The model looks only at current demand. A community investment in a community-owned and managed digital road sys-

tem, where all services are provided by the private sector, would have substantial benefits.

Powhatan 30 Year Telecom Expenditure Analysis			
	Households still on dial-up	Households with "little" broadband cable modem/DSL	Households with no Internet
Total households	9,875		
Total businesses	767		
Percentage of households	15%	59%	26%
Number of households	1,481	5,826	2,568
Average monthly telecom expenditures	Local phone: $25 Long distance: $25 Cable/satellite TV: $55 Dial up Internet: $20	Local phone: $25 Long distance: $25 Cable/satellite TV: $65 Broadband Internet: $40	Local phone: $25 Long distance: $25 Cable/satellite TV: $55
Annual telecom cost/ household	$1,500	$1,860	$1,260
30 year telecom expenditure	$66,656,250	$325,104,750	$97,051,500
Total residential expenditures	$488,812,500		
Total telecom expenditures[1]	**$562,134,375**		

[1] Business, schools, institutions, and government costs estimated conservatively at 15% of residential expenditures
Source: Mediamark Research, Inc.

Community investments in infrastructure will accelerate the availability of broadband options within the community, especially in the business and retail sector. It is important to note that Powhatan would not sell services to the public and would not compete with private sector firms. Instead, private sector firms, including existing telecom providers, would use the new infrastructure to compete with each other. Service providers using the network would pay a small portion of revenue to the network for the use of the infrastructure.

Needs Assessment

What is Broadband?

There is much confusion about the "true" definition of broadband. From the perspective of economic development, there can be no upper limit on the definition of broadband. Saying that broadband (as an example) is 5 megabits/second of bandwidth or 10 megabits/second is to immediately tell businesses in the region that there will be structural limits on their ability to do business in the future–it is dictating the size of truck that can be used to deliver goods and services. Here is the only appropriate definition of broadband:

Broadband is whatever amount of bandwidth is needed to support a business' ability to compete in the global economy.

Broadband is a community and economic development issue, not a technology issue. The essential question is not, "What system should we buy?" or "Is wireless better or cheaper than fiber?" Instead, the question is:

"What do our businesses and residents need to be able to compete globally over the next thirty years?"

If Powhatan is to make investments in broadband and telecommunications infrastructure, it is absolutely critical that those investments are able to scale gracefully to meet business and economic development needs for decades. This drives the solution towards an integrated fiber and wireless system, rather than a wireless only service orientation. Wireless is able to provide basic Internet access needs, but is not able to support advanced video and multimedia services. Some off the shelf business videoconferencing systems in use today require a minimum of 50 megabits of bandwidth--far beyond the capabilities of any wireless system. Two key concepts that should drive community investments in telecom are:

"Broadband" is not the Internet

Bandwidth is not a fixed number

Broadband and "the Internet" are often used interchangeably, but this has led to much confusion. Broadband refers to a delivery system, while "the Internet" is just one of many services that can be carried on a broadband network. The challenge for communities is to ensure that businesses and homes have a broadband network with sufficient bandwidth to deliver all the services that will be needed and expected within the next three to four years, including but not limited to "the Internet."

Bandwidth needs for the past decade have been growing by 25% to 50% per year, and show no sign of slowing. As computers and associated hardware (e.g. video cameras, audio equipment, VoIP phones) become more powerful and less expensive, new applications and services are continually emerging that drive demand for more bandwidth. The

table below indicates the likely growth in bandwidth, based on current uses, emerging high end equipment, and research lab/university/government networks already deployed and in use. Lightpaths refer to placing multiple wavelengths (paths) of light on a single fiber. High end commercial equipment already in production is routinely placing 20+ lightpaths on a single fiber, with each lightpath capable of carrying data at gigabit speeds. This technology will move down to ordinary business and residential network equipment over the next ten to fifteen years. Current fiber being installed will require only a relatively inexpensive equipment upgrade to increase carrying capacity over the same fibers.

From a report by the Information Technology and Innovation Foundation (March, 2009), listed below are the bandwidth requirements for services already commonly in use and for emerging services like telepresence business videoconferencing.

Application/Service	Upstream Bandwidth Requirement	Downstream Bandwidth Requirement
Medium resolution videoconferencing	1.2 megabits	1.2 megabits
Streaming video (720p)		1.2 megabits
Standard definition TV		4 megabits
Basic HD videoconferencing (720p)	1.2 to 4 megabits	1.2 to 4 megabits
Telepresence high resolution HD videoconferencing	5 megabits	5 megabits
Video home security service	10 megabits	
HD digital television (1080p)		15 megabits
Telepresence very high resolution HD videoconferencing (1080p)	15 megabits	15 megabits

Note that the business videoconferencing services all require symmetric bandwidth. This is a critically important issue, as current incumbent “little broadband” services like DSL and cable modem systems do not offer symmetric bandwidth (where the upstream and downstream bandwidth is equal). Using this information we can project what Powhatan County homes and businesses will need in the coming years.

	Next 2-4 years	Next decade	Twenty years
Small business needs (1-9 employees)	10-25 megabits of symmetric bandwidth and 5-10 megabits of Internet access	100 megabits of symmetric bandwidth and 20-40 megabits of Internet access	Gigabit+ symmetric bandwidth and 50 to 100 megabits of Internet access

	Next 2-4 years	Next decade	Twenty years
Medium-sized business needs (10-100 employees)	50-100 megabits of symmetric bandwidth and 10-20 megabits of Internet access	Gigabit symmetric bandwidth and 50 to 100 megabits of Internet access	Multiple gigabit symmetric circuits and lightpaths and 100+ megabits of Internet access
Large business needs (100-1000+ employees)	Gigabit+ symmetric bandwidth and 100+ megabits of Internet access	Multiple gigabit symmetric connections and 250 to 500 megabits of Internet access	Multiple gigabit symmetric circuits and lightpaths and 1 Gigabit+ of Internet access
Residential needs	25-50 megabits of symmetric bandwidth and 4-8 megabits of Internet access	100 megabits of symmetric bandwidth and 20-30 megabits of Internet access	A Gigabit symmetric circuit and/or lightpaths, with 50 to 100 megabits of Internet access

Use Trends and Service Needs Analysis

Mark Peterson, a Professor of Community and Economic Development at the University of Arkansas who studies the impact of broadband access and affordability on rural communities, wrote recently, "Broadband connectivity is not the infrastructure of the future, it is the infrastructure of the present." Powhatan County faces a challenge in economic development infrastructure with primarily "little broadband" (i.e. DSL, wireless, and cable services) when many communities, regions, and countries have already made the decision to focus resources on the development of "big broadband," which is typically fiber with a minimum capacity of 100 megabits or Gigabit to the premises.

- A third of IBM employees work from home at least part time, and the company has reported annual savings of $110 million.
- Australia's government is converting the entire telecommunications infrastructure for the country to an open access system by buying a major portion of Telstra assets. Telstra, which is currently the country's primary incumbent telecom provider, will become a service provider on the new open network.
- Fiber to the premise attracts home buyers, who are willing to pay $2000 to $4600 more for a house with fiber service.
- Fiber to the home users say they are able to work from home more often, averaging 7.3 workdays per month, reducing their carbon footprint and decreasing wear and tear (and maintenance) on roads.
- More than 13% of homes in the U.S. had been passed by fiber by mid 2009.
- Nationally, less than 10% of homes have no access to any kind of broadband service, but in the region, more than 16% of homes still have no broadband access, or 50% higher than the national average.

In its March, 2009 report, the ITIF (Information Technology & Innovation Foundation) listed some of the next generation services and applications enabled by high performance, affordable broadband. The table on the next page lists these and other services that all represent broadband-enabled applications and services that must be available in Powhatan County if the region is to remain economically viable.

Residential and Business	Videoconferencing
	IP TV (Internet Protocol TV)
	HD streaming video
	Ultra hi-def (BluRay) video streaming
	Video on demand (e.g. Netflix)
	Place-shifted video
	Cloud computing services
	Online and cloud-based gaming
	Smart homes, buildings, and appliances, including smart electric meters, AMR (automated meter reading), and AMI (advanced metering infrastructure)
	Remote computer aided design (CAD)
	Work from home jobs
	Business from home
	3D graphic rendering and CGI server farms
	Remote network management and managed services
	Virtual collaboration spaces (e.g. enhanced GoToMeeting, Webex style services)
Public Safety	Intelligent transportation applications (smart road systems)
	Public safety and first responder networks
	Emergency dispatch and coordination
	Webcast agency meetings (e.g. virtual meetings)
	Online training for first responders, fire, and rescue
Society	Broadcast of local sports events
	Videoconferencing of community and town hall meetings for wider participation
	Wider availability of nonprofit and community organization services
Health Care	Teleconsultations
	Telepathology
	Telesurgery
	Remote patient monitoring
	Remote diagnosis
	Remote medical imaging
	Grid computing for medical research
Education and Research	Distance education
	Virtual classrooms
	Remote instrumentation
	Multi-campus collaboration
	Digital content repositories and distribution (digital libraries)
	Data visualization
	Virtual laboratories
	Grid computing for academic research

When analyzing future service needs, it is important to take into account ALL services that may be delivered over a broadband connection. As we noted in the previous section, "broadband" is not a service--it is a delivery medium. If we think about broadband using a roads analogy, broadband is the road, not the trucks that use the road. Internet access is a service delivered by a broadband road system, and that Internet service is just one of many services that are in demand. Today, congestion on broadband networks is not due just to increased use of email and Web surfing, but many other services.

FCC Commissioner Deborah Tate spoke in April, 2008 at the Broadband Properties conference in Dallas, Texas. Commissioner Tate noted that:

- Demand for bandwidth has been doubling every two years for the last ten years.
- By 2015 (just four years from now), the FCC thinks bandwidth requirements will be fifty times (50x) what they are today (current average bandwidth to homes and businesses is 1-2 megabits). In Japan, where they have had 100 megabit connections to homes and businesses available for several years, they are already observing congestion--meaning 100 megabit pipes are already filling up.
- Americans are watching more than 10 billion videos per month over the Internet. The table and chart below illustrate the growth in average bandwidth to the home over the past fourteen years.

The FCC's prediction of a 50x increase in bandwidth needs in just five years indicates that DSL and cable modem services will be adequate, especially for businesses, but also for home uses of telecom services.

- This means that current DSL, wireless, and cable modem services are completely inadequate for future needs. Current DSL offerings are in the range of 384 kilobits to 768 kilobits for most residential users, 768 kilobits to 1.5 megabits for business DSL users, and there are severe distance limitations on DSL. Higher bandwidth (2-5 megabits) is possible, but as the DSL bandwidth goes up, the distance it can be delivered goes down.
- Current wireless offerings are in the range of 1/2 megabit to 1 megabit, and future WiMax services will only be able to deliver 2-4 megabits. Some wireless providers are rolling out 10-15 megabit services, but wireless does not scale up well with respect to cost. As bandwidth increases, the cost of the equipment also increases, and even a 15 megabit service is well short of the FCC projections of the need for 50 megabits of bandwidth in the near term. Wireless performance and capacity is heavily dependent upon backhaul (the local connection to the provider's core network); if this connection is also wireless, the bandwidth available at the access point is shared among all users, even if the rated capacity of an individual connection is 15 megabits. In other words, if the

backhaul capacity is 100 megabits, and twenty local users are sharing that capacity, actual bandwidth available to any single user may be much lower than 15 megabits. If all the users are trying to watch video at the same time (not uncommon in early evening), performance can suffer drastically.

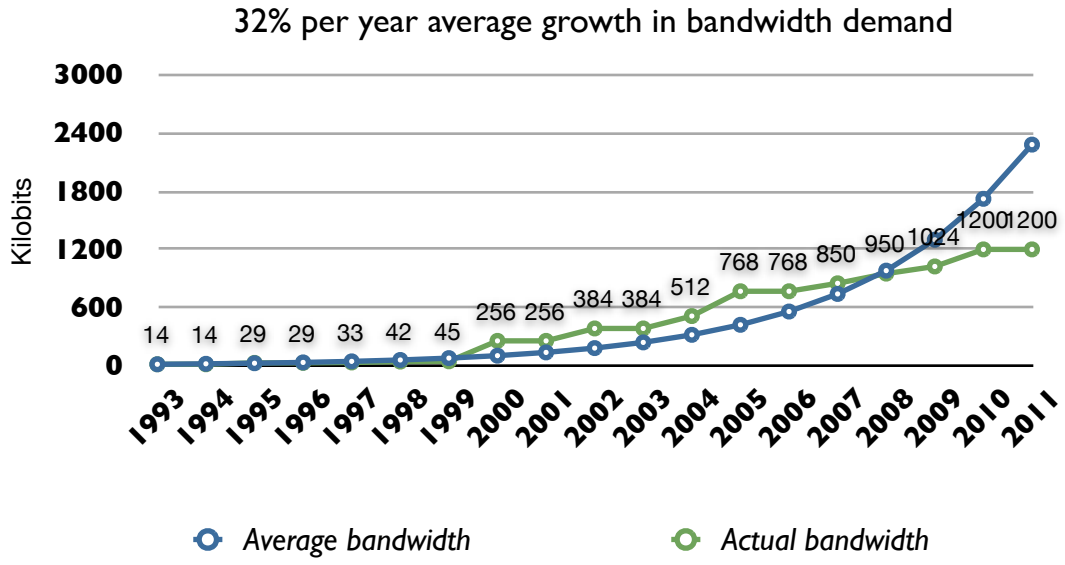
- Current average bandwidth for cable modem services is typically 1 to 2 megabits. It is important to note that cable providers make heavy use of the phrase "up to" in their advertising, and it is not unusual to see ads promoting cable modem speeds of "up to 6 megabits." However, that amount of bandwidth is shared among many users (often 200 or more) in a neighborhood, which results in much lower average speeds, and during peak use times in residential areas, the actual bandwidth available to a single household may be less than one megabit.

The challenge for Powhatan's leaders is to ensure that the County has a telecommunications infrastructure in place that will be able to handle the 50x bandwidth increase projected by the FCC (which is based on many years of real world data).

At the same conference, a talk by a DirecTV official provided additional insight into residential bandwidth needs. The DirecTV speaker noted that one of their biggest complaints is that the company does not have enough HD format programming. He went on to note that a single channel of "standard" HD content uses 10 megabits of bandwidth when delivered via IP-TV, and a live event like a race or sporting event (e.g. football) requires 15 megabits of bandwidth. The firm is already delivering video programming to end users using Internet-based IP-TV formats, and noted that many buildings and homes do not have the internal cabling to support the IP-TV bandwidth needs. He also indicated that their early IP-TV users cannot tell the difference between IP-TV delivery of video and traditional cable/satellite delivery.

In 1993, the year that the Blacksburg Electronic Village began offering the first residential Internet access in the world, the average connection speed was 14,400 bits per second. At the end of 2007, the average bandwidth to the home is fifty times that for DSL service (768,000 bits per second), and over 70 times that for the typical cable modem connection (about 1,000,000 bits per second). DSL speeds have flattened out (the green line on the chart) because DSL capacity has flattened out, not because demand has diminished. The blue line (average bandwidth) has been increasing steadily year by year.

Year	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Average bandwidth	14	19	25	33	44	59	78	103	137	181	240	318	422	559	740	981	1300	1722	2282
Actual bandwidth	14	14	29	29	33	42	45	256	256	384	384	512	768	768	850	950	1024	1200	1500



Service Bandwidth Needs for the Next Five Years

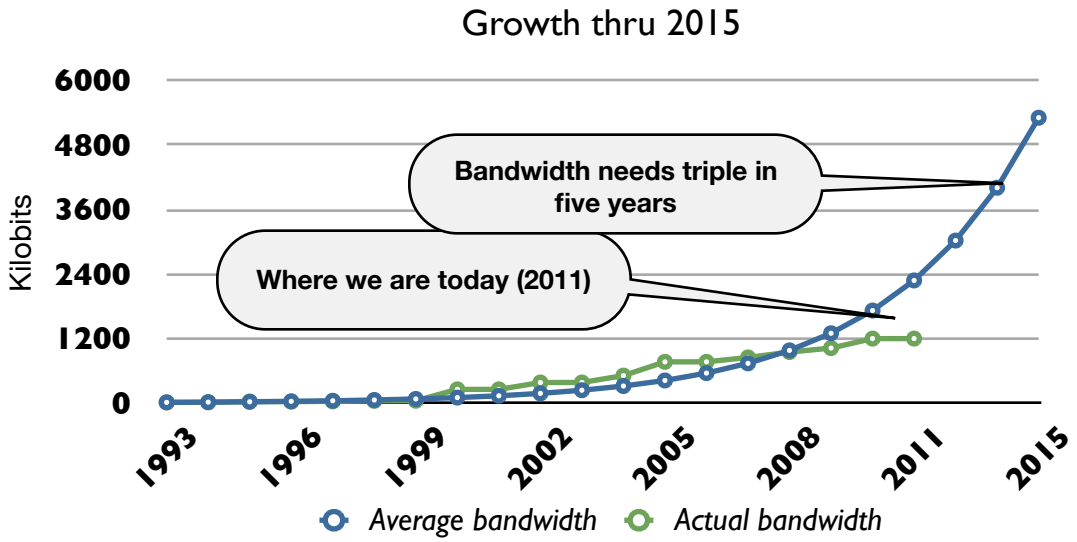
The table and chart below extends the average bandwidth trend out an additional five years. Using the same growth rate that has been documented for the past fourteen years, it is easy to see that DSL does not have the capacity to meet anticipated needs. In fact, in the next five years, bandwidth demand will triple if historical growth rates are maintained--and the average annual growth has been 32% per year since 1993. There is no reason to believe that this will change in the short term. The growth of video-oriented content like YouTube and many other video content services, including emerging movies on demand, will likely push bandwidth demands even higher than the historical growth rate.

As noted above, over the past fourteen years, average yearly growth has been 32%. The future projections for service needs later in this section are designed on an average annual growth of just 5%. ***The lower rate used for projections in this report provides a very conservative estimate of future need.*** The lower rate is also used because eventually, bandwidth needs to businesses and homes will flatten out as service demands mature and the infrastructure catches up. Skeptics who may suggest that no more bandwidth is needed than what is currently available may wish to study these charts carefully.

The business demand aggregation studies on the following pages illustrate why a wireless only strategy for broadband is likely not only to fail strictly from a capacity perspective, but could also be dangerous from an economic development perspective. The amount of bandwidth that will be needed in Powhatan in five years just to support the business community cannot be provided by wireless alone. A combined telecommunications infrastructure that is able to provide fiber connections to most businesses will be

important to retain existing businesses and to help attract new businesses to the community.

Year	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2014	2015
Average bandwidth	14	19	25	33	44	59	78	103	137	181	240	318	422	559	740	981	1300	1722	2282	3023	4006	5308
Actual bandwidth	14	14	29	29	33	42	45	256	256	384	384	512	768	768	850	950	1024	1200	1200			



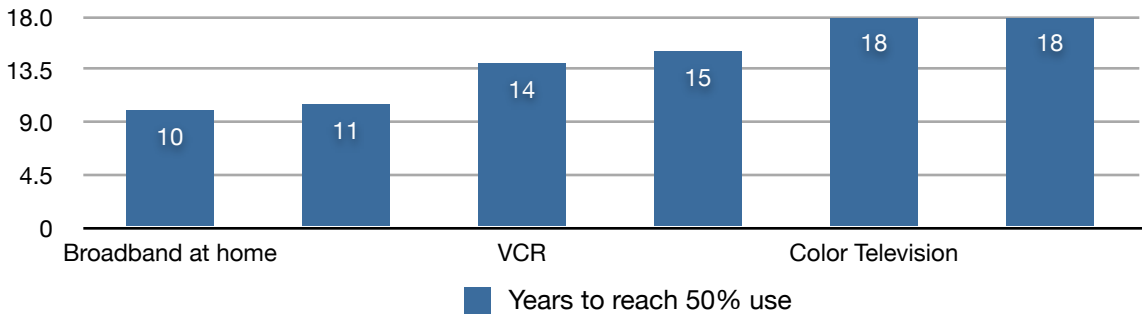
Broadband at Home Penetration Rate

The table and graph below illustrates the rapid pace of adoption of the Internet and the demand for broadband. While it took eighteen years to reach the point where half of American households had technology like a color TV or a personal computer, the time required to reach that point for broadband access to the Internet was almost half that, or about 80% less time.

Another way to think about broadband is that it has been more popular than color television.

Adoption Time	Years to reach 50% use
Broadband at home	10
CD player	10.5
VCR	14
Cell phone	15
Color Television	18
Personal computer	18

Source: Pew/Internet Measuring Broadband Report, 2007



Service and Gap Analysis

We are slowly making the first steps toward media-rich communities. In these communities, residents will have, literally, a world of information at their fingertips. Residents of media–rich communities will be able to access virtually any movie ever made with a few mouse clicks. They will be able to choose from a rich variety of music, search the Web, and access massive archives of multimedia video and audio programming. The characteristics of media-rich communities of the future includes:

- Abundant, inexpensive bandwidth locally
- Massive connection to the rest of the world
- Community information utility vested in the community
- A knowledgeable and engaged citizenry
- Rich local content from a multitude of sources
- A wide variety of information devices, including video monitors, distributed audio systems, converged media centers (computers), PDAs, wireless handheld phones, and tablet computing devices.

These media–rich communities will be attractive to an emerging new group of businesspeople and entrepreneurs that typically are well-educated, own their own businesses, and are making choices about where they lived based on family needs and interests, rather than business interests. This new breed of entrepreneurs place a high value on the kinds of amenities that contribute to a good quality of life–traditional neighborhoods, vibrant downtown areas, a wide range of cultural and recreation opportunities, walkable destinations for personal and business needs, good schools, and a sense of place.

These businesspeople and their families make relocation decisions based on quality of life only where there is abundant and affordable broadband, because broadband is the enabler of these new Knowledge Economy businesses. Many of these micro-enterprises are located in homes, and so neighborhoods are now business districts. Broadband is reshaping our communities in positive ways–less commuting, less need for high capacity transportation systems, more focus on community and civic life, and more emphasis on personal relationships.

The telecommunications business has already begun to move from a Manufacturing Economy model of dedicated, privately owned networks carrying one or just two or three services (e.g. voice, video, and Internet) to a Knowledge Economy model that is based on a single, shared infrastructure that can offer a wide variety of services from many different providers. These emerging services need much more bandwidth than is currently available on copper-based systems.

Business Bandwidth Needs

The next table shows bandwidth consumption for several types of businesses and a projection of the bandwidth needed 5 and 10 years out. The cost of fuel is already affecting business travel decisions, and more and more businesses will invest in HD quality business videoconference systems to reduce the need for travel. These HD systems require substantial bandwidth; a two way HD video conference requires 20-25 megabits during the conference, and a three way conference requires 30-35 megabits during the conference. As more workers try to reduce the cost of driving to and from work by working part or full time from home, the business location must provide network access (Virtual Private Network, or VPN) to the employees working from home. These home-based workers will make extensive use of videoconferencing to attend routine office meetings remotely and to enhance communications with co-workers, including videoconferences with other home-based workers in the company. A VPN network providing remote access to just two or three home-based employees could require 50 megabits of bandwidth during normal work hours.

	Large Business		Small Business		Home Based Worker		Business From Home	
Description	A larger business with about 50 workstations.		A small business with 10 to 15 employees, and 7-10 workstations.		A single employee working at home for his/her company.		A home business with one or two employees working at home.	
	Concurrent Use	**Mbps**	**Concurrent Use**	**Mbps**	**Concurrent Use**	**Mbps**	**Concurrent Use**	**Mbps**
Telephone	20	1.28	5	0.32	1	0.064	1	0.064
TV		0		0		0		0
HDTV		0		0		0		0
Credit Card Validation	4	4	1	1		0		0
Security System	1	0.25	1	0.25	1	0.25	1	0.25
Internet	20	30	7	10.5	1	1.5	1	1.5
VPN Connection	5	25		0	1	5		0
Data Backup	5	7.5	1	1.5	1	1.5	1	1.5
Web Hosting	1	2		0		0		0
Telehealth (provider)		0		0		0		0
Workforce Training (online classes)	2	20	1	10		0	1	10
HD Videoconferencing	10	140	2	28	1	14		0
Totals		**230.0**		**51.6**		**22.3**		**13.3**
5 years from now (megabits)	**690**		**155**		**67**		**40**	
10 years from now (megabits)	**2070**		**464**		**201**		**120**	

Residential Bandwidth Needs

The table on the following page depicts the bandwidth needed for typical residential services which are available now or will be available in near future. In a next generation network all services will be delivered over a single network infrastructure which will require an access network that can support providing most services to most consumers simultaneously. Today's shared networks (cable and wireless in particular) rely on the "bursty" nature of traffic to provide services to end users. If all end users were consuming their "advertised" bandwidth today's cable and DSL networks would grind to a halt.

In fact, they already are; some cable providers have begun to receive heavy criticism for undocumented manipulation of data traffic. Existing cable modem network users are overwhelming the digital cable networks that were upgraded as little as three or four years ago, and the firms have had to artificially reduce the bandwidth available for certain kinds of high bandwidth services (e.g. peer to peer file sharing). Some cable providers have even run into capacity issues with the TV portion of their networks, and some consumers have observed that some HD TV channels have been so highly compressed that picture quality has been noticeably degraded when compared to the same channel delivered by satellite.

Within five years, a single channel of HD television that is watched via a video on demand service (e.g. NetFlix, Blockbuster, iTunes, etc.) will use 5 to 10 megabits of bandwidth, with a total download file size of several gigabits. A dual layer Blu-Ray movie disc has a capacity of 50 gigabits. This format delivers high quality HD movies, and over time, home users will expect to be able to download movies in the high quality HD format.

The table below is designed to show bandwidth consumption in several scenarios. Network design requires a system than can meet peak demand across the entire network, meaning the network must be able to deliver peak bandwidth demand to a majority of households at the same time. Super Bowl Sunday is a typical example of a day when a majority of households may be watching a video at the same time. Political debates, season finales of popular shows, and even a typical Saturday afternoon during football season may see many households trying to access multiple channels of video simultaneously. This table shows the severe gap between current DSL, wireless, and cable modem options in Powhatan and projected future demand.

	Residential Daytime		Early Evening		Evening and Late Night		Snow Day	
Description	Intermittent Television and Internet use across a small percentage of households.		Increased television, telephone, and Internet use as children arrive home from school and employees from work. Use of other services increases.		Peak television and Internet use. Multiple TV's are on, phone and computer being used.		On top of typical daytime traffic children are home from school, and many employees are home working.	
	Concurrent Use	**Mbps**	**Concurrent Use**	**Mbps**	**Concurrent Use**	**Mbps**	**Concurrent Use**	**Mbps**
Telephone	1	0.064	1	0.064	1	0.064	1	0.064
TV	1	2.5	1	2.5	1	2.5	1	2.5
HDTV		0		0	1	8		0
Security System	1	0.25	1	0.25	1	0.25	1	0.25
Internet	1	1.5	1	1.5	2	3	3	4.5
Online Gaming		0		0		0		0
VPN Connection		0		0		0	1	5
Data Backup		0	1	1.5		0	1	1.5
Telehealth (subscriber)		0		0		0		0
Distance Learning / Workforce Training		0	1	10	1	10	2	20
HD Videoconferencing		0		0		0	1	14
Totals		**4.3**		**15.8**		**23.8**		**47.8**
5 years from now (megabits)	**13**		**47**		**71**		**143**	
10 years from now (megabits)	**39**		**142**		**214**		**430**	

Organizational and Economic Development Needs

The table below identifies the organizational and economic development needs associated with community investments in broadband infrastructure. Selection of the right network equipment vendors and best practice in the construction of the network are necessary but not sufficient. A well-engineered network may not meet other needs and could ultimately fail if the wrong business model is chosen or the network costs too much to operate.

Needs	Description
Meet community and economic development needs	Community and economic development goals and objectives drive technology decisions, not vendor sales goals.
World class engineering	Invest in open access infrastructure that will last for decades, using best of class engineering designs and solutions
World class network systems	Invest in network systems designed specifically for shared public/private use. Systems should be easy to manage and maintain, and should be easy for service providers to use.

Needs	Description
Financially sustainable business model	Use demand aggregation to create the right size marketplace for services. Operate the system as a shared public/private partnership, and ensure that government does not compete with business.
Low cost operations	Systems should be easy to operate, and should be highly automated to minimize need for expensive staff. Outsource most operations and maintenance to qualified private sector firms to create jobs and business opportunities.
Create opportunities for business	Aggregate demand to create new business opportunities for service providers. Keep prices low to encourage widespread use.
Create revenue opportunities for local government	Properly designed open access systems can create new opportunities for service providers, lower the cost of telecom services for all, and create new revenue streams for participating local governments. These revenue streams can be used for other community and economic development projects.

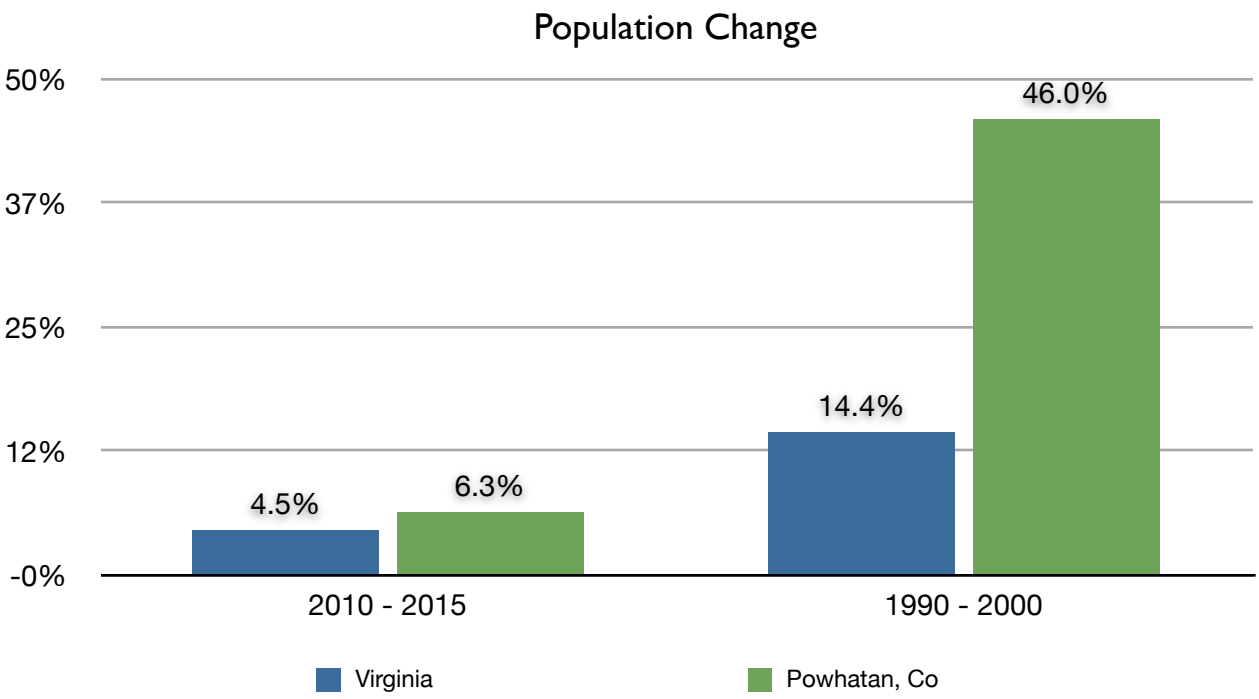
Demographic Analysis

Population of the region

Powhatan county experienced substantial growth in the last decade, but this has slowed considerably. Over the next several years, Powhatan County is still expected to grow, but at a much more modest pace. Improved telecom services and more affordable telecom services will play a key role in supporting work from home jobs and new business and entrepreneurial activities.

Year	Virginia		Powhatan, Co	
	Population	% Change	Population	% Change
2015	8,226,501	4.50%	30,341	6.30%
2010	7,874,646		28,543	
2000	7,078,515	14.40%	22,377	46.00%
1990	6,187,393		15,328	

Source US Bureau of Census 1990 and 2000 Decennial Census SF1 DP-1
* US Census Bureau Population Estimates Program
* Weldon Cooper Center for Public Service, UVa

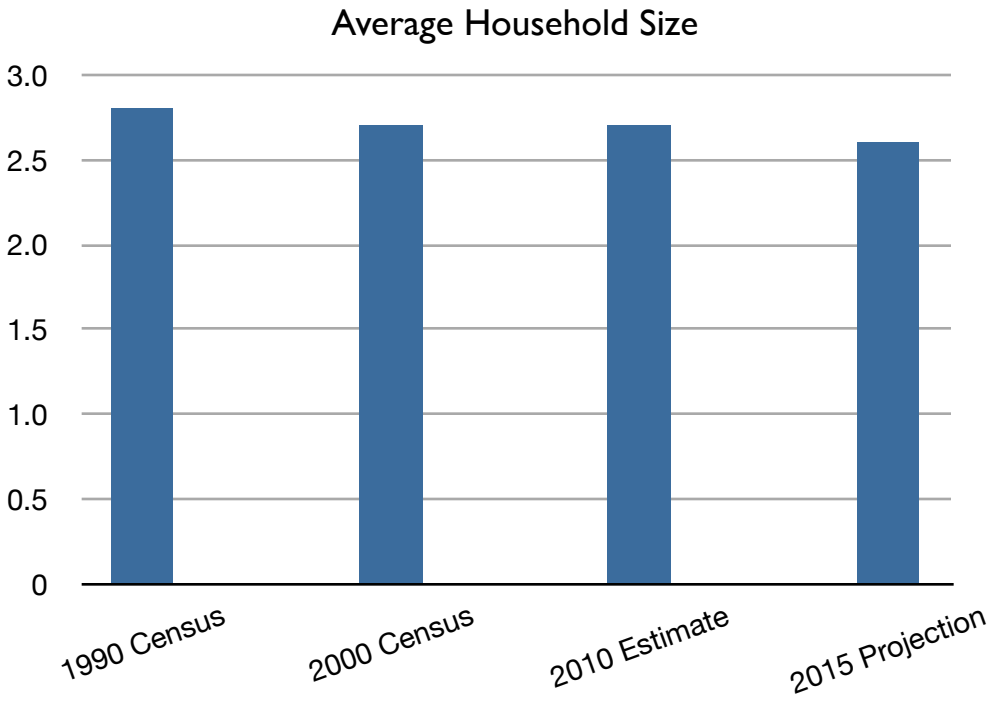


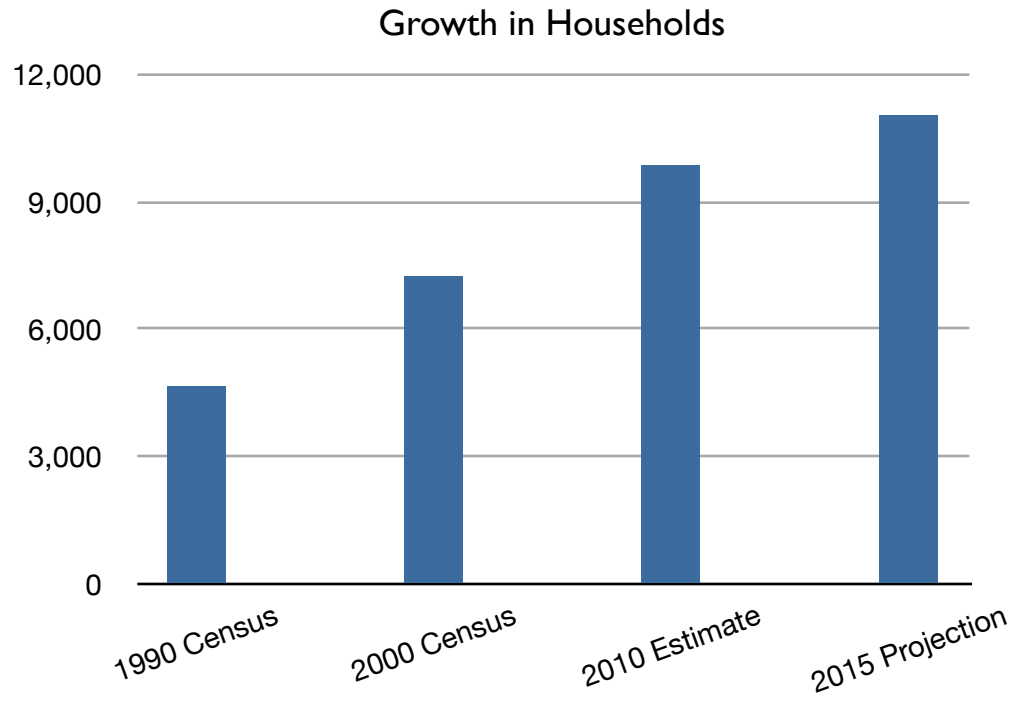
Household Size and Growth Trends

The number of households in Powhatan is expected to rise in the next five years, while the number of persons living in the average household will remain close to the same. The size of an average household and the number of households is an important set of data when predicting broadband take rates and modeling potential income. Most services are subscribed on a per household basis, rather than on a per person basis.

When calculating infrastructure investment costs, household statistics are also important because duct and fiber connections are made to the household (premise). Projected steady growth in households suggests that the County will see steady demand for connections (as opposed to a situation where the number of households is shrinking). The table below shows housing projections using census data.

	1990 Census		2000 Census		2010 Estimate		2015 Projection		1990 to 2000	2010 to 2015
Total Households	4,672		7,258		9,875		11,057		55.4%	12.0%
Size of Household:										
1 Person	629	13.5%	1,070	14.7%	1,452	14.7%	1,635	14.8%	68.5%	12.6%
2 Person	1,657	35.5%	2,691	37.1%	3,924	39.7%	4,551	41.2%	63.1%	16.0%
3 Person	1,014	21.7%	1,542	21.3%	2,224	22.5%	2,559	23.1%	52.1%	15.1%
4 Person	852	18.2%	1,264	17.4%	1,479	15.0%	1,504	13.6%	48.4%	1.7%
5 Person	347	7.4%	519	7.2%	559	5.7%	569	5.2%	38.9%	1.8%
6 Person	113	2.4%	133	1.8%	172	1.7%	174	1.6%	32.7%	1.2%
7 + Person	60	1.3%	39	0.5%	65	0.7%	65	0.6%	-35.0%	0.0%
Average Household Size	2.8		2.7		2.7		2.6		-3.6%	-3.7%


Average Household Size
3.0
2.5
2.0
1.5
1.0
0.5
0
1990 Census
2000 Census
2010 Estimate
2015 Projection


Growth in Households
12,000
9,000
6,000
3,000
0
1990 Census
2000 Census
2010 Estimate
2015 Projection

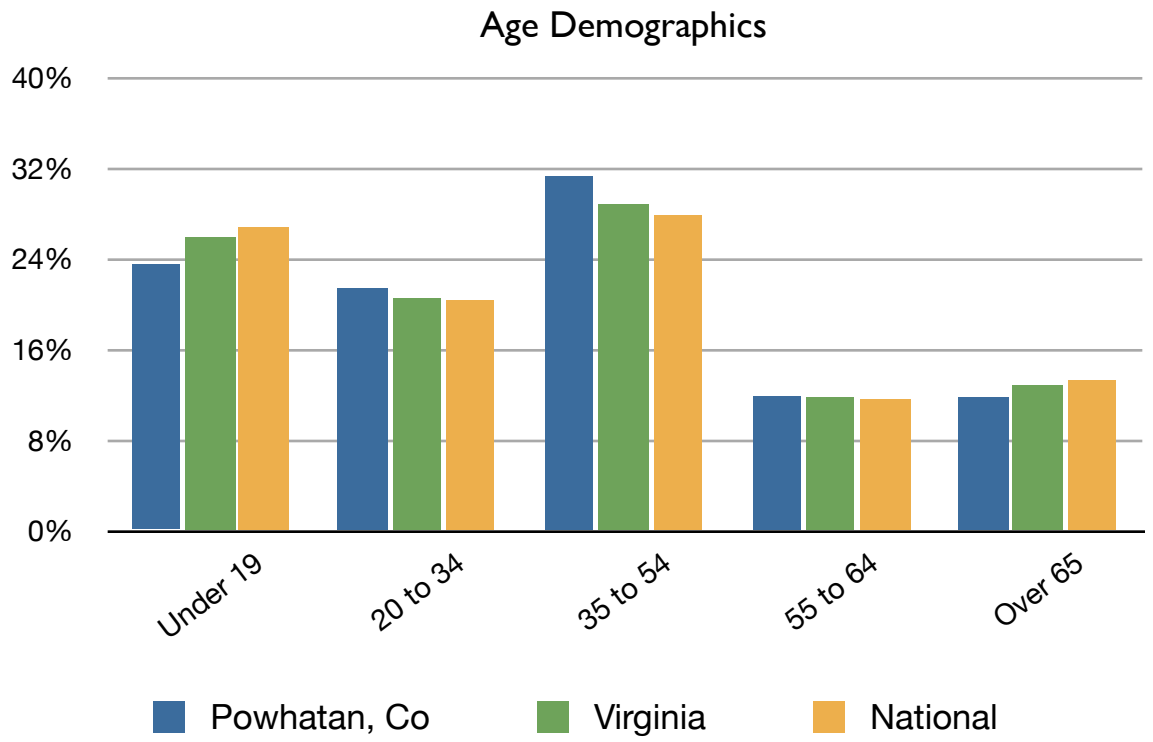
Age distribution

Powhatan's population is similar to the state and national averages. Different age groups use the Internet differently, and only high speed broadband can cater to the needs of each. Younger generations are often avid consumers of online video and most working aged people will benefit greatly from a high speed connection to their home. At the same time, an ongoing awareness and education effort is often needed to help older people make good use of technology.

In our work in other areas, local real estate agents report consistently that many home buyers will NOT look at homes that do not have broadband connections, especially younger, first time home buyers. So broadband availability (or the lack of it) is changing where people choose to live.

	Powhatan, Co	Virginia	National
Under 19	23.5%	25.9%	26.8%
20 to 34	21.4%	20.6%	20.4%
35 to 54	31.3%	28.9%	27.9%
55 to 64	11.9%	11.8%	11.6%
Over 65	11.8%	12.8%	13.3%

Source US Bureau of Census 1990 and 2000 Decennial Census SF1 DP-1

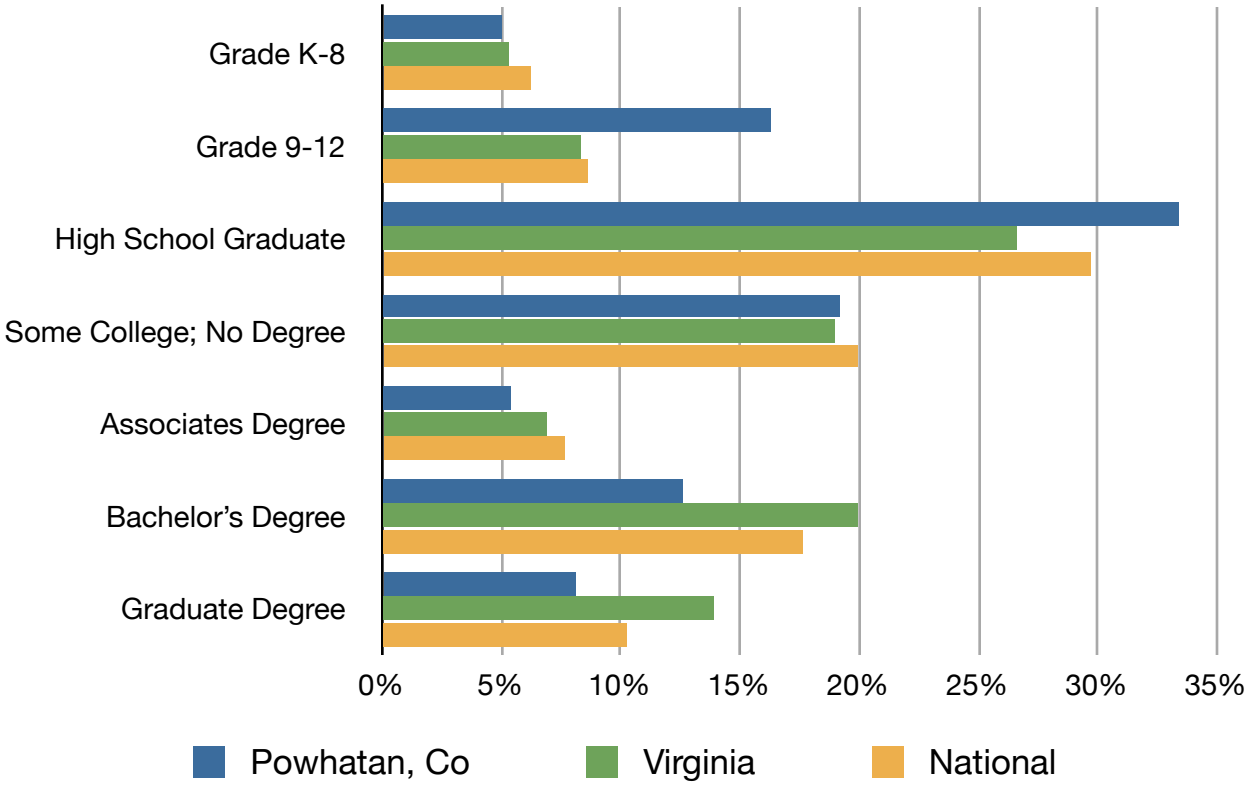


Education

The level of educational attainment in Powhatan is falls short of state and national averages when it comes to advanced degrees. Increased availability of broadband could help change this over time as increased awareness and connectivity would allow residents to complete their education by attending online classes. Increased connectivity could also attract a different mix of residents (e.g., business people and entrepreneurs who can work from home).

	Powhatan, Co	Virginia	National
Grade K - 8	5.0%	5.3%	6.2%
Grade 9 - 12	16.3%	8.3%	8.6%
High School Graduate	33.4%	26.6%	29.7%
Some College, No Degree	19.2%	19.0%	19.9%
Associates Degree	5.4%	6.9%	7.6%
Bachelor's Degree	12.6%	20.0%	17.6%
Graduate Degree	8.1%	13.9%	10.3%

Source US Bureau of Census 1990 and 2000 Decennial Census SF3 DP-2



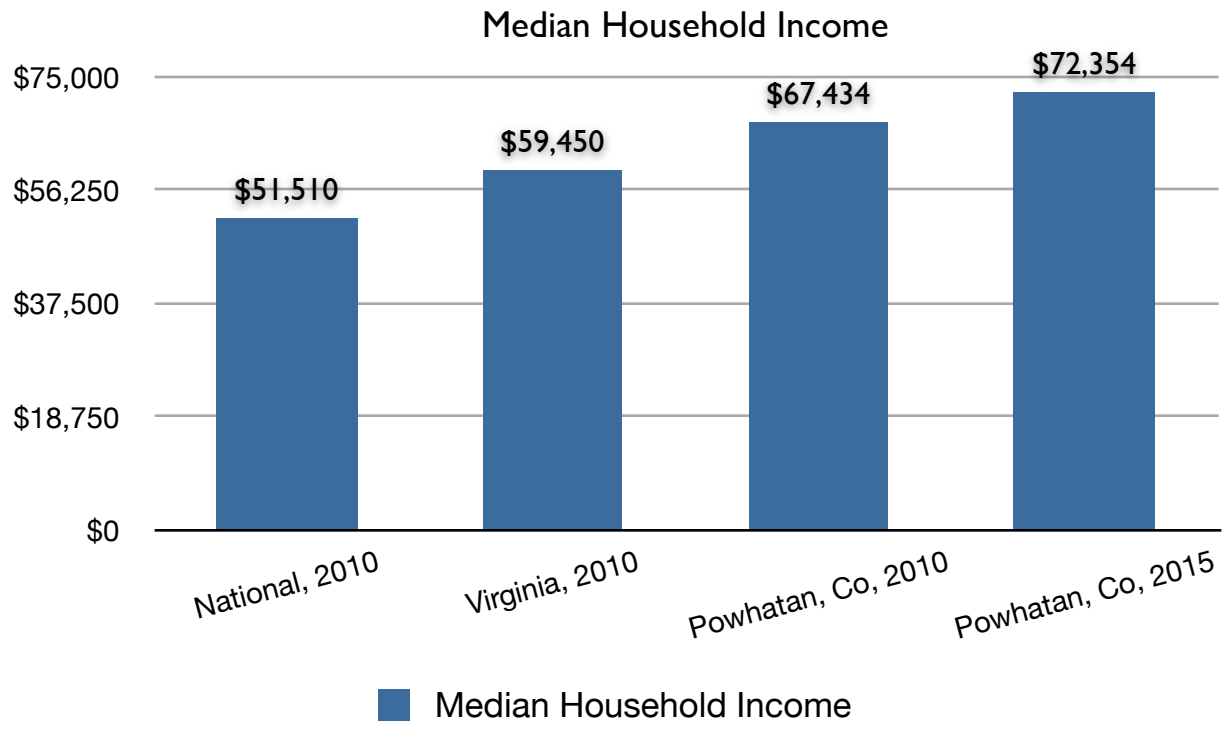
Median Household Income

The Median Household Income of Powhatan is higher than the national average and state averages. This reflects the Powhatan's proximity to the Richmond metro area, with the largest employment sector being retail and wholesale jobs. County investments in broadband infrastructure could spur increased competition and lower prices for residents and businesses.

Improved Internet access in the County would continue to shift some employment and job opportunities towards office and professional employees. Home-based businesses and working from home jobs, either part time or full time, could contribute more to the local economy, and broadband at home is already considered a requirement among white collar professionals.

	National, 2010	Virginia, 2010	Powhatan, Co, 2010	Powhatan, Co, 2015
Median Household Income	$51,510	$59,450	$67,434	$72,354

Source US Bureau of Census 1990 and 2000 Decennial Census SF3 DP-3

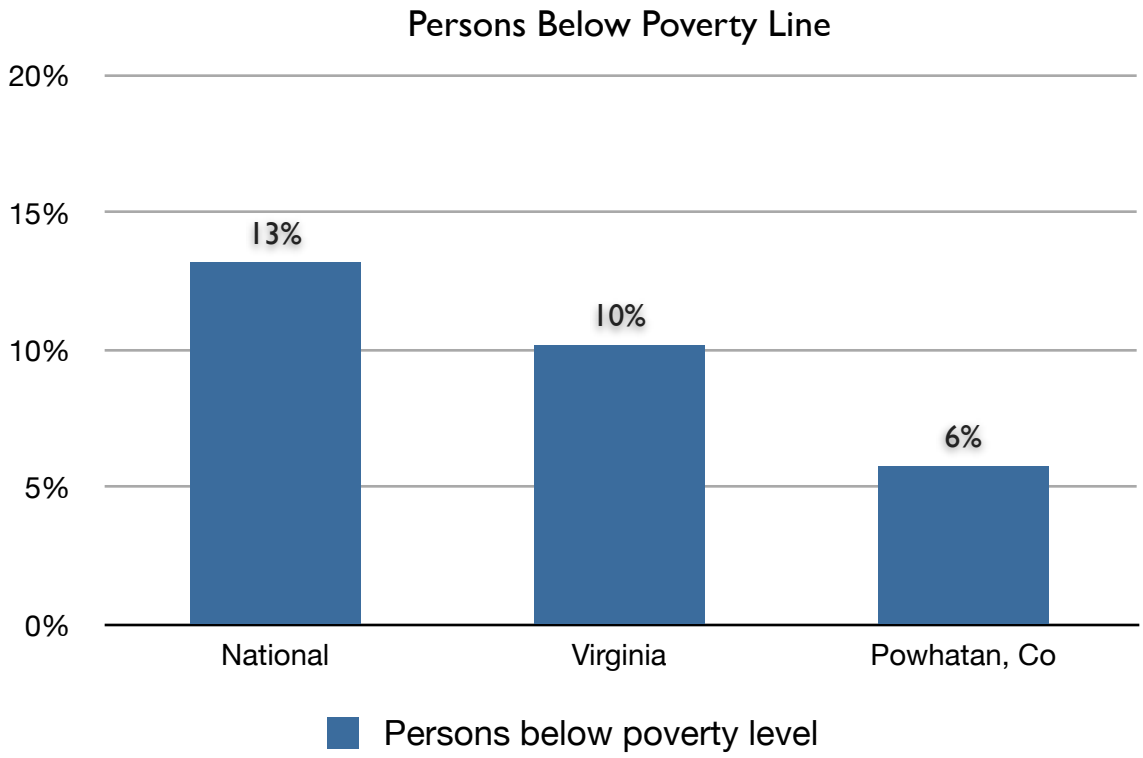


Families Below Poverty Level

The following table poverty level for Powhatan County. At 5.8% the percentage of residents living below the poverty level, Powhatan's poverty rate is much lower than the national and Virginia averages.

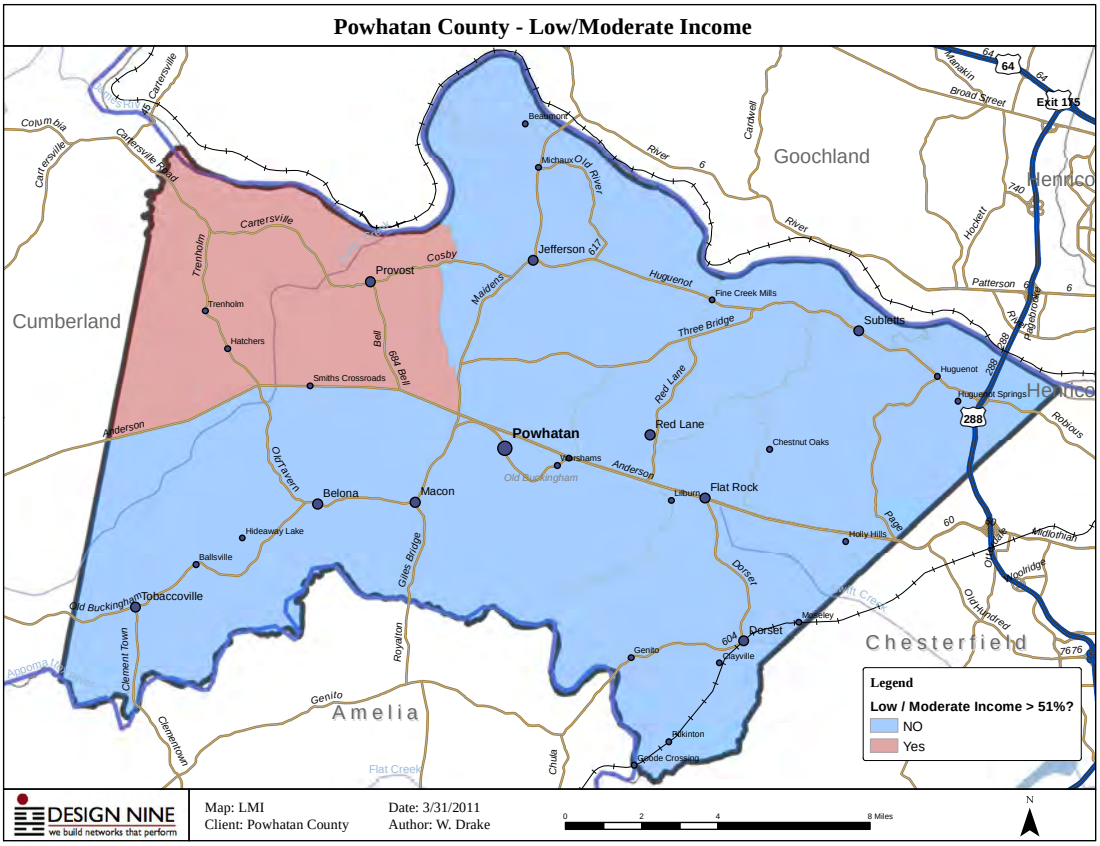
	National	Virginia	Powhatan, Co
Persons below poverty level	13.2%	10.2%	5.8%

Source US Bureau of Census, State and County Quickfacts
Accessed 2011, Data from 2008 & 1999



Low and Moderate Income

The map below shows the concentration of Low and Moderate Income households in Powhatan County. LMI areas are eligible for certain kinds of broadband funding opportunities, including some from the Virginia Department of Housing and Community Development.



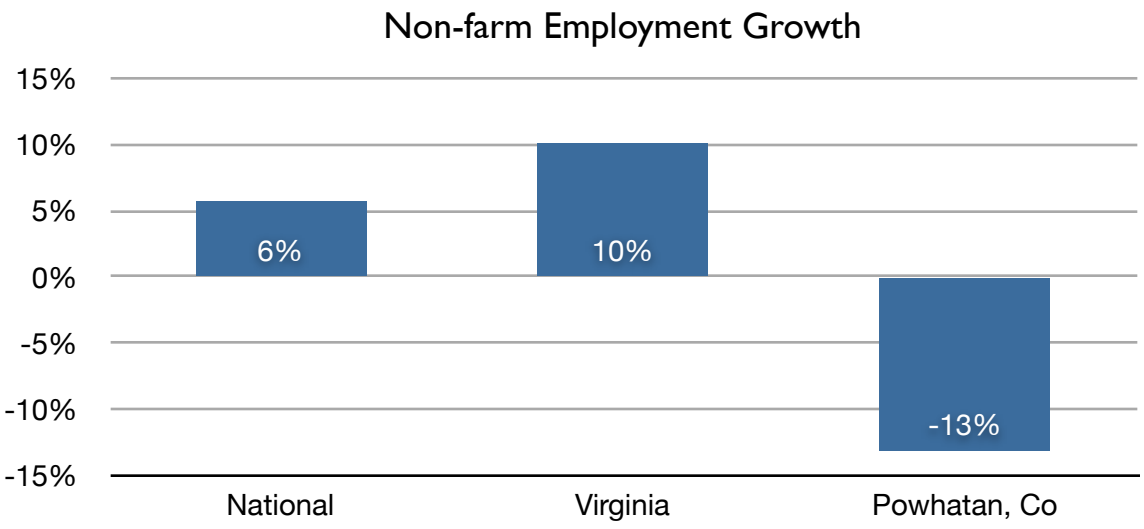
Non-farm employment growth

Powhatan County is experiencing a sharp decrease in the number of jobs, underscoring the need for corrective action through economic development focus and broadband infrastructure investments. A joint CMU/MIT study released in 2005 showed that regions with good distribution of broadband service enjoyed more economic growth than regions without quality access to broadband services.

A study by the Phoenix Center showed that broadband was also an important tool for job-seekers; those looking for jobs were more likely to find work than those on dial-up or those without any Internet access.

	National	Virginia	Powhatan, Co
Nonfarm employment growth	5.7%	10.1%	-13.1%

Source US Bureau of Census 2008 State and County Quickfacts



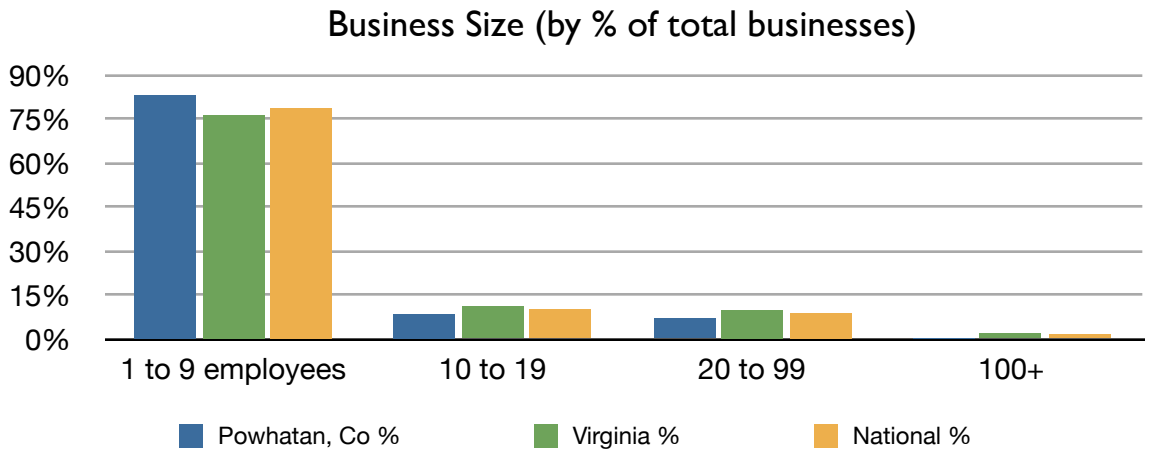
Business size distribution

Powhatan has mostly small businesses, and enjoys a business size distribution similar to state and national averages, reflecting a reasonable balance.

The trend is toward smaller businesses, and most job creation is in the category of small business (25 employees or less). Increased broadband availability and increased competition among providers could lower costs for existing businesses, making it easier for them to fund business expansion. Improved affordability and availability of broadband in Powhatan may also help the County attract new small businesses, especially business owners looking for good quality of life.

Number of Businesses	Powhatan, Co	Virginia	National
1 to 9 employees	640	214,551	9,425,021
10 to 19	67	31,501	1,223,909
20 to 99	55	28,033	1,082,421
100+	5	5,752	216,151
Total businesses	767	279,837	11,947,502

Business Size Distribution	Powhatan, Co %	Virginia %	National %
1 to 9 employees	83.4%	76.7%	78.9%
10 to 19	8.7%	11.3%	10.2%
20 to 99	7.2%	10.0%	9.1%
100+	0.7%	2.1%	1.8%
Total businesses	767	279,837	11,947,502

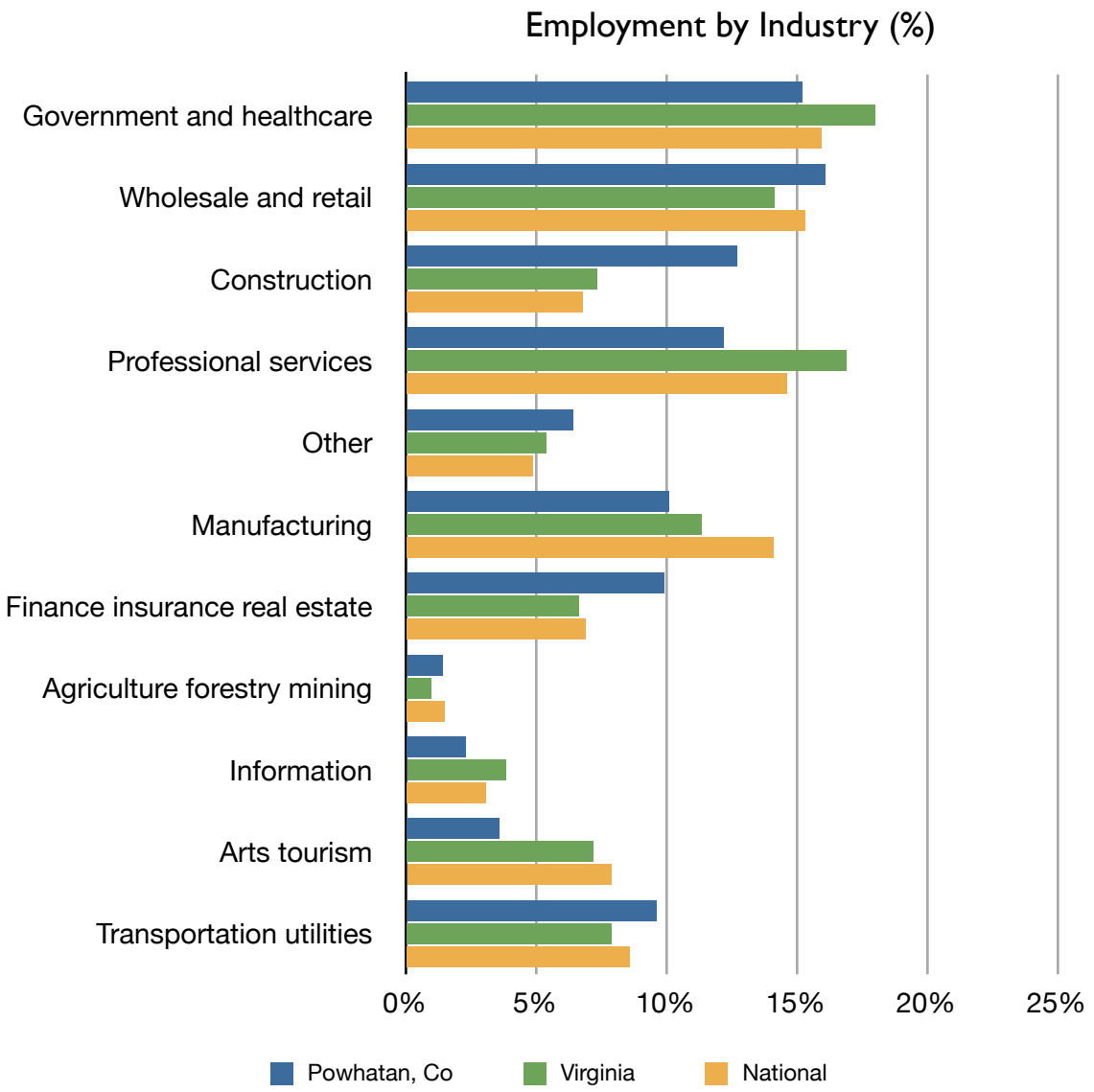


Business and Jobs Distribution

The County's largest employer is the retail sector. Government/healthcare, construction, and professional services are the next largest employers. Professional services are needed by Knowledge Economy businesses and entrepreneurs, and special attention should be paid to this sector to ensure that local businesses have access to the services they need to grow. Entrepreneurial businesses tend to outsource more kinds of services that small businesses did in the past. Powhatan County, by ensuring that high quality professional services remain available (e.g. business focused accounting and bookkeeping services, business-oriented legal practices, receptionist services, copy and shipping services, temp worker services) may be able to better attract Knowledge Economy businesses.

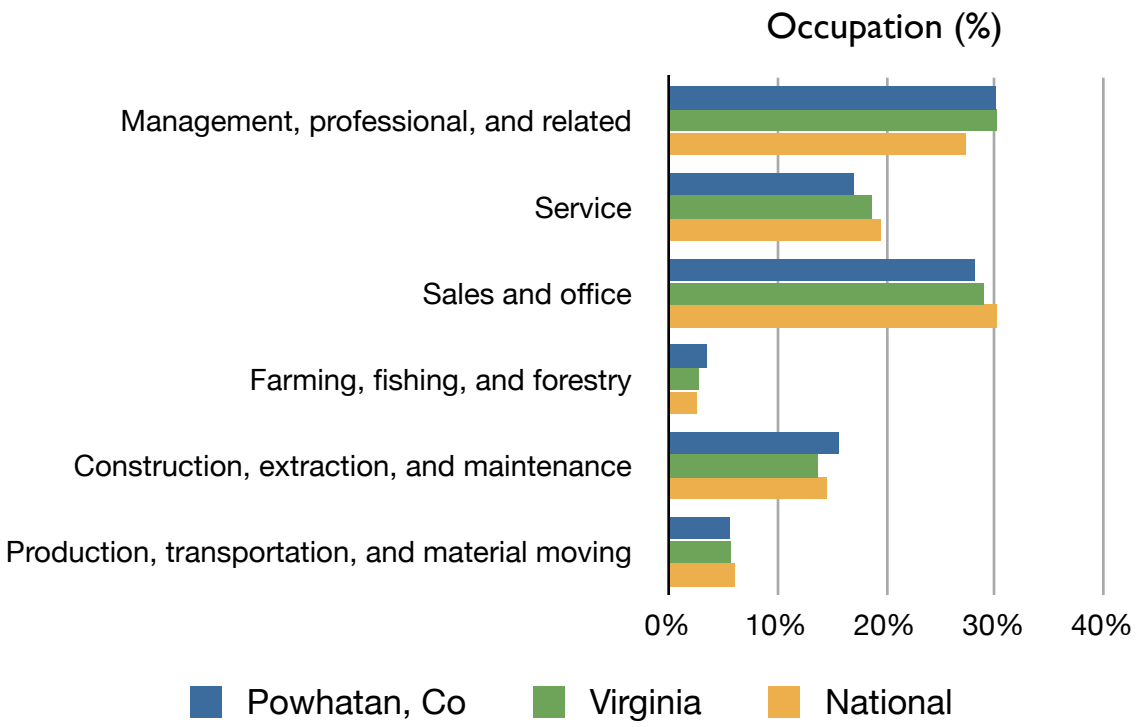
Improvements and upgrades in the town center to improve the general appearance of the downtown area will help attract more businesses. Incentives for landlords to rehab older retail and second floor spaces can help increase the inventory of good quality professional office space. Relocation decisions are now frequently made in 90 days or less, so the County should strive to always have some good quality office space always available (with broadband cabling to the building and within the building). There is a modest amount of Class A office space in Powhatan on the east side of the county. This asset should be a priority when planning fiber or other facilities.

	Powhatan, Co	Virginia	National
Government and healthcare	15.2%	17.98%	15.94%
Wholesale and retail	16.1%	14.15%	15.33%
Construction	12.7%	7.3%	6.8%
Professional services	12.2%	16.91%	14.62%
Other	6.4%	5.4%	4.9%
Manufacturing	10.1%	11.4%	14.1%
Finance insurance real estate	9.9%	6.63%	6.89%
Agriculture forestry mining	1.4%	0.98%	1.49%
Information	2.3%	3.8%	3.1%
Arts tourism	3.6%	7.2%	7.87%
Transportation utilities	9.6%	7.9%	8.59%



Distribution by Occupation (count)	Powhatan, Co	Virginia	National
Management, professional, and related	1,630	1,111,409	39,462,909
Service	922	686,471	28,181,022
Sales and office	1,527	1,067,943	43,576,884
Farming, fishing, and forestry	190	100,196	3,683,569
Construction, extraction, and maintenance	847	505,055	20,966,046
Production, transportation, and material moving	303	210,225	8,735,467
Totals	5,419	3,681,299	144,605,897

Distribution by Occupation (%)	Powhatan, Co	Virginia	National
Management, professional, and related	30.1%	30.2%	27.3%
Service	17.0%	18.6%	19.5%
Sales and office	28.2%	29.0%	30.1%
Farming, fishing, and forestry	3.5%	2.7%	2.5%
Construction, extraction, and maintenance	15.6%	13.7%	14.5%
Production, transportation, and material moving	5.6%	5.7%	6.0%

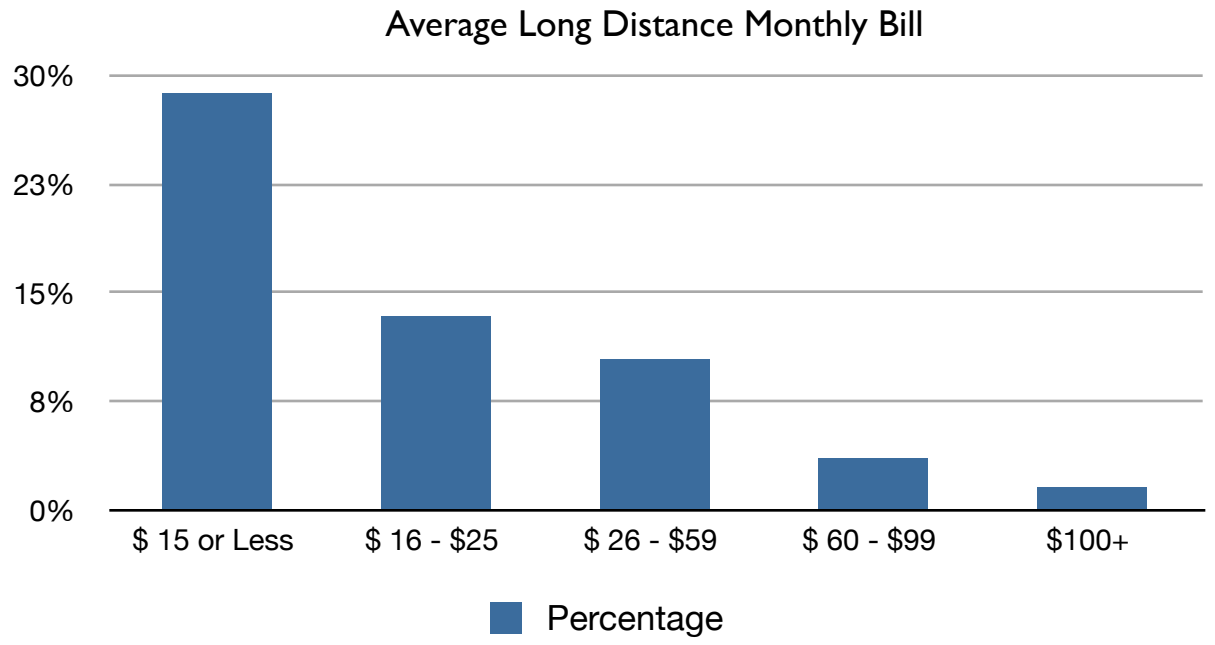

Occupation (%)
Management, professional, and related
Service
Sales and office
Farming, fishing, and forestry
Construction, extraction, and maintenance
Production, transportation, and material moving
0%
10%
20%
30%
40%
Powhatan, Co
Virginia
National

Telephone Usage in Powhatan County

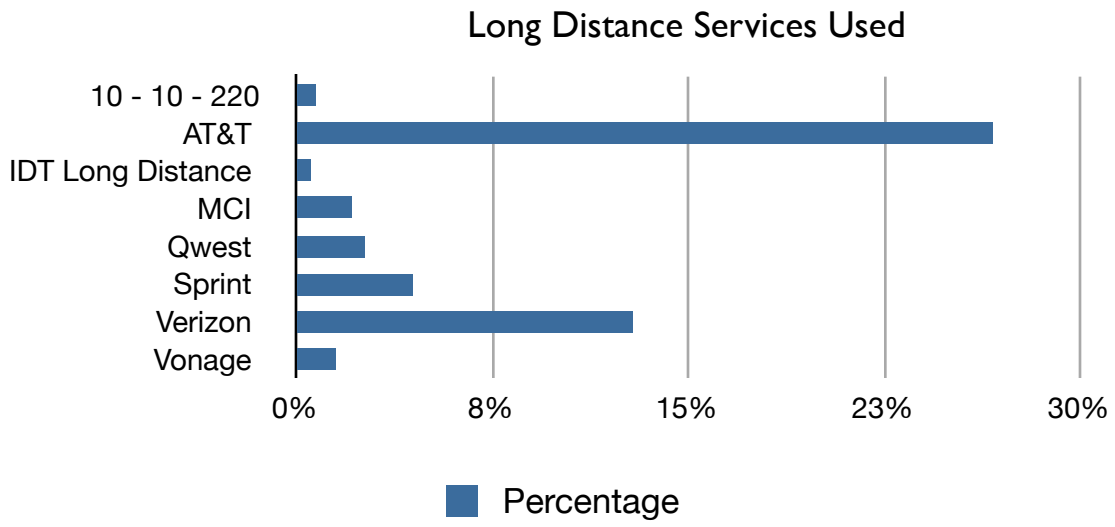
Telephone usage in the County is average with almost 90% of households having at least one landline telephone. On average, Powhatan County residents pay about as much on telephone bills than residents in other areas. Given the level of activity of phone use, a less expensive VoIP-based telephone service (Voice over IP) is likely to be very popular, especially for those on fixed incomes (e.g. retirees and the elderly).

Average Long Distance Monthly Bill	Total	Percentage	Index
Have a landline telephone	19,983	88.5%	106
Long Distance Costs			
$ 15 or Less	6,497	28.8%	106
$ 16 - $25	3,013	13.3%	113
$ 26 - $59	2,353	10.4%	105
$ 60 - $99	813	3.6%	110
$100+	356	1.6%	113

Source Mediamark Research, Inc.



Long Distance Services Used	Total	Percentage	Index
10 - 10 - 220	168	0.7%	93
AT&T	6,017	26.6%	108
IDT Long Distance	129	0.6%	73
MCI	482	2.1%	102
Qwest	597	2.6%	115
Sprint	1,008	4.5%	119
Verizon	2,914	12.9%	109
Vonage	344	1.5%	139



Number of Cell Phones in Home	Total	Percentage	Index
One Cellphone	4,643	20.6%	85
Two Cellphones	8,414	37.3%	107
Three Cellphones	4,078	18.1%	119
Four or More Cellphones	3,209	14.2%	118
Household owns beeper or pager	827	3.7%	114

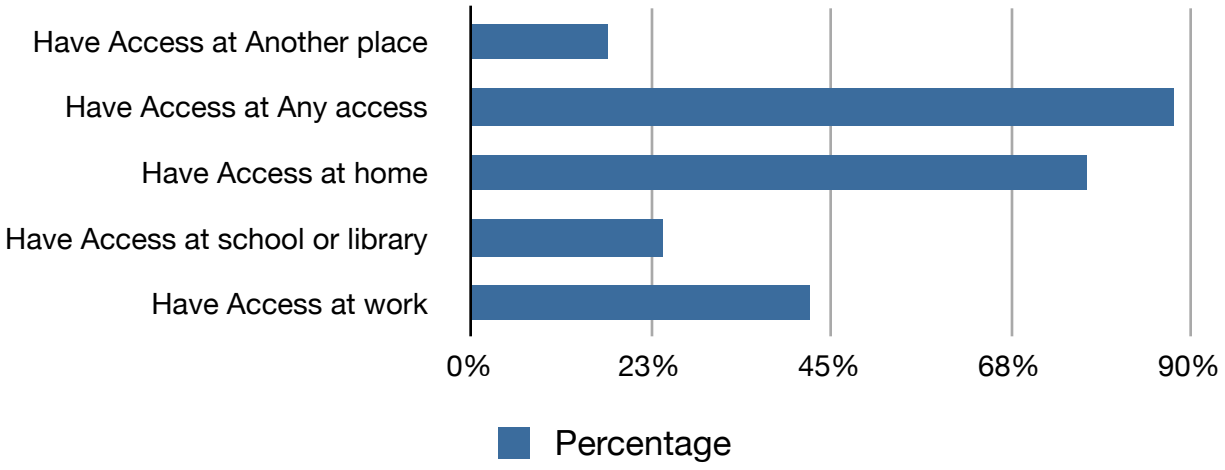
Internet Usage in Powhatan County

While usage of the Internet is only one facet of a community broadband project, this data highlights the importance of the Internet to the area. Powhatan residents are similar to residents in most other areas in terms of access from home and access at work. Nationally, close to 70% of residents tend to have some kind of Internet access from home (including dial up).

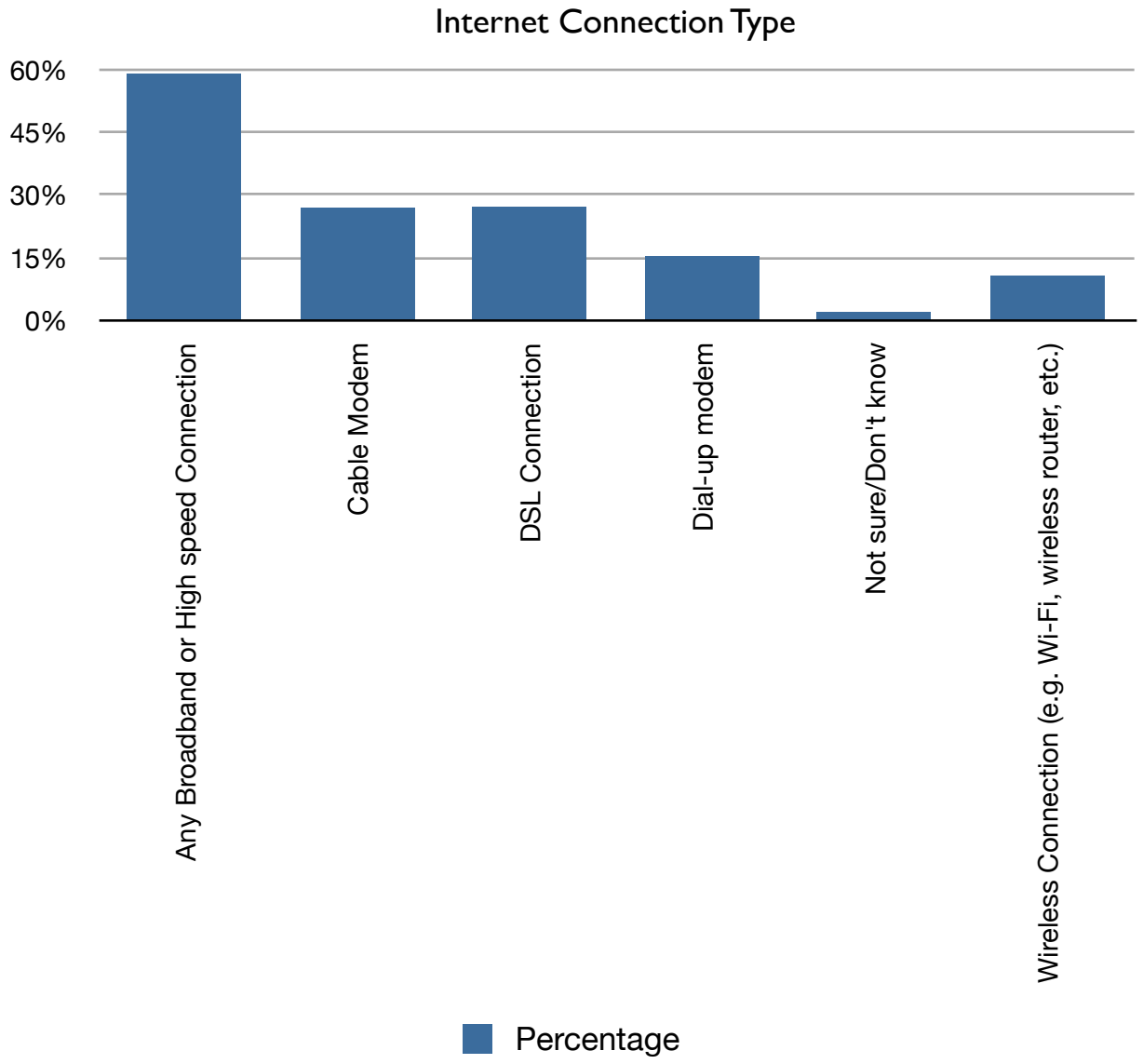
About 75% of residents indicate any Internet usage, which reflects the opportunity for more broadband connectivity and increased usage of what's available.

Internet Access	Total	Percentage	Index
Any Internet/Online usage	16,920	74.9%	110
Have Access at Another place	3,849	17.0%	92
Have Access at Any access	19,836	87.8%	106
Have Access at home	17,391	77.0%	113
Have Access at school or library	5,421	24.0%	99
Have Access at work	9,555	42.3%	113

Source Mediamark Research, Inc.



Internet Connection Type	Total	Percentage	Index
Any Broadband or High speed Connection	13,343	59.1%	112
Cable Modem	6,098	27.0%	110
DSL Connection	6,105	27.0%	114
Dial-up modem	3,439	15.2%	123
Not sure/Don't know	460	2.0%	90
Wireless Connection from a computer or laptop (e.g. Wi-Fi, wireless router, etc.)	2,382	10.5%	108

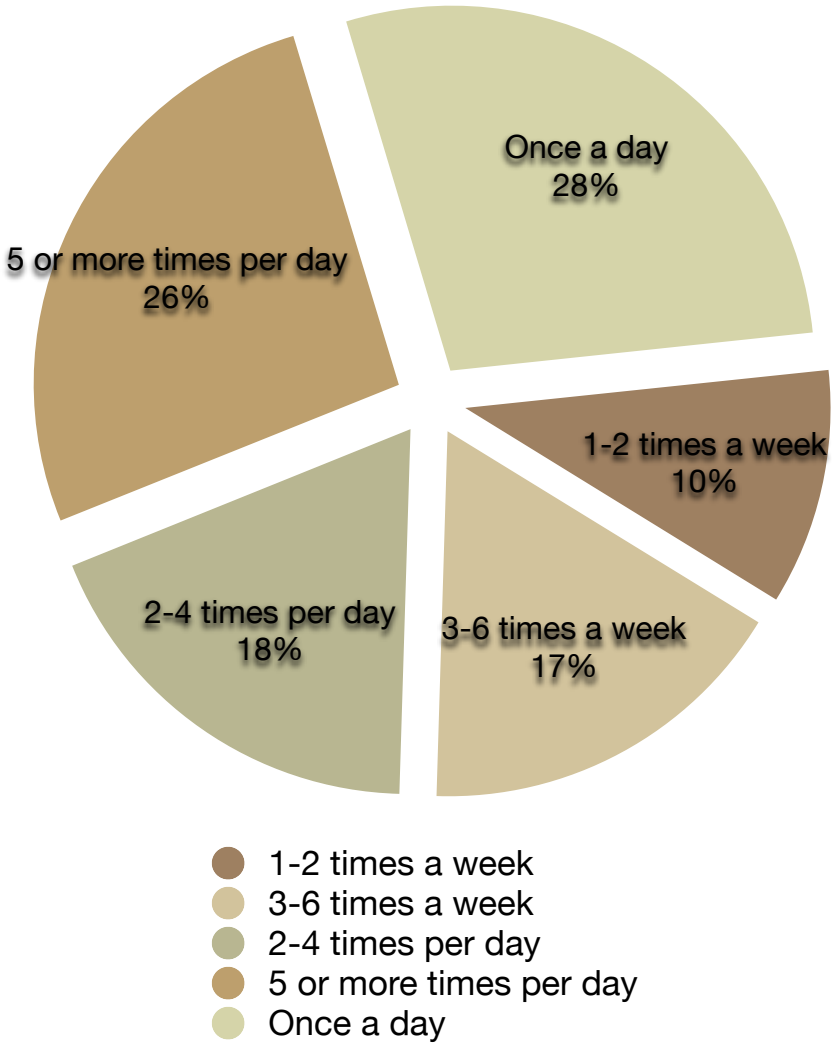

Internet Connection Type
60%
45%
30%
15%
0%
Any Broadband or High speed Connection
Cable Modem
DSL Connection
Dial-up modem
Not sure/Don't know
Wireless Connection (e.g. Wi-Fi, wireless router, etc.)
Percentage

Internet Activity in Powhatan

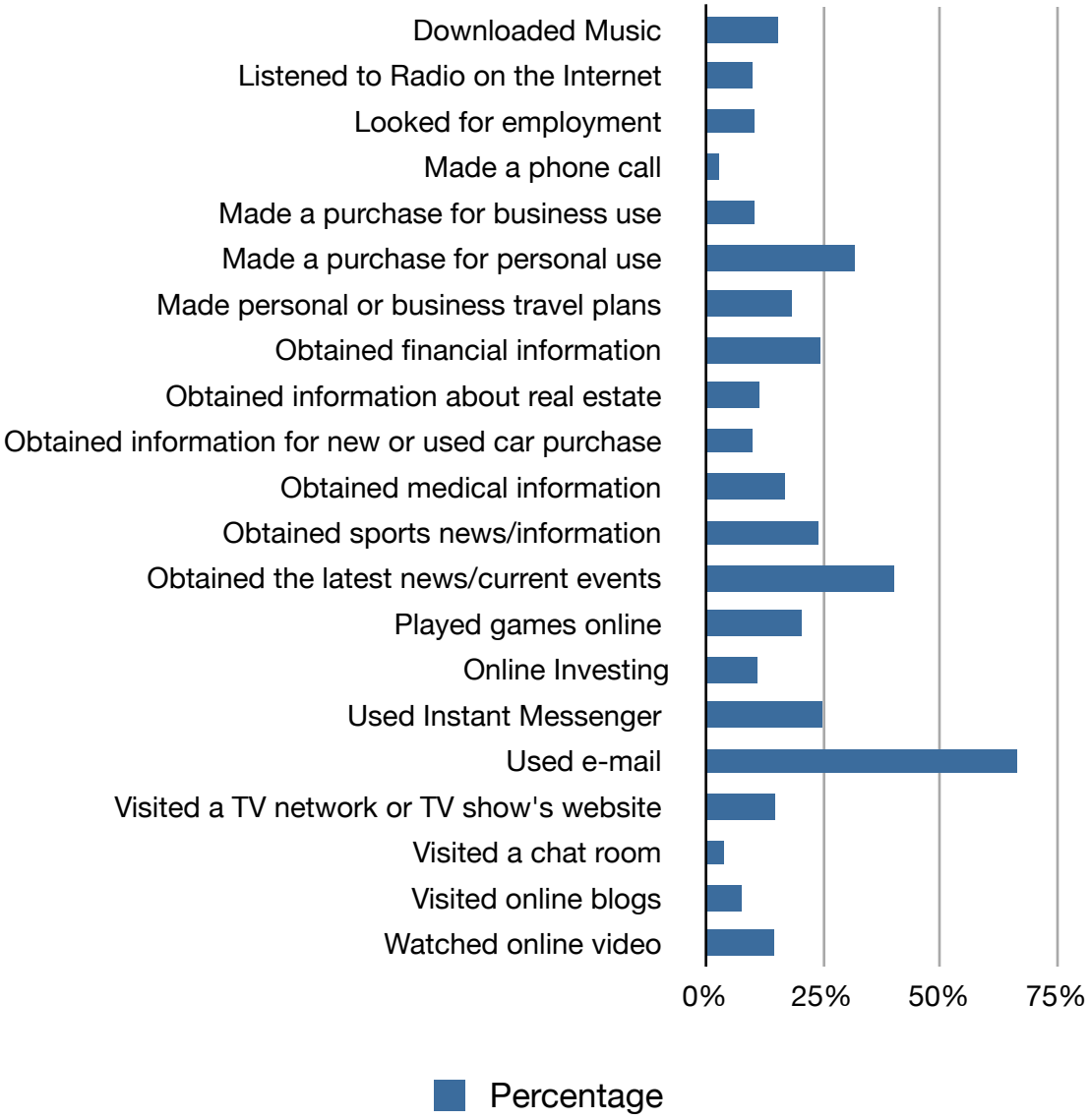
The tables how Internet use in the County compares to other areas of the country. The information below shows that Powhatan residents are making use of the Internet frequently. 72% of residents are using the Internet on a daily basis.

Source Mediamark Research, Inc.

Internet Use Frequency	Total	Percentage
Internet - Times looked at/used: 1-2 times a week	623	10.4%
Internet - Times looked at/used: 3-6 times a week	1,000	16.7%
Internet - Times looked at/used: Once a day	1,102	18.4%
Internet - Times looked at/used: 2-4 times per day	1,583	26.5%
Internet - Times looked at/used: 5 or more times per day	1,676	28.0%



Internet Uses	Total	Percentage	Index
Downloaded Music	3,447	15.27%	96
Listened to Radio on the Internet	2,200	9.74%	101
Looked for employment	2,327	10.31%	99
Made a phone call	615	2.72%	101
Made a purchase for business use	2,320	10.27%	115
Made a purchase for personal use	7,146	31.65%	108
Made personal or business travel plans	4,110	18.20%	109
Obtained financial information	5,477	24.26%	112
Obtained information about real estate	2,534	11.22%	108
Obtained information for new or used car purchase	2,208	9.78%	112
Obtained medical information	3,803	16.84%	109
Obtained sports news/information	5,391	23.88%	112
Obtained the latest news/current events	9,067	40.16%	114
Played games online	4,568	20.23%	105
Tracked investments/Traded stocks, bonds or mutual funds	2,449	10.85%	109
Used Instant Messenger	5,576	24.69%	101
Used e-mail	14,971	66.30%	111
Visited a TV network or TV show's website	3,305	14.64%	109
Visited a chat room	830	3.68%	85
Visited online blogs	1,716	7.60%	99
Watched online video	3,243	14.36%	102


Downloaded Music
Listened to Radio on the Internet
Looked for employment
Made a phone call
Made a purchase for business use
Made a purchase for personal use
Made personal or business travel plans
Obtained financial information
Obtained information about real estate
Obtained information for new or used car purchase
Obtained medical information
Obtained sports news/information
Obtained the latest news/current events
Played games online
Online Investing
Used Instant Messenger
Used e-mail
Visited a TV network or TV show's website
Visited a chat room
Visited online blogs
Watched online video
0%
25%
50%
75%
Percentage

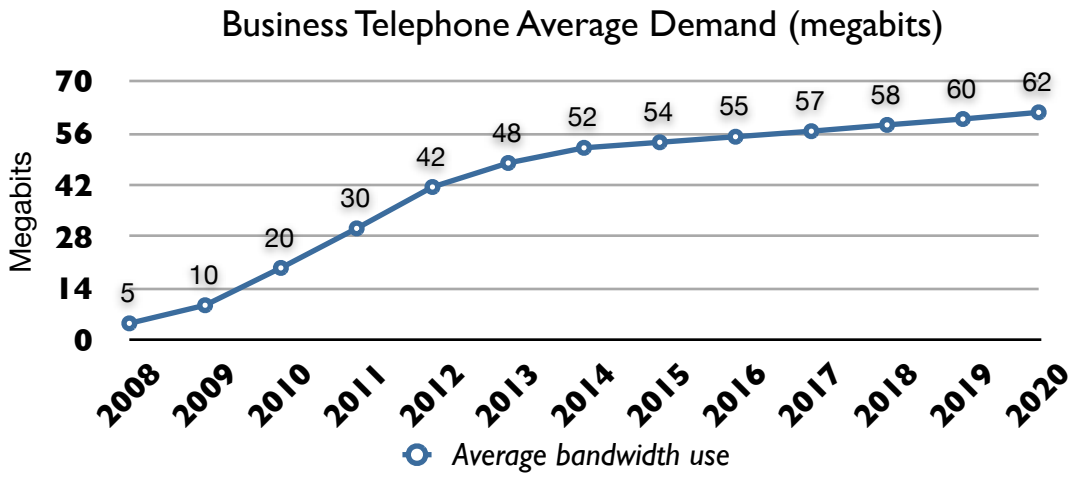
Business Telephone Demand in Powhatan County

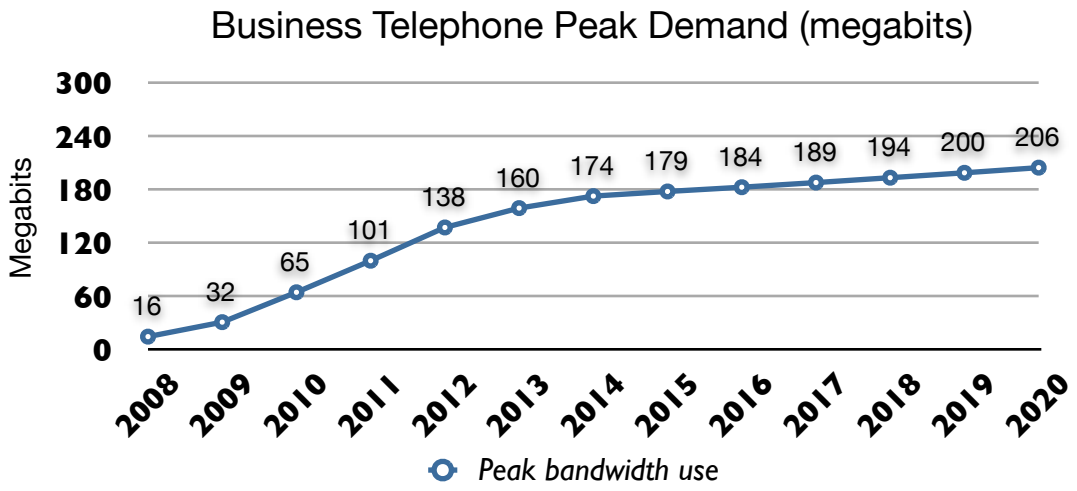
Business telephone demand is important because virtually all businesses require a telephone and most businesses require a landline. Very small start up businesses may use only a cellular phone but the quality of the call and the variability of the signal means that even small "mom and pop" businesses typically have at least one landline.

Over the past five years, there has been an increasing shift of business phone service away from the traditional analog phone line to Internet-based phone service (VoIP, or Voice over Internet Protocol). By some estimates, more than 4 million business telephone lines have been converted to VoIP over the past five years. Many business users switch to VoIP phone services because of the greatly expanded service options available, but most businesses also typically see savings of 25% to 40% savings on their overall phone bill. Businesses that must make make long distance calls and/or international calls may see as much as an 80% reduction on their monthly phone bill.

Telephone is the single most important business service, and the projections below assume that 95% of Powhatan's businesses will switch to VoIP by 2014. Bandwidth for phone services is relatively modest (about 128 kilobits per phone line). VoIP is one of the easiest services to provide and can offer some of the biggest savings to businesses.

Year	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Businesses	767	789	811	834	858	882	907	933	959	986	1,014	1,043	1,073
Businesses with phone	690	710	730	751	772	794	816	840	863	887	913	939	966
Take rate	10%	20%	40%	60%	80%	90%	95%	95%	95%	95%	95%	95%	95%
Average bandwidth use	4.6	9.5	19.6	30.3	41.5	48	52.1	53.6	55.1	56.6	58.3	59.9	61.7
Peak bandwidth use	15.5	31.8	65.4	100.9	138.3	160.1	173.6	178.8	183.6	188.8	194.3	199.8	205.6


Business Telephone Average Demand (megabits)
Megabits
70
56
42
28
14
0
5
10
20
30
42
48
52
54
55
57
58
60
62
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
Average bandwidth use


Business Telephone Peak Demand (megabits)
Megabits
300
240
180
120
60
0
16
32
65
101
138
160
174
179
184
189
194
200
206
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
Peak bandwidth use

Business Internet Demand in Powhatan County

Internet demand is more difficult to project than telephone service because many different services (including VoIP telephone service) can be carried over a single broadband connection. The table and charts below provide three different sets of projections for the amount of bandwidth that Powhatan will likely need over the next ten years, based on a mix of low, moderate, and peak use.

Low use represents a typical mix of daily online business activities:

- Email access.
- Web access.
- Access to specialized business information and databases.
- Occasional high capacity services like computer backups.

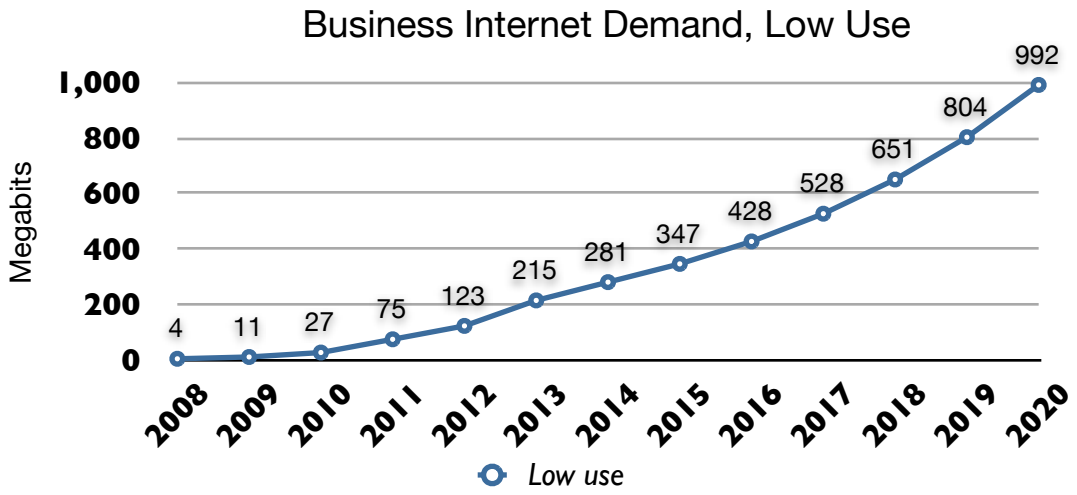
Moderate use includes the low use services but also adds additional business activities:

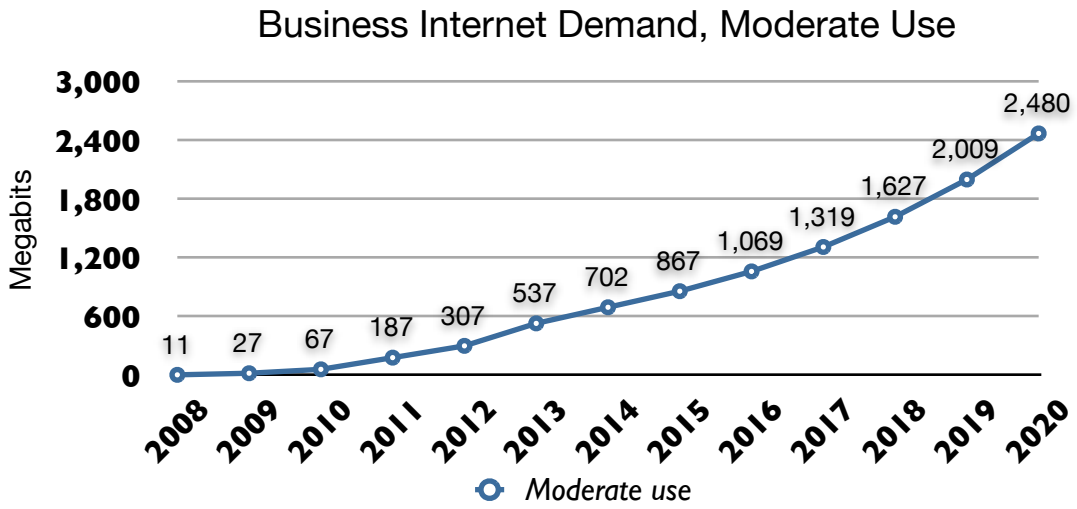
- Some streaming video (e.g. online business training).
- Hosting of e-commerce "shopping cart" Web site for online sales.
- Daily transfer of documents and files between multiple business locations (e.g. engineering drawings, medical files, etc.).
- Hosting of Web sites with multimedia heavy content like videos.

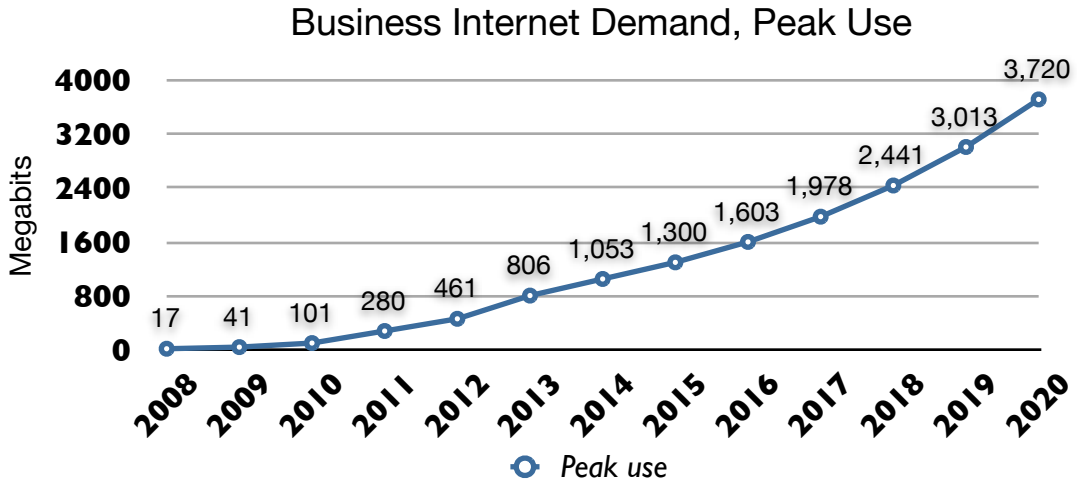
Peak use includes regular use of:

- Business videoconferencing in HD format.
- Multi-site business videoconferences (three or more sites connected at the same time).
- High demand Web sites with heavy traffic that requires multiple servers (e.g. popular e-commerce sites, popular news and information sites).
- Telemedicine and telehealth services, including regular transfer of radiology files, real time access to medical records, and video-enabled remote diagnostic services.

Year	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Businesses	767	789	811	834	858	882	907	933	959	986	1,014	1,043	1,073
Businesses with Internet (%)	65%	70%	80%	85%	90%	95%	95%	95%	95%	95%	95%	95%	95%
Businesses with Internet	690	710	730	751	772	794	816	840	863	887	913	939	966
Take rate	5%	10%	20%	45%	60%	85%	90%	90%	90%	90%	90%	90%	90%
Low use	4	11	27	75	123	215	281	347	428	528	651	804	992
Moderate use	11	27	67	187	307	537	702	867	1,069	1,319	1,627	2,009	2,480
Peak use	17	41	101	280	461	806	1,053	1,300	1,603	1,978	2,441	3,013	3,720


Business Internet Demand, Low Use
Megabits
1,000
800
600
400
200
0
4
11
27
75
123
215
281
347
428
528
651
804
992
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
Low use

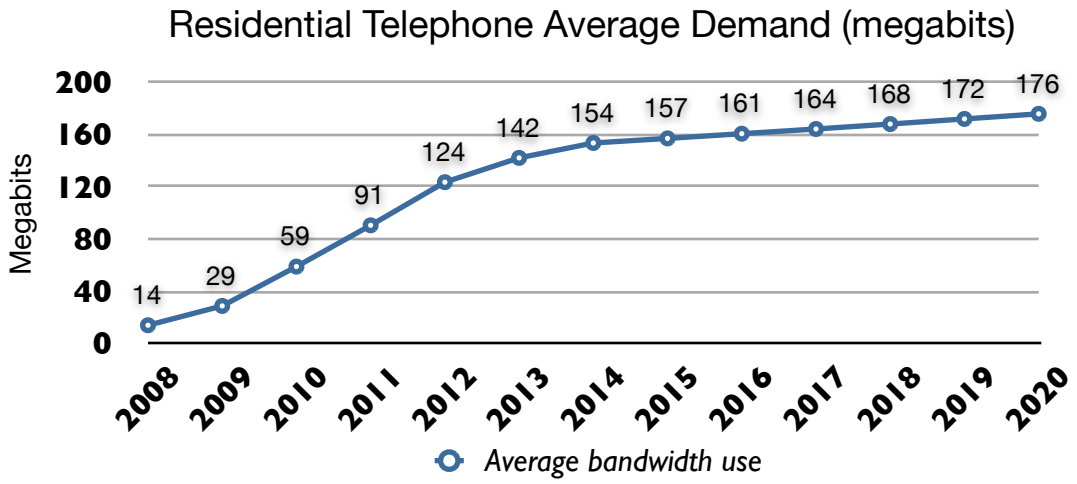

Business Internet Demand, Moderate Use
Megabits
3,000
2,400
1,800
1,200
600
0
11
27
67
187
307
537
702
867
1,069
1,319
1,627
2,009
2,480
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
Moderate use

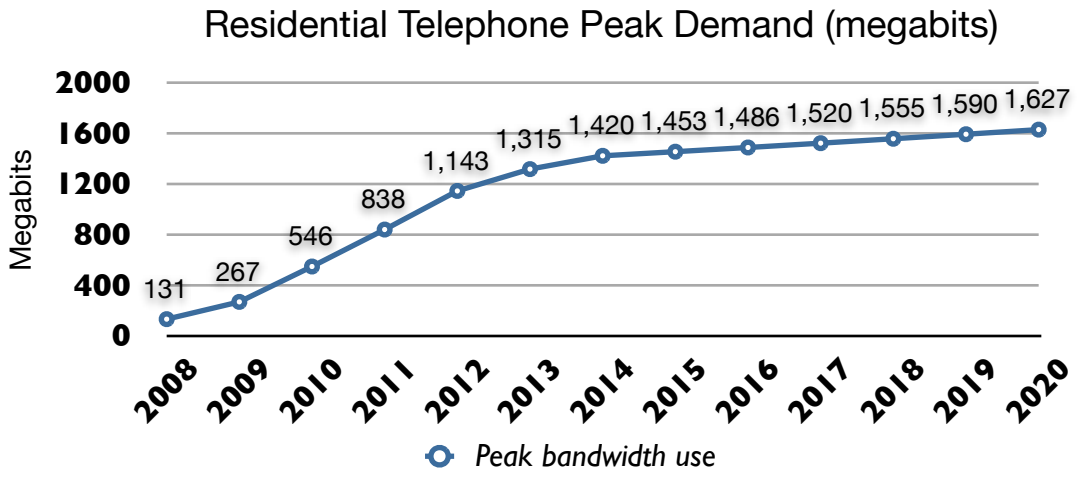

Business Internet Demand, Peak Use
Megabits
4000
3200
2400
1600
800
0
17
41
101
280
461
806
1,053
1,300
1,603
1,978
2,441
3,013
3,720
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
Peak use

Residential Telephone Demand in Powhatan

Most homes have a telephone, and despite a gradual shift among college age people to have only a cellphone, most homes will continue to have at least one landline, especially as VoIP phone service becomes more widely available: VoIP phone services are already being bundled with other packages, and will be less expensive than a cellphone (unlike the current situation, where many cellphone plans are less expensive than landlines).

Year	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Households	9,875	10,101	10,333	10,570	10,812	11,060	11,314	11,573	11,838	12,109	12,387	12,671	12,961
Households with phone	8,817	9,019	9,226	9,438	9,654	9,875	10,102	10,334	10,570	10,812	11,060	11,314	11,573
Take rate	10%	20%	40%	60%	80%	90%	95%	95%	95%	95%	95%	95%	95%
Average band-width use	14	29	59	91	124	142	154	157	161	164	168	172	176
Peak bandwidth use	131	267	546	838	1,143	1,315	1,420	1,453	1,486	1,520	1,555	1,590	1,627



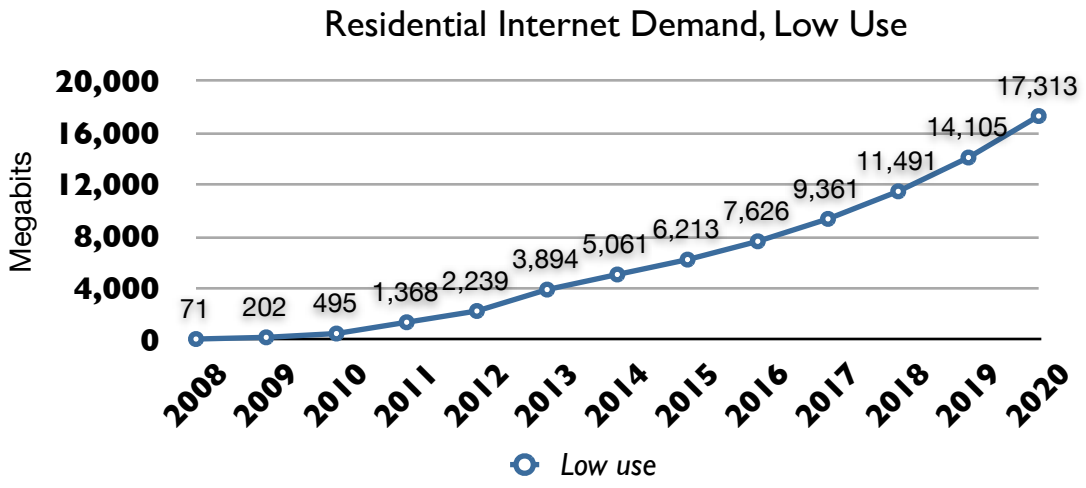


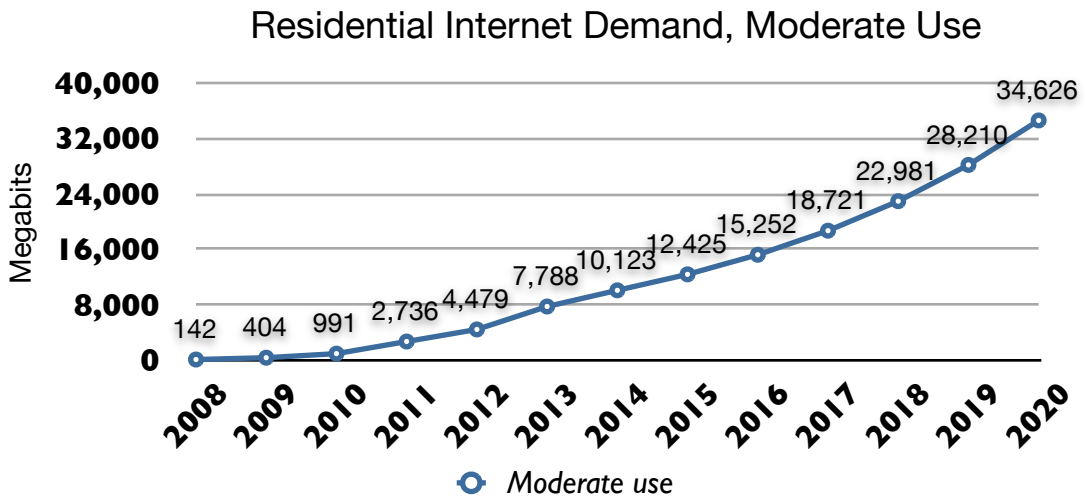
Residential Internet Demand in Powhatan

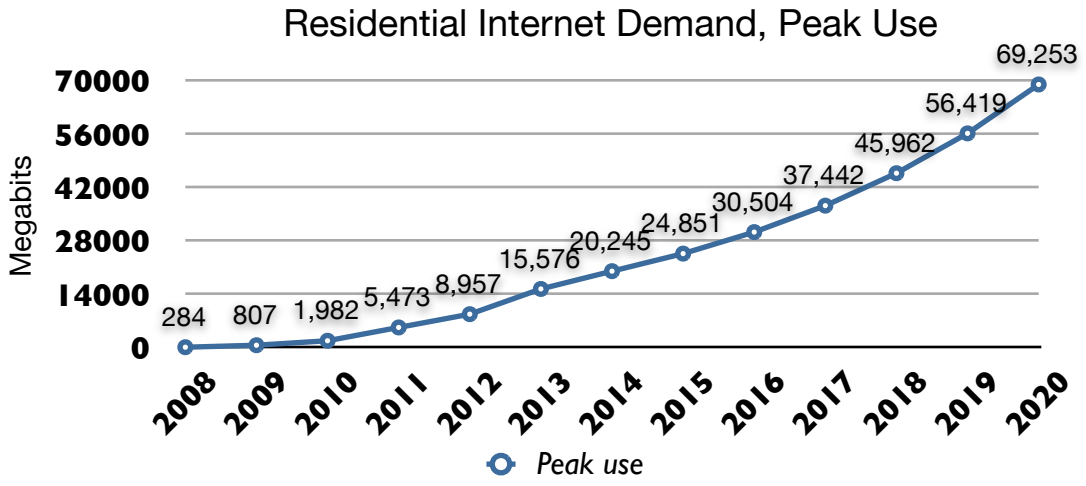
Residential Internet demand will be highly variable, based on time of day and type of service. Powhatan County residents will make wide use of many kinds of services, including:

- Email
- Web surfing
- Shopping online
- Distance learning
- Work from home opportunities, both full time and part time
- Backup services (long term storage of photos, home movies, and music)
- Home security services
- Telemedicine and telehealth services
- Access to news and current events

Year	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Households	9,875	10,101	10,333	10,57	10,812	11,060	11,314	11,573	11,838	12,109	12,387	12,671	12,961
Households with Internet (%)	78%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%
Households with Internet	7,674	9,091	9,300	9,513	9,731	9,954	10,183	10,416	10,654	10,898	11,148	11,404	11,665
Take rate	5%	10%	20%	45%	60%	85%	90%	90%	90%	90%	90%	90%	90%
Low use	71	202	495	1,368	2,239	3,894	5,061	6,213	7,626	9,361	11,491	14,105	17,313
Moderate use	142	404	991	2,736	4,479	7,788	10,123	12,425	15,252	18,721	22,981	28,210	34,626
Peak use	284	807	1,982	5,473	8,957	15,576	20,245	24,851	30,504	37,442	45,962	56,419	69,253




Residential Internet Demand, Moderate Use
Megabits
40,000
32,000
24,000
16,000
8,000
0
142
404
991
2,736
4,479
7,788
10,123
12,425
15,252
18,721
22,981
28,210
34,626
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
Moderate use


Residential Internet Demand, Peak Use
Megabits
70000
56000
42000
28000
14000
0
284
807
1,982
5,473
8,957
15,576
20,245
24,851
30,504
37,442
45,962
56,419
69,253
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
Peak use

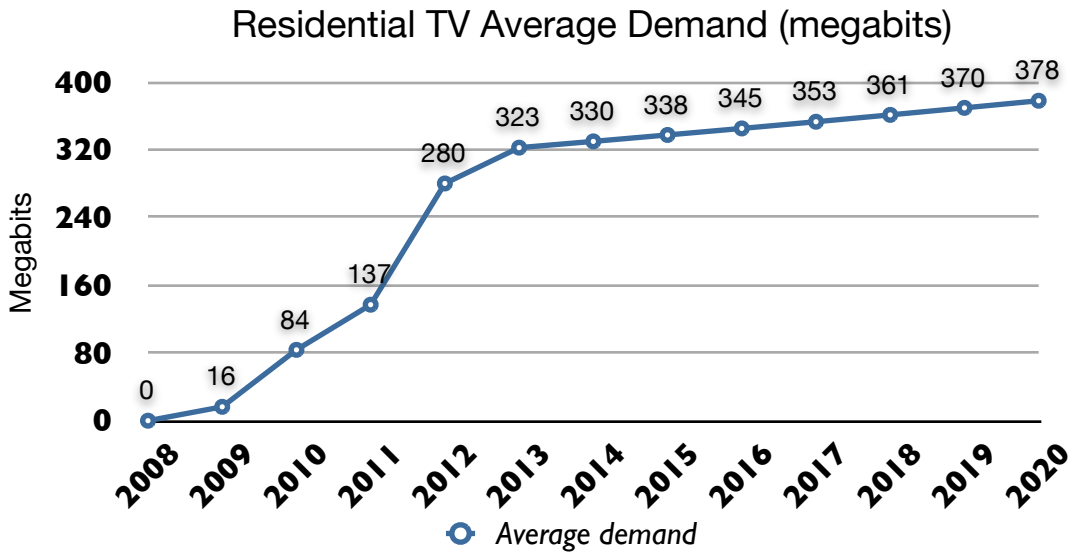
Distance learning from home with live video feeds will require high performance 2+ megabit connections in the near term (next 2-4 years), and over the next 4 to 7 years, there will be many distance learning courses that will incorporate live HD two way video feeds, enabling students to participate in classroom discussions at a much higher quality level. Given Powhatan's distance from four year schools, distance learning could be an important home-based application for workforce training and retraining. Some Virginia community colleges offer "hybrid courses" where a student attends several class sessions at the college and the remaining sessions online from their home, the library, or another location.

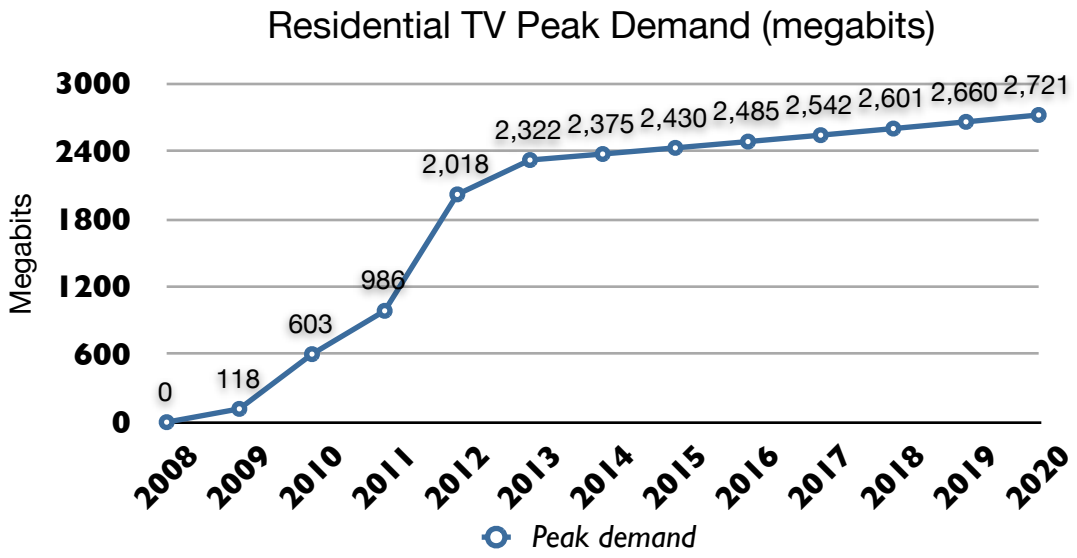
Entertainment will also drive bandwidth demand from the home, and the popularity of video sites like YouTube provide a good indication of the long term demand for video in many forms, including:

- Live feeds (e.g. live TV shows, sports coverage, and live news reports).
- Video on demand (TV shows available for viewing at any time, rather than at scheduled times).
- Movies on demand (instead of going to the video store).
- Two way video conversations (family, friends).
- Video stored on home computers and distributed across the Internet (e.g. videos of grandchildren, family activities).
- Local video content streamed live or from a server (e.g. high school football games, other sporting events, council meetings, other civic activities).

HD video will create the most demand for bandwidth. A single channel of HD video requires 12 to 18 megabits of bandwidth. Most homes in Powhatan County have multiple, meaning that a minimum of 25 megabits of bandwidth is required just to have both televisions on and tuned to two different channels. If a third person in the home is attending an evening distance learning course that uses HD video, the total bandwidth need would be more than 40 megabits.

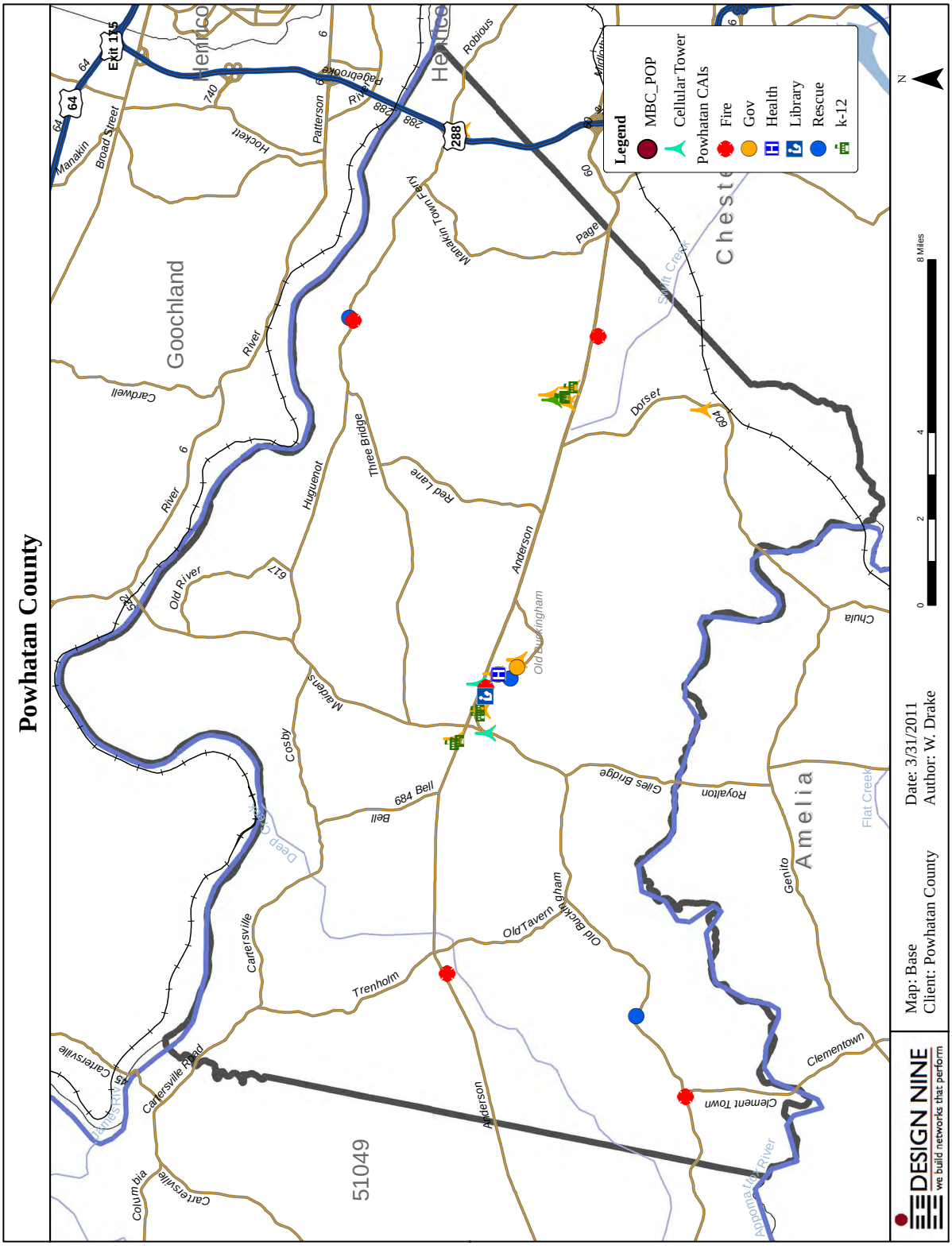
Year	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Households	9,875	10,101	10,333	10,570	10,812	11,060	11,314	11,573	11,838	12,109	12,387	12,671	12,961
Households with TV	8,888	9,091	9,300	9,513	9,731	9,954	10,183	10,416	10,654	10,898	11,148	11,404	11,665
Take rate	0%	5%	25%	40%	80%	90%	90%	90%	90%	90%	90%	90%	90%
Average demand	0	16	84	137	280	323	330	338	345	353	361	370	378
Peak demand	0	118	603	986	2,018	2,322	2,375	2,430	2,485	2,542	2,601	2,660	2,721

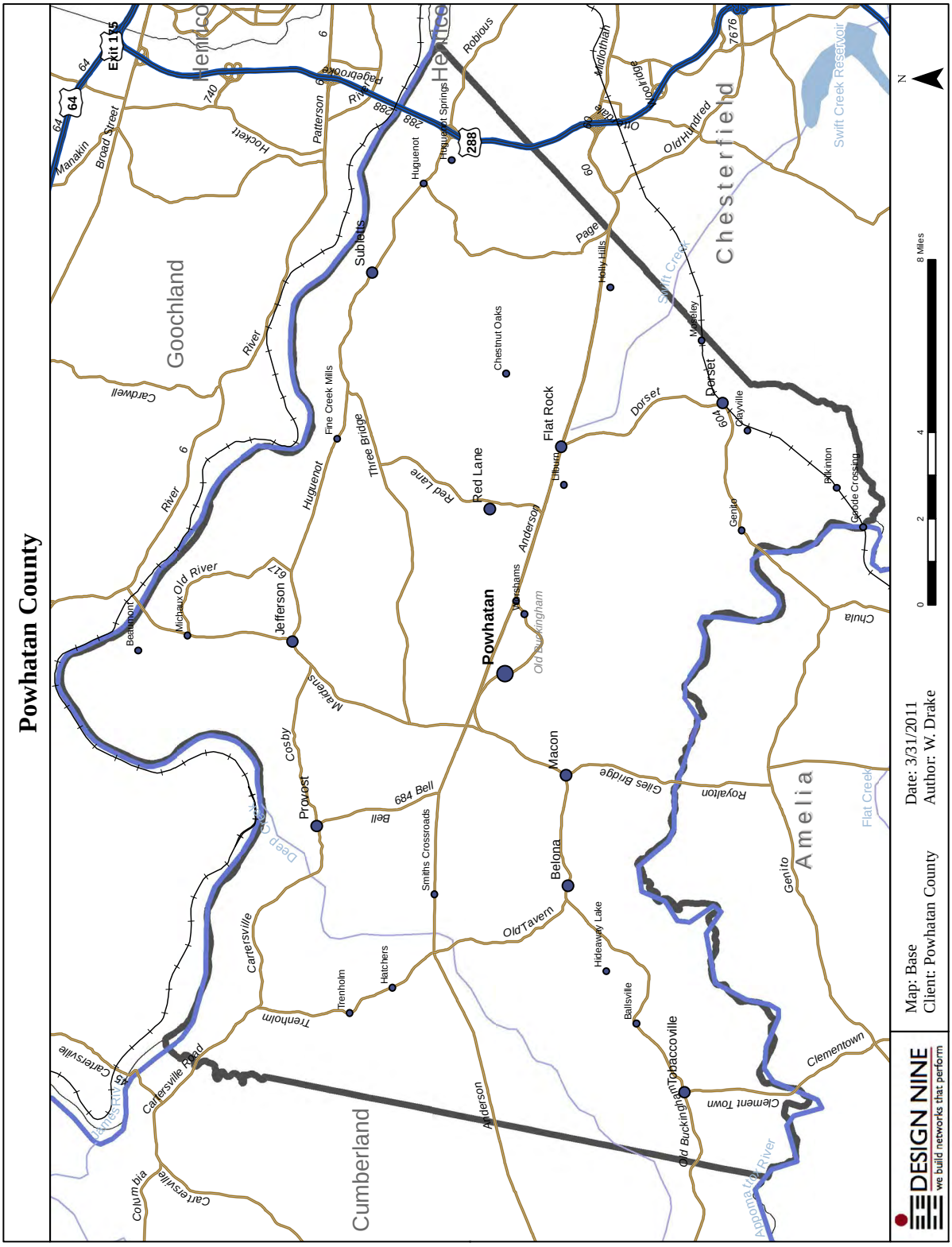

Residential TV Average Demand (megabits)
Megabits
400
320
240
160
80
0
0
16
84
137
280
323
330
338
345
353
361
370
378
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
Average demand

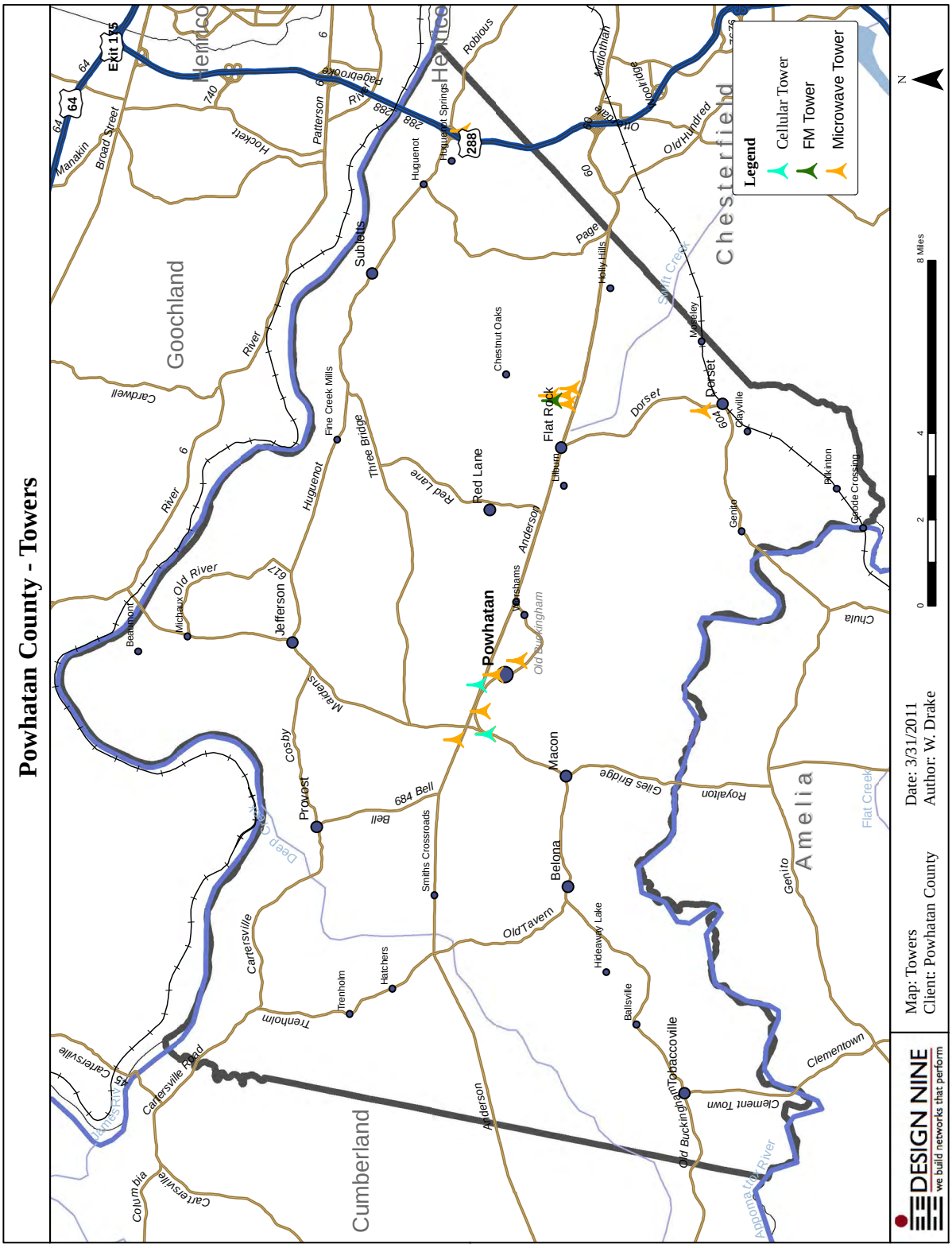

Residential TV Peak Demand (megabits)
Megabits
3000
2400
1800
1200
600
0
0
118
603
986
2,018
2,322
2,375
2,430
2,485
2,542
2,601
2,660
2,721
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
Peak demand

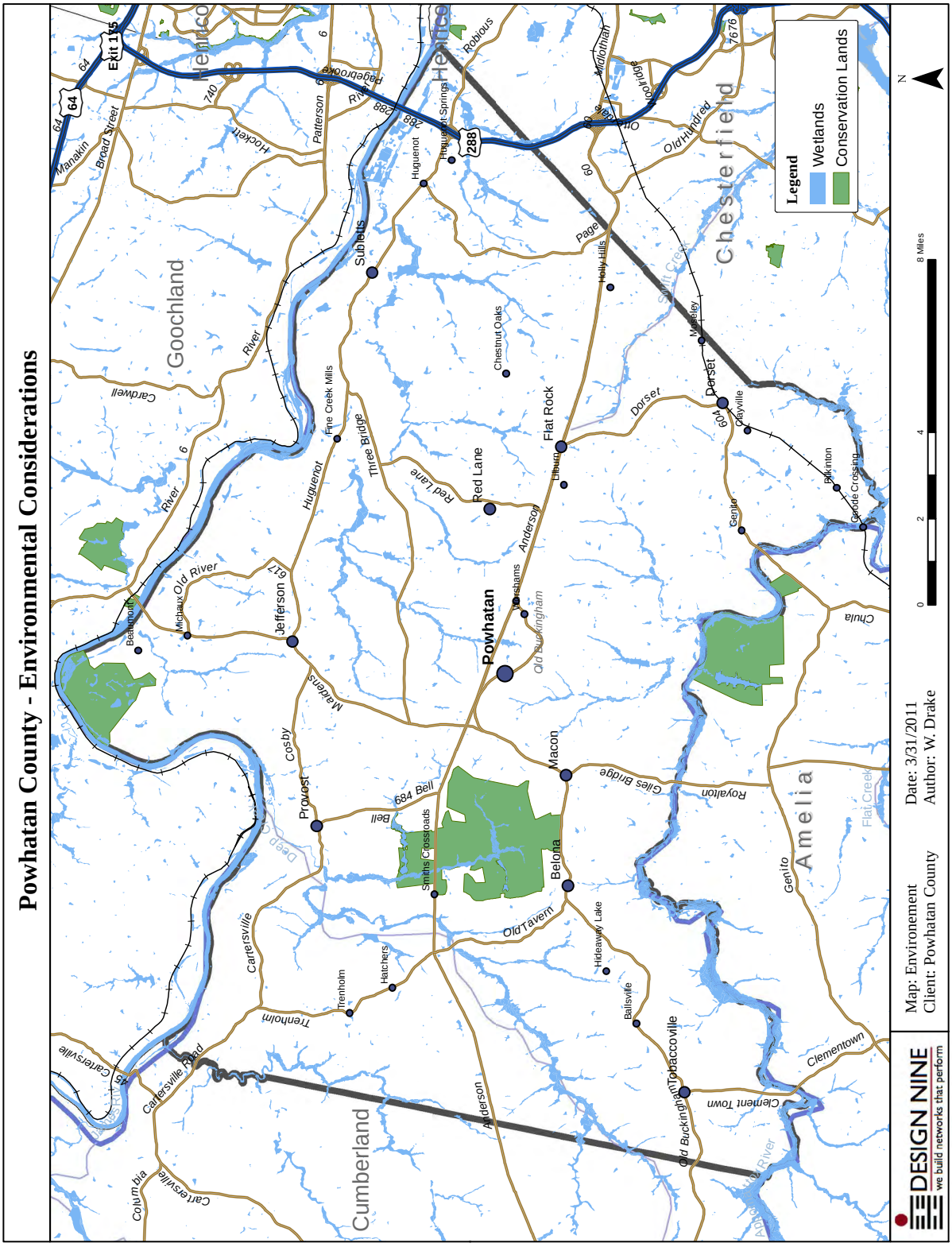
Powhatan County Community Facilities

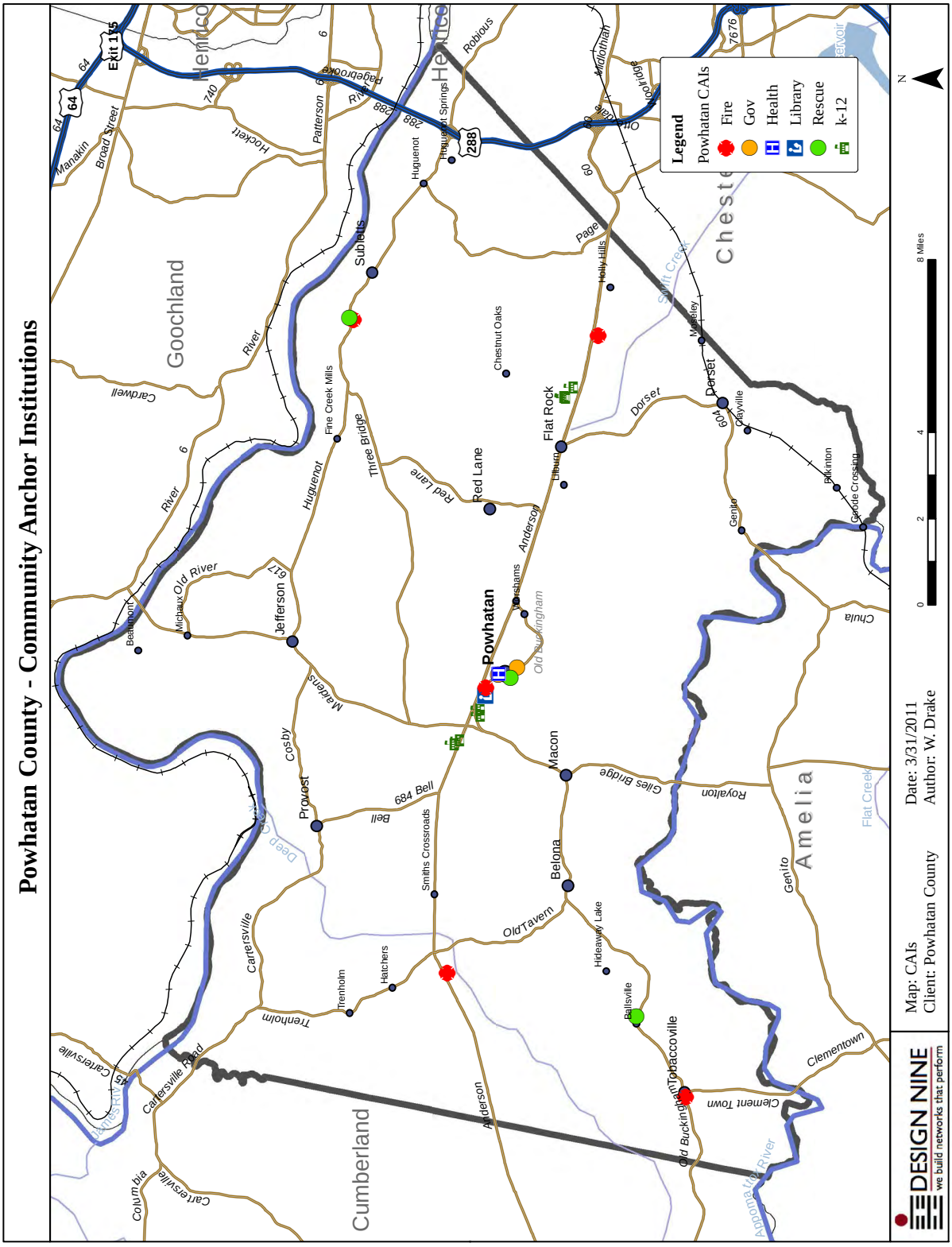
Name	Address	Category
Flat Rock Elementary School	2210 Batterson Road	k-12
Powhatan High School	1800 Judes Ferry Road	k-12
Powhatan Vocational School	1800 Judes Ferry Road	k-12
Powhatan Elementary School	4111 Old Buckingham Road	k-12
Powhatan Junior High	4135 Old Buckingham Road	k-12
Pocahantas Middle School	4290 Anderson Highway	k-12
Pocahantas Elementary School	4294 Anderson Highway	k-12
Macon Co. 3	6377 Old Buckingham Road	Fire
Ballsville		Rescue
Deep Creek Co. 5	5631 Anderson Highway	Fire
Powhatan Co. 1	3971 Old Buckingham Road	Fire
Main Station		Rescue
Huguenot Co. 2	1922 Urbine Road	Fire
Fine Creek		Rescue
Fine Creek Co. 4	1825 Huguenot Trail	Fire
County Administration	3834 Old Buckingham Road	Gov
Emergency Management	3864 Old Buckingham Road	Gov
Free Clinic	3908 Old Buckingham Road	Health
Public Library	2270 Mann Road	Library

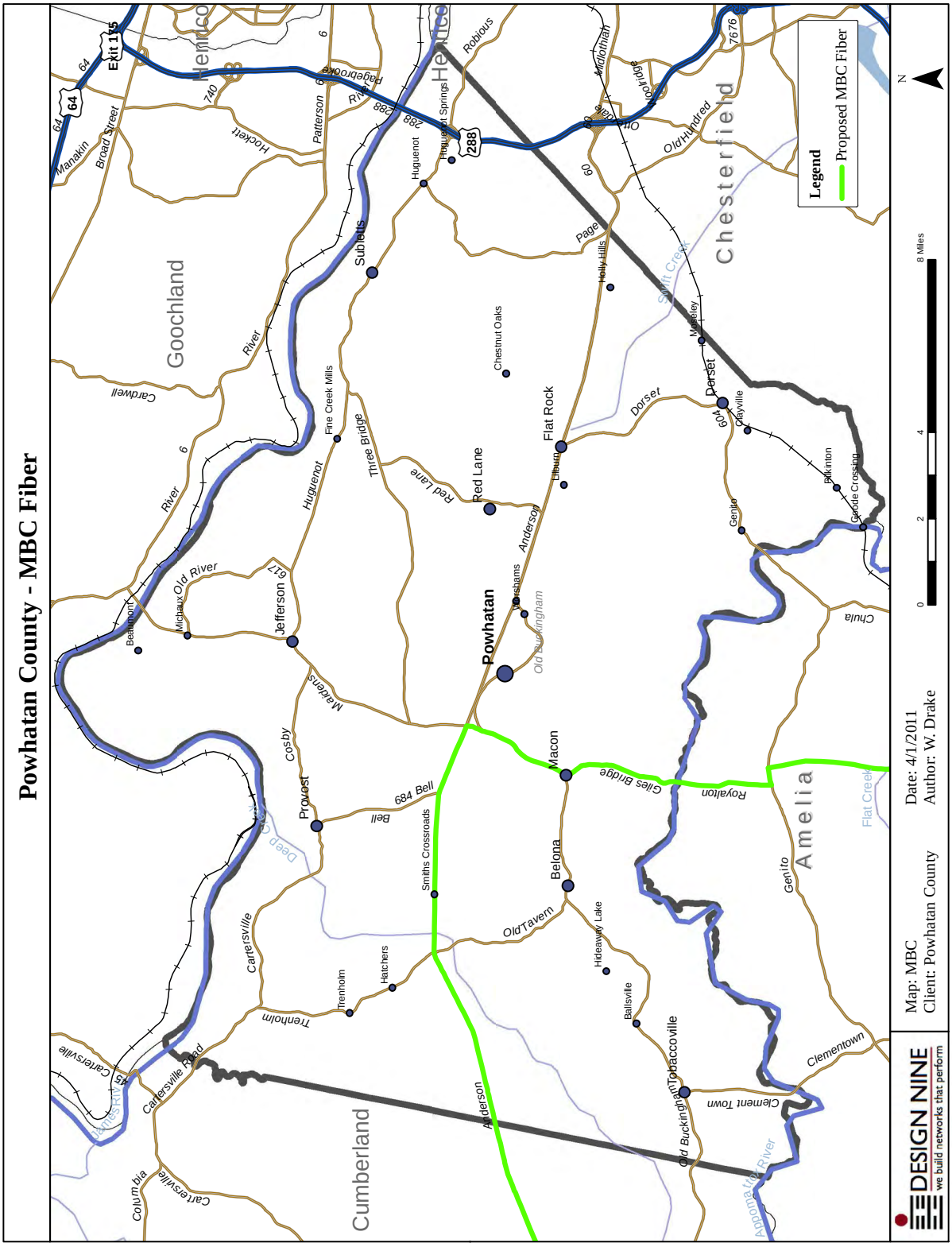

Powhatan County
Legend
MBC_POP
Cellular Tower
Powhatan CAIs
Fire
Gov
Health
Library
Rescue
k-12
Map: Base
Client: Powhatan County
Date: 3/31/2011
Author: W. Drake
DESIGN NINE
we build networks that perform
0
2
4
8 Miles
N
Goochland
Amelia
Chesterfield
Exit 175
Manakin
Broad Street
Hockett
Patterson
Ragebrooke
Robious
Midlothian
Page
Dorset
Swift Creek
Chula
Manakin Town Ferry
Three Bridge
Red Lane
Huguenot
Anderson
Old Buckingham
Old River
Cardwell
Maidens
Cosby
Bell
684 Bell
Giles Bridge
Royalton
Genito
Flat Creek
Deep Creek
Carters Run
Carters Run
Carterville
Carterville Road
Columbia
Carterville
Trenholm
Old Tavern
Old Buckingham
Clement Town
Clementtown
Appomattox River
51049
740
288
64
9
6
60
604
617
45

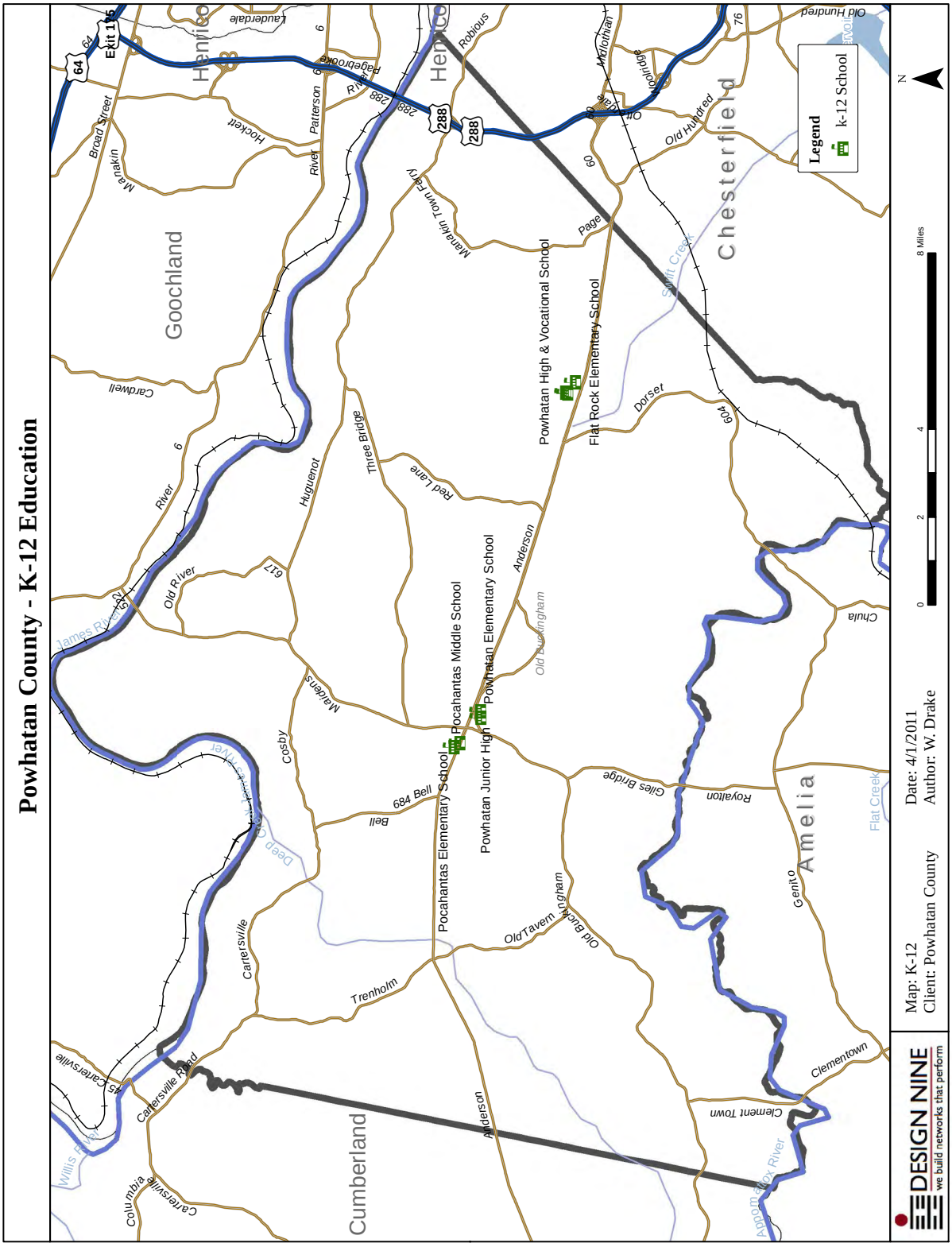

Powhatan County
Goochland
Cumberland
Chesterfield
Amelia
Powhatan
Flat Rock
Red Lane
Belona
Macon
Provost
Subletts
Dorset
Tobaccoville
Clementown
Swift Creek Reservoir
Map: Base
Client: Powhatan County
Date: 3/31/2011
Author: W. Drake
DESIGN NINE
we build networks that perform
0
2
4
8 Miles
N

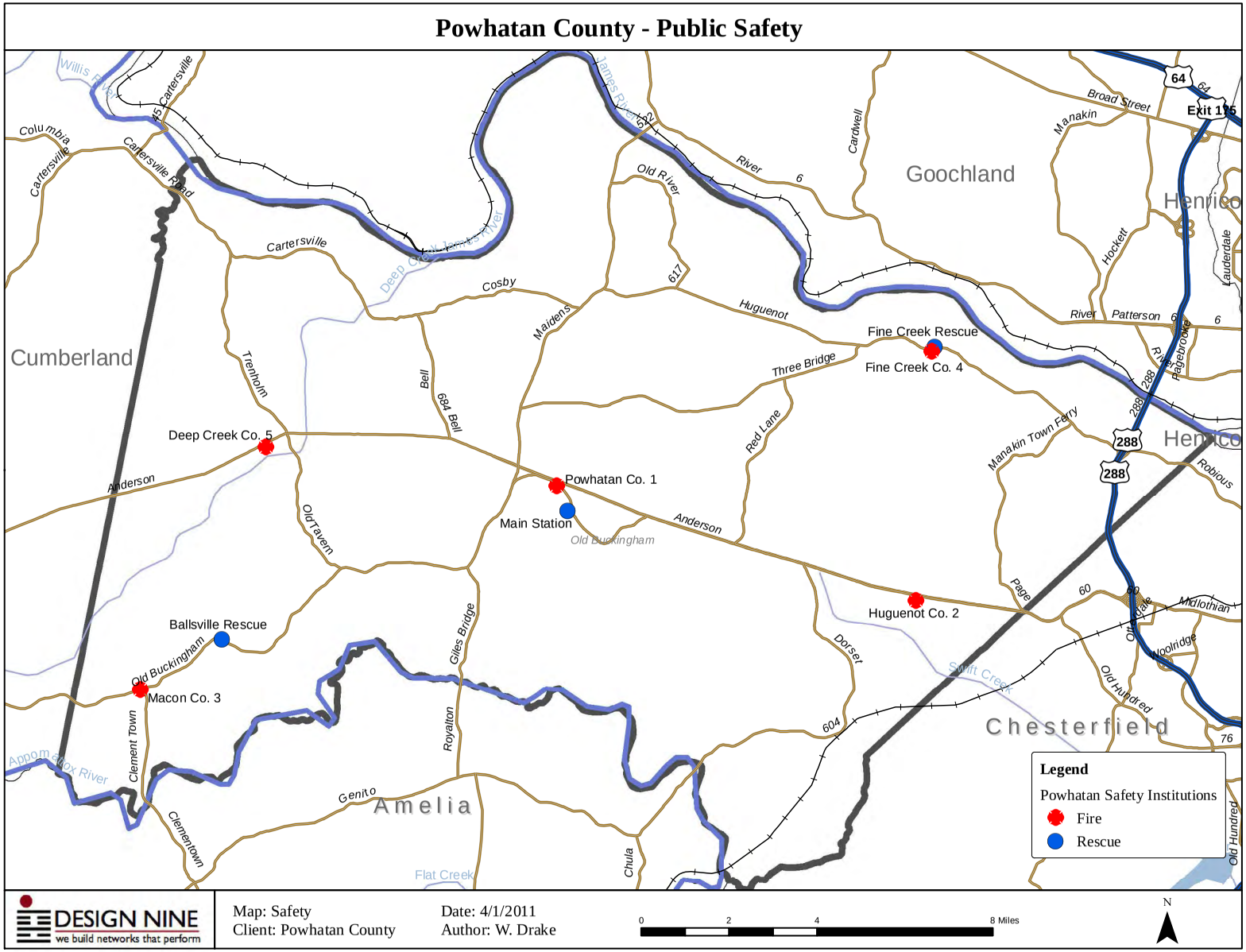

Powhatan County - Towers
Legend
Cellular Tower
FM Tower
Microwave Tower
Map: Towers
Client: Powhatan County
Date: 3/31/2011
Author: W. Drake
DESIGN NINE
we build networks that perform
Goochland
Cumberland
Chesterfield
Amelia
Powhatan
Red Lane
Flat Rock
Macon
Belona
Old Tavern
Dorset
Genito
Clementown
Tobaccoville
Ballsville
Hideaway Lake
Smiths Crossroads
Provost
Cosby
Jefferson
Subletts
Huguenot
Three Bridge
Fine Creek Mills
Chestnut Oaks
Holly Hills
Page
Swift Creek
Midlothian
Old Hundred
Robious
Huguenot Springs
Beaumont
Michaux
Old River
Carwell
Manakin
Broad Street
Exit 135
Hockett
Patterson
Pagebrooke
Trenholm
Hatchers
Carterstville
Carterstville Road
Columbia
Deep Creek
Flat Creek
Appomattox River
Old Buckingham
Anderson
Marlens
Bell
684 Bell
Giles Bridge
Royalton
Clement Town
Genlyd
Gayville
Bikinton
Goode Crossing
Chula
Moseley
Libuno
Yorshams
0
2
4
8 Miles
N


Powhatan County - Environmental Considerations
Legend
Wetlands
Conservation Lands
Powhatan
Flat Rock
Red Lane
Belona
Macon
Subletts
Genito
Tobaccoville
Clementown
Cumberland
Goochland
Chesterfield
Amelia
Map: Environement
Client: Powhatan County
Date: 3/31/2011
Author: W. Drake
DESIGN NINE
we build networks that perform
0
2
4
8 Miles
N


Powhatan County - Community Anchor Institutions
Legend
Powhatan CAIs
Fire
Gov
Health
Library
Rescue
k-12
Map: CAIs
Client: Powhatan County
Date: 3/31/2011
Author: W. Drake
DESIGN NINE
we build networks that perform
0
2
4
8 Miles
N
Powhatan
Goochland
Cumberland
Amelia
Chesterfield
Henrico
Hanover
Exit 135
64
Manakin
Broad Street
Hockett
Patterson
Pagebrooke
740
288
Huguenot
Huguenot Springs
Robious
Midlothian
Turnpike
Old
Page
Holly Hills
Swift Creek
Moseley
Dorset
Otterville
Perkinton
Gaddie Crossing
Genito
Chula
Flat Rock
Libbie
Chestnut Oaks
Red Lane
Three Bridge
Fine Creek Mills
Subletts
Cardwell
River
Huguenot
Michaux
Old River
Jefferson
617
Bellmont
Anderson
Powhatan
Old Buckingham
Madkins
Cosby
Provost
Bell
684
Macon
Giles Bridge
Royalton
Belona
Smiths Crossroads
Old Tavern
Hideaway Lake
Ballsville
Tobaccoville
Clement Town
Clementown
Flat Creek
Appomattox River
Columbia
Cartersville
Cartersville Road
Trenholm
Hatchers
Deep Creek
Old Buckingham


Powhatan County - MBC Fiber
Legend
Proposed MBC Fiber
Map: MBC
Client: Powhatan County
Date: 4/1/2011
Author: W. Drake
DESIGN NINE
we build networks that perform
0
2
4
8 Miles
N
Goochland
Cumberland
Powhatan
Amelia
Chesterfield
Henrico
Powhatan
Flat Rock
Red Lane
Belona
Macon
Provost
Subletts
Dorset
Tobaccoville
Clementown
Cartersville
Jefferson
Michaux
Beaumont
Trenholm
Hatchers
Smiths Crossroads
Old Tavern
Hideaway Lake
Ballsville
Genito
Clement Town
Chula
Genito
Deep Run
Swift Creek
Flat Creek
Appomattox River
Old Buckingham
Anderson
Giles Bridge
Royalton
Bell
Three Bridge
Fine Creek Mills
Chestnut Oaks
Holly Hills
Midlothian
Old Hundred
Robious
Huguenot
Huguenot Springs
Patterson
Hockett
Broad Street
Manakin
Exit 195
64
288
60
6
9
617
684
7676
740


Powhatan County - K-12 Education
Legend
k-12 School
Pocahantas Elementary School
Pocahantas Middle School
Powhatan Junior High
Powhatan Elementary School
Powhatan High & Vocational School
Flat Rock Elementary School
Goochland
Cumberland
Chesterfield
Amelia
Henrico
Exit 116
Broad Street
Hockett
Patterson
Rayebrooke
Robious
Midlothian
Old Hundred
Old Huguenot
Three Bridge
Red Lane
Page
Dorset
Anderson
Old Buckingham
Old Tavern
Trenholm
Carters ville
Carters ville Road
Cosby
Watkins
Bell
684 Bell
Giles Bridge
Royalton
Genito
Clementown
Clement Town
Chula
Flat Creek
Swift Creek
Deep Creek
James River
Old River
Willis River
Appomattox River
Columbia
Maryland
Lauderdale
Cardwell
Maryland
Maryland Town Ferry
Old Buckingham
Old Tavern
Old Hundred
Carters ville
Carters ville Road
Anderson
Clement Town
Clementown
Royalton
Giles Bridge
Bell
684 Bell
Cosby
Watkins
Trenholm
Old Buckingham
Old Tavern
Anderson
Page
Dorset
Old Huguenot
Three Bridge
Red Lane
Anderson
Old River
James River
Willis River
Deep Creek
Flat Creek
Swift Creek
Appomattox River
Columbia
Carters ville
Chula
Genito
Royalton
Giles Bridge
Bell
684 Bell
Cosby
Watkins
Trenholm
Old Buckingham
Old Tavern
Anderson
Clement Town
Clementown
Carters ville Road
Carters ville
Old River
Huguenot
Three Bridge
Red Lane
Page
Dorset
Anderson
Old Huguenot
Old River
Maryland
Maryland Town Ferry
Cardwell
Lauderdale
Hockett
Patterson
Rayebrooke
Robious
Midlothian
Old Hundred
Broad Street
Exit 116
64
288
60
76
9
6
Map: K-12
Client: Powhatan County
Date: 4/1/2011
Author: W. Drake
DESIGN NINE
we build networks that perform
0
2
4
8 Miles
N


Powhatan County - Public Safety
Cumberland
Goochland
Henrico
Chesterfield
Amelia
Fine Creek Rescue
Fine Creek Co. 4
Deep Creek Co. 5
Powhatan Co. 1
Main Station
Huguenot Co. 2
Ballsville Rescue
Macon Co. 3
Old Buckingham
Cartersville
Cosby
Maidens
Huguenot
Three Bridge
Red Lane
Manakin Town Ferry
Anderson
Old Tavern
Trenholm
Bell
684 Bell
Gilles Bridge
Royalton
Clement Town
Clementtown
Genito
Dorset
Page
Swift Creek
Old Hundred
Midlothian
Broad Street
Exit 175
Manakin
Cardwell
Old River
Hocket
Lauderdale
Patterson
Ridgebrooke
Robious
Deep Creek
Flat Creek
Chula
Appomattox River
James River
Willis River
Columbia
Cartersville Road
Old Buckingham
Legend
Powhatan Safety Institutions
Fire
Rescue
DESIGN NINE
we build networks that perform
Map: Safety
Client: Powhatan County
Date: 4/1/2011
Author: W. Drake
0
2
4
8 Miles
N

Powhatan County - Community Anchor Institutions