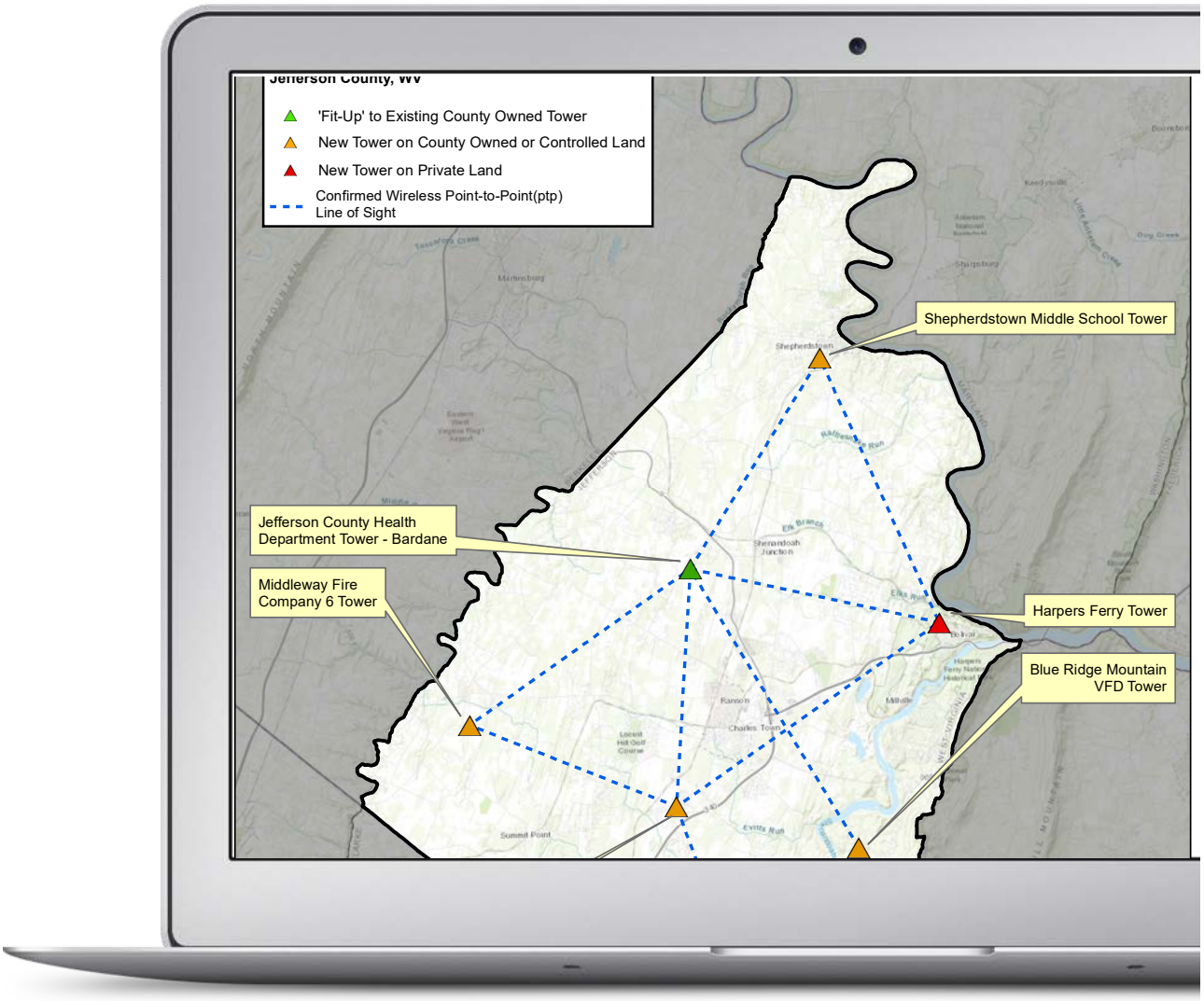
TECHNICAL BROADBAND DEVELOPMENT PLAN

Jefferson County, West Virginia



DESIGN NINE
broadband planners

TABLE OF CONTENTS

1 EXECUTIVE SUMMARY

A broadband study of Jefferson County began in the summer of 2020 and was completed later in 2020. The study included meetings with stakeholders and interested parties in the county, interviews and meetings with businesses, meetings with county officials, and residential and business broadband surveys. The report has several key sections:

- **Technical and Asset Analysis** – Demographic data, tower and fiber assets in the county, underserved and unserved areas of the county, and geo-coded survey results.
- **Market, Current Use, and Gap Analysis** – A review of current service provider service offerings, speeds, and prices for those services and what bandwidth is available.
- **Broadband Surveys** – In Jefferson County, both a residential broadband survey and a business broadband survey was distributed. A strong response was received.
- **Connectivity Solutions** – This section provides an overview of various technologies, including both broadband wireless and broadband fiber.
- **Preliminary Design and Cost Estimates** – Design and estimates of county-wide fixed point wireless network and fiber designs and cost estimates for three fiber projects.
- **Infrastructure Funding and Grant Opportunities** – A discussion of a variety of grant and funding strategies.

The survey data collected as part of this study indicates that residents and businesses are anxious for better Internet service. Because a very large number of often passionate comments were received, they have been included in a separate document.

- 89% of respondents are interested in having access to Gigabit fiber Internet.
- 97% believe that local government should help facilitate better Internet access.
- 55% of residents report the quality of Internet service is affecting where they choose to live.
- 99% of businesses indicated that the Internet is important to the success of their business.
- 88% of businesses reported that they need employees able to work from home.

Summary of Findings and Recommendations

The County government should not become an Internet provider. Instead, it should focus on developing public/private partnerships by making targeted investments in broadband infrastructure like towers and dark fiber. These assets have long life spans of forty years or more and can be leased out to private sector ISPs. While the revenue from the lease agreements will be modest, the funds generated can be used to support maintenance of this infrastructure.

Improved and Affordable Fiber and Wireless is Needed. Many residents and businesses rely heavily on poor DSL Internet access and need an alternative. Making county-owned towers available to Wireless Internet Service Providers (WISPs) and provisioning new towers in some underserved areas will support improved Internet service. Business parks, industrial parks, and downtown areas will all benefit from community-owned fiber. Affordable and available fiber in economic growth target areas can increase property values, make commercial and industrial building spaces more attractive, and help attract and retain jobs and businesses.

Seek Grant Funds. The Federal government has been steadily increasing the amount of grant funding available for broadband infrastructure, with USDA and HUD both having programs that are designed to help underserved and unserved areas construct new broadband infrastructure. Some Federal grant applications will be due in mid-spring of 2021, so planning for submitting grant proposals should begin in early January 2021.

Manage Expectations. The current deficiencies in Internet access in the county took decades to develop, and the proposed improvements should be approached as a multi-year process, with an expectation of substantial improvements in access and availability in twelve to eighteen months.

Make Basic Investments in Broadband Infrastructure. The map on the next page show the recommended wireless and fiber identified for Jefferson County. The locations were selected based on underserved and unserved areas of the county that could benefit from improved broadband service. Each key area project includes one or more new or existing towers that are fitted for use by WISPs (Wireless Internet Service Providers). The locations identified are not the only places that towers may be needed, and WISPs should be asked to assist in identifying other areas in the county where new towers are needed. The table to the right shows the estimated costs for the proposed wireless improvements. These expenditures can be phased and built incrementally as funding is developed.

Meet with local and regional ISPs. ISPs should be provided a copy of this report, and then be invited to meet to provide input on what infrastructure investments would enable them to expand service most efficiently. Local and regional WISPs may be able to provide insight into where towers are most needed and what they are willing to pay for tower space. ISP suggestions should inform the broadband strategy for the County.

Develop a long term funding strategy. Grants may not provide sufficient funds to reach the County's long-term goals. Evaluate longer term funding strategies, like using a special assessment, or implementing a very small increase in property taxes. Revenue would be earmarked exclusively for broadband improvements. Expansion of broadband in Jefferson will be most successful by recognizing that funding will come from a range of funding sources rather than a single source. Grants, public/private partnerships, some local funds, and other sources may all be needed to achieve success.

Grants can be extremely important in the early stages of an effort to support planning activities and/or to fund a first-phase build-out initiative. However, grants rarely allow spending on operational expenses. Grants should be used carefully as one-time cash injections to support very specific goals. Communities that have relied too heavily on "the next grant" as a key source of expansion or operational funding usually experience severe financial problems.

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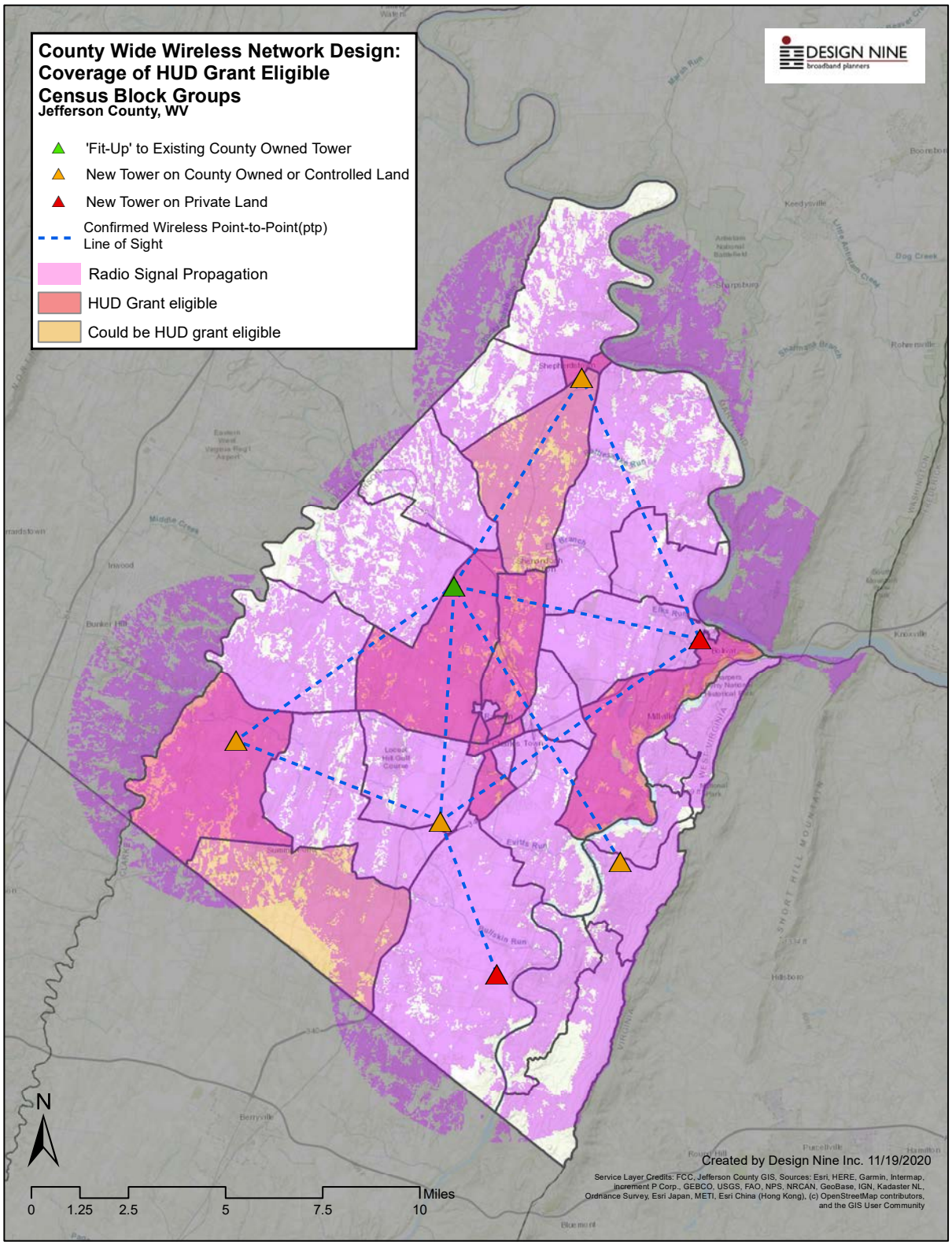
The map on the next page shows the proposed locations of new towers (six) and the improvements to one existing tower. This county-wide fixed point wireless broadband Internet design covers an estimated 86% of the county, and the remaining areas could be included by careful siting of community utility poles with line of sight to the taller towers. At least three of the proposed new towers are in areas eligible for HUD grants.


County Wide Wireless Network Design:
Coverage of HUD Grant Eligible
Census Block Groups
Jefferson County, WV
'Fit-Up' to Existing County Owned Tower
New Tower on County Owned or Controlled Land
New Tower on Private Land
Confirmed Wireless Point-to-Point(ptp)
Line of Sight
Radio Signal Propagation
HUD Grant eligible
Could be HUD grant eligible
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Created by Design Nine Inc. 11/19/2020
Service Layer Credits: FCC, Jefferson County GIS, Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

2 TECHNICAL AND ASSET ANALYSIS

A wide variety of assets in Jefferson County are identified in the following pages.

The included maps provide detail on the following:

Points of Interest – This information is used to identify key users of Internet services that could benefit from improved broadband infrastructure in the county. K12 schools, public safety facilities, fire and rescue locations, health facilities, and county facilities are included.

LMI/HUD Areas – Low and Moderate Income (LMI) and HUD-eligible areas often qualify for certain kinds of grants not available to other areas.

Towers – Of particular importance are towers, which can be divided approximately into two categories: publicly owned towers and privately owned towers. As a general rule, WISPs (Wireless Internet Service Providers) have found that the lease fees to obtain space on cellular towers is too high to justify the expected revenue from broadband Internet customers in the area around that tower. To improve broadband Internet coverage in rural areas of the county, some new towers are going to be needed, with very modest lease fees–to attract WISPs onto those towers.

The fixed point wireless network designs make the assumption that as a general rule, access to space on the cellular towers is too expensive, and so some new towers will be needed even where there may be an existing privately owned tower. If funding is developed for one or more of the county-wide wireless networks (or a portion of one of the county-wide networks), an early and important step would be to assess space availability on existing towers where the design has specified a tower. If some existing towers can be used rather than building a new tower, there would be significant cost savings.

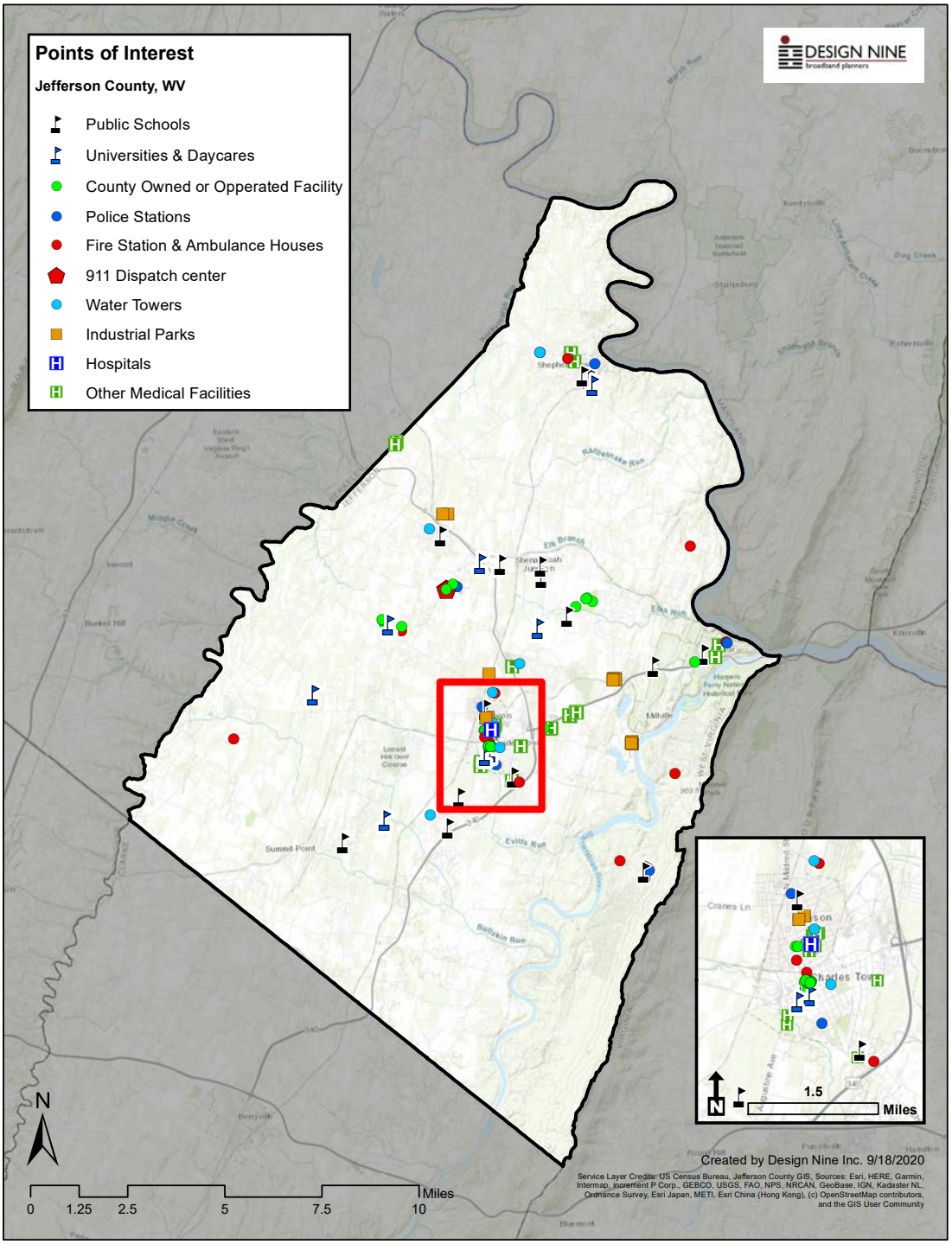
Fiber Routes – In most areas of the county, fiber routes are typically long haul routes passing through the county to other major metro areas and/or connecting only a few institutional and enterprise customers. Companies like Segra and Level3 have some local fiber available for business and institutional customers.

Service Levels – This map illustrates information on served, underserved, and unserved areas in the county obtained from FCC 477 reports. The data is self-reported by the service providers.

WV Broadband Council Data – This data has been provided by the West Virginia Broadband Enhancement Council and includes ISP-provided data and speed test results.

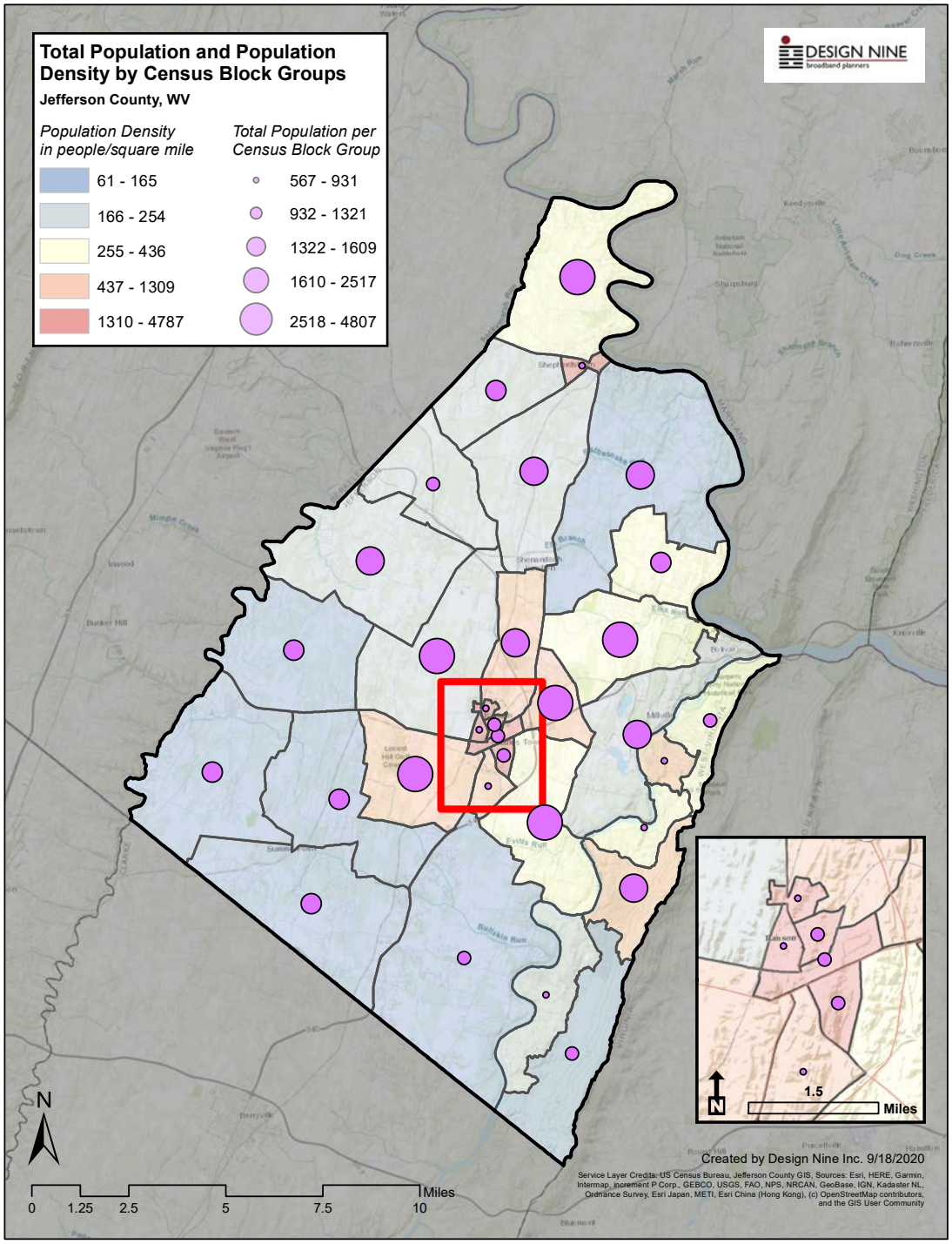
2.1 POINTS OF INTEREST

County facilities, municipal facilities, libraries, K12 and higher education facilities, fire and rescue stations, and public safety locations are all candidates to be anchor tenants for fixed point wireless and/or fiber services.



2.2 POPULATION AND DENSITY DISTRIBUTION

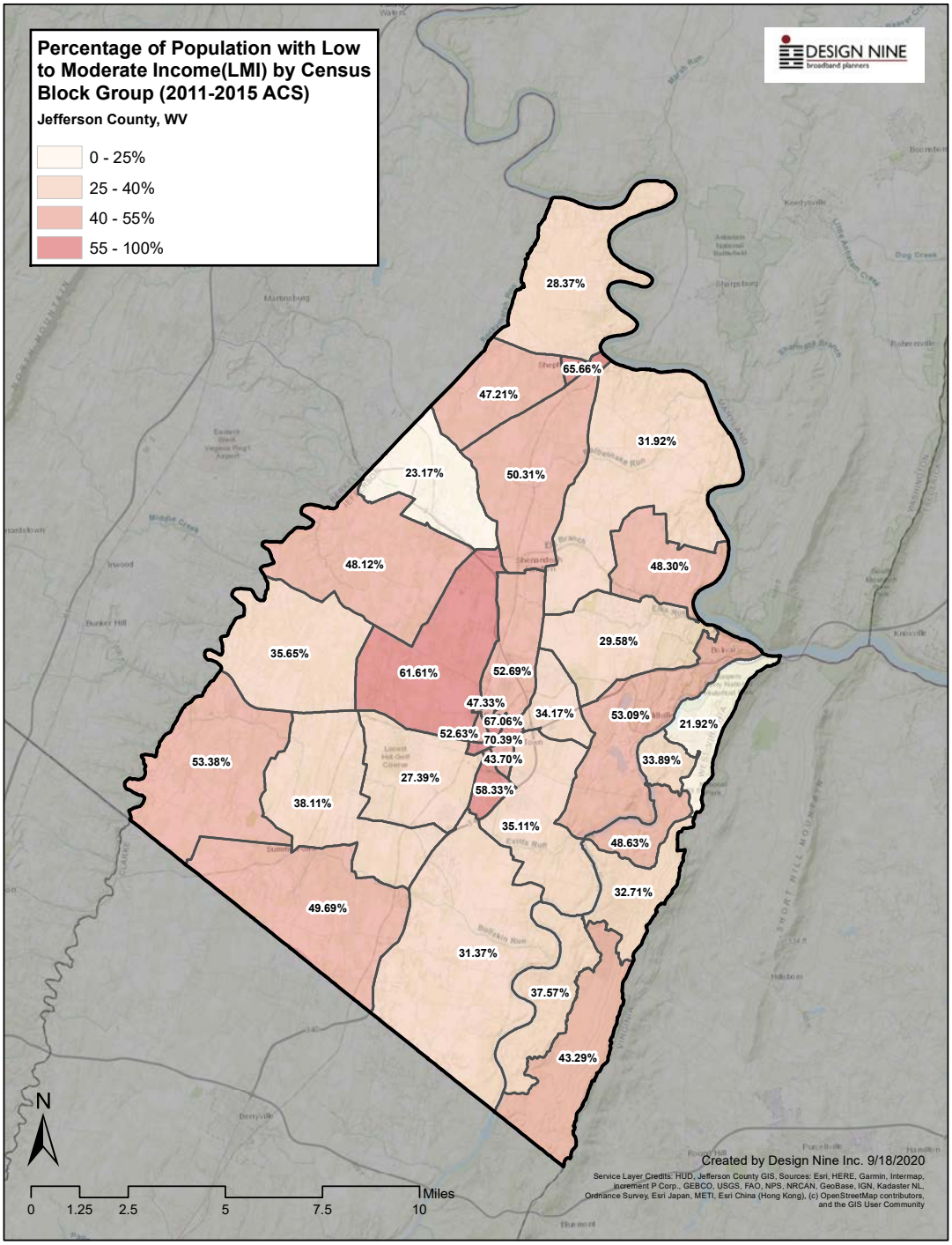
This map shows the population and density distribution in the county, by census block. This information can be helpful when working with service providers and when trying to identify what technologies are most appropriate for various areas of the county.

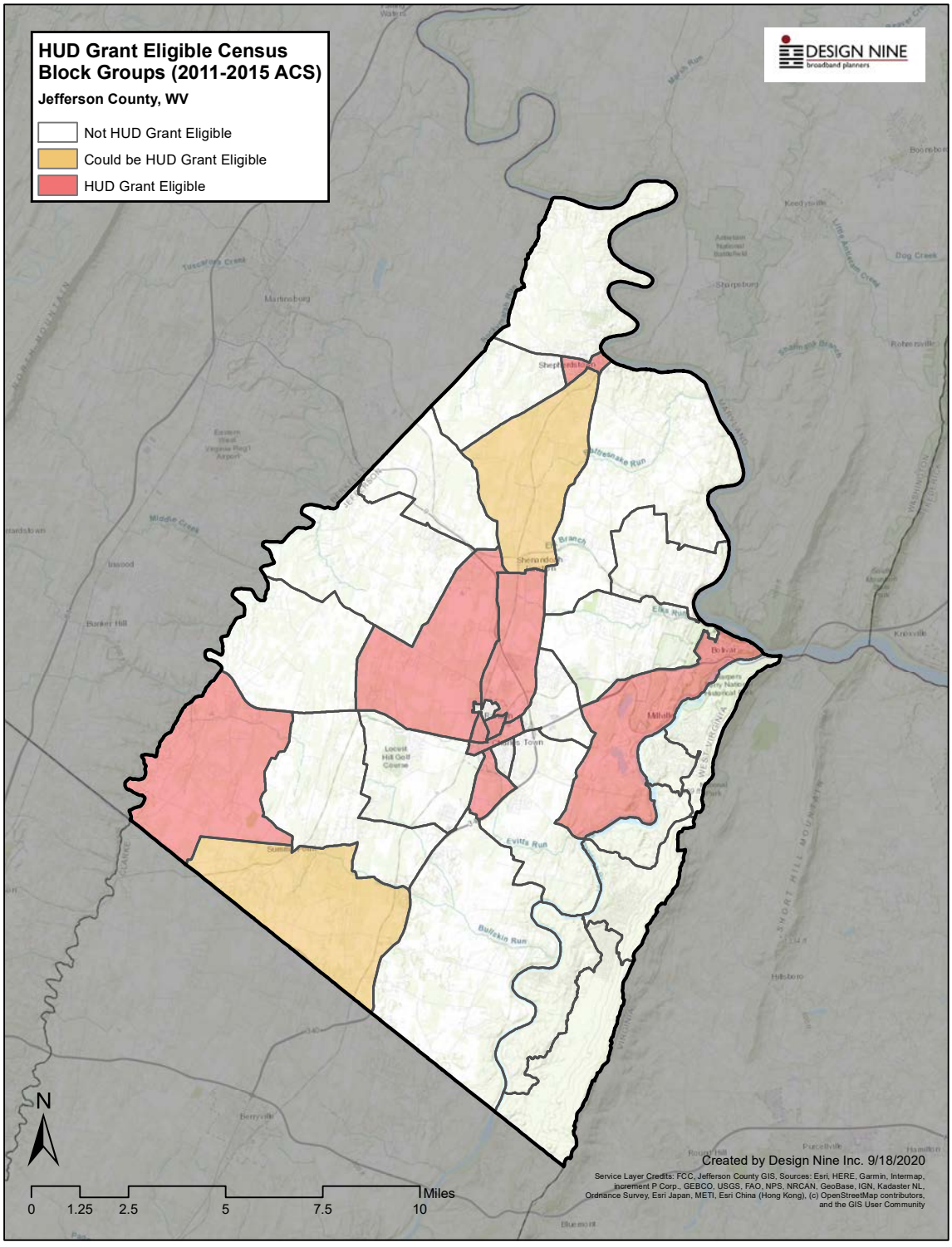


2.3 LMI AND HUD ELIGIBLE AREAS

HUD-eligible areas are determined by LMI (Low and Moderate Income) statistics—but can be different from census blocks in the county that meet LMI thresholds.

HUD-eligible census blocks can qualify for CDBG funding for telecom infrastructure projects.




HUD Grant Eligible Census Block Groups (2011-2015 ACS)
Jefferson County, WV
Not HUD Grant Eligible
Could be HUD Grant Eligible
HUD Grant Eligible
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Created by Design Nine Inc. 9/18/2020
Service Layer Credits: FCC, Jefferson County GIS, Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

2.4 TOWERS IN THE COUNTY

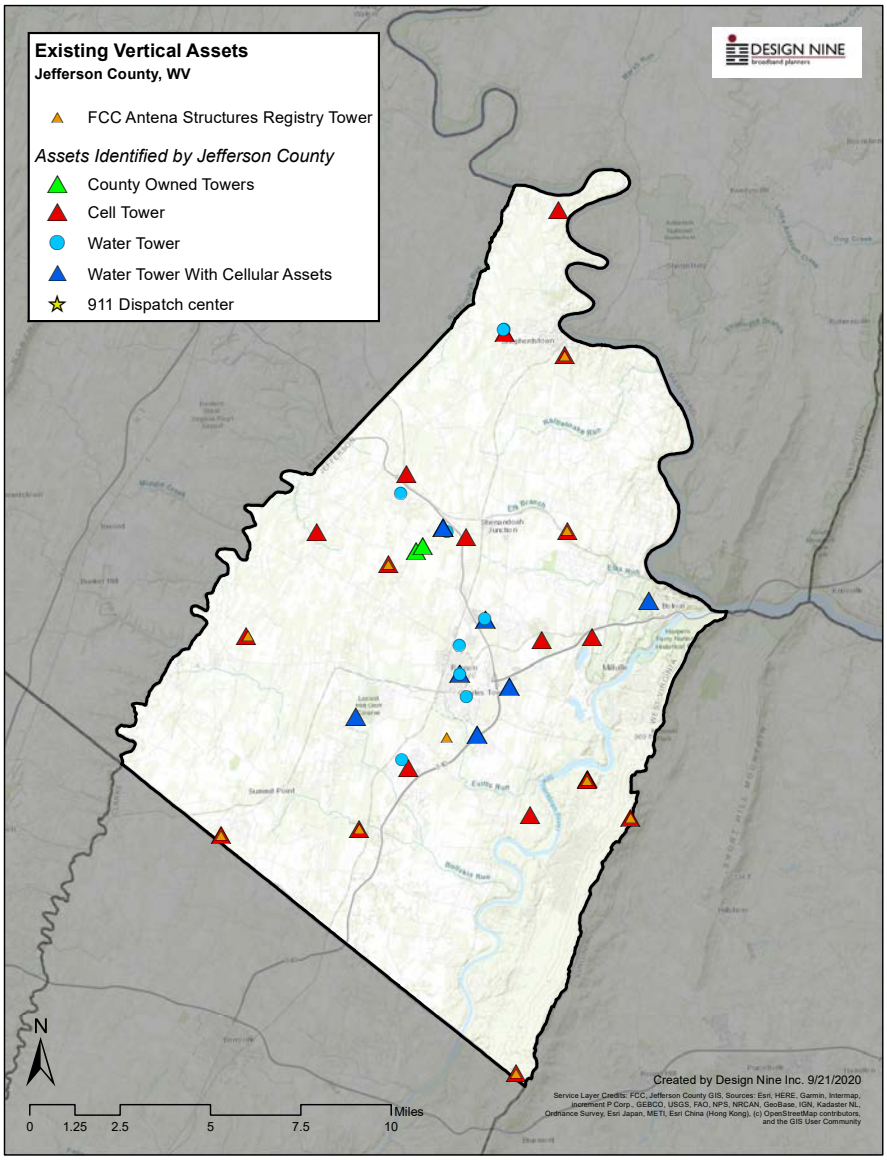
A variety of publicly-owned and privately owned towers are shown here. Tower data is collected from an FCC database, County data, and other publicly available sources. The FCC database usually includes most towers that are in a locality, and generally includes all or nearly all cellular towers. Tower ownership data is not always updated in a timely manner in the FCC database.

Towers can be divided approximately into two categories: publicly owned towers and privately owned towers. Publicly owned towers can be owned by local government, by regional authorities, or by the state. In the county, privately owned cellular towers are the most common type of tower, and are generally clustered along major roadways and higher density population areas.

Many commercial towers, especially cellular towers, may have tower lease fees that are too high for a WISP (Wireless Internet Service Provider) to make a business case for putting fixed point broadband equipment on the tower. The cost to a WISP for getting on a privately owned tower often has to be checked on a case by case (tower by tower) basis.

To improve broadband Internet coverage in rural areas of the county, some new towers are going to be needed, with very modest lease fees –to attract WISPs onto those towers.

A second consideration for placing WISP equipment on a cellular tower is where space is available–that is, at what height? Space may be available at an affordable price, but the location on the tower may not be high enough to cover an area large enough for a decent number of customers.



This table provides additional detail on tower owners and tower locations.

Tower Name, Jefferson Cty GIS OBJECTID, or FCC File Number	Tower Type	Address or Location Description	Tower or Parcel Owner	Tower Latitude	Tower Longitude	GIS data source
1983	Cell Tower	67 GRANNY SMITH LN	WALKER SARAH E ET AL	39.3789	-77.8837	Jefferson Cty GIS
3564	Cell Tower	8428 SHEPHERDSTOWN PIKE	UNITED STATES CELLULAR CORPORATION	39.4252	-77.8008	Jefferson Cty GIS
8135	Cell Tower	844 WHEATLAND RD	SUNNYSIDE LIMITED PARTNERSHIP	39.2368	-77.9113	Jefferson Cty GIS
9166	Cell Tower	125 ASHLAND WOODS DR	NORFOLK SOUTHERN RAILWAY COMPANY	39.2393	-77.7713	Jefferson Cty GIS
9301	Cell Tower	543 MISSION RD N	WILT KENNETH L	39.2553	-77.7933	Jefferson Cty GIS
13267	Cell Tower	3343 SHEPHERDSTOWN PIKE	SBA INFRASTRUCTURES, LLC	39.3547	-77.8009	Jefferson Cty GIS
16660	Cell Tower	17340 POPPY RD	AMERICAN TOWERS INC	39.1379	-77.8327	Jefferson Cty GIS
16769	Cell Tower	2464 HITE RD	UNITED STATES CELLULAR CORPORATION	39.3428	-77.8939	Jefferson Cty GIS
23571	Cell Tower	512 SANDPIPER LN	CABLE HOLDCO EXCHANGE V LLC	39.4347	-77.8316	Jefferson Cty GIS
23593	Cell Tower	54 LORD FAIRFAX ST	JEFFERSON COUNTY BOARD OF EDUCATION	39.2610	-77.8853	Jefferson Cty GIS
23594	Cell Tower	8839 CHARLES TOWN RD	STEELER DEVELOPMENT LLC	39.3531	-77.8535	Jefferson Cty GIS
24031	Cell Tower	1333 MOUNT HAMMOND LN	D'ANGELO STANLEY W	39.2412	-77.8232	Jefferson Cty GIS
24239	Cell Tower	539 MISSION RD N	WILT KENNETH L	39.2548	-77.7934	Jefferson Cty GIS
24242	Cell Tower	178 GOLF COURSE DR	SLEEPY HOLLOW REAL ESTATE LLC	39.3113	-77.8152	Jefferson Cty GIS
24282	Cell Tower	770 HARDESTY RD	SUMMIT POINT AUTOMOTIVE RESEARCH CETNER LLC	39.2356	-77.9826	Jefferson Cty GIS
24544	Cell Tower	237 TEL FARM LN	LEFEVRE THOMAS E	39.3151	-77.9677	Jefferson Cty GIS
24733	Cell Tower	11945 LEETOWN RD	OWENS MICHAEL K ET AL	39.3561	-77.9305	Jefferson Cty GIS
24859	Cell Tower	176 ROBERT C BYRD DR	Federal Government	39.3119	-77.7893	Jefferson Cty GIS
26145	Cell Tower	251 CAPTAIN HENDRIX DR	NCTC-Federal Government	39.4835	-77.8024	Jefferson Cty GIS
911 Dispatch Center Tower	County Owned Tower	28 INDUSTRIAL BLVD	Jefferson County	39.3481	-77.8793	Manually Digitized by Design Nine Inc.
Jefferson County Health Department Tower	County Owned Tower	1948 WILTSHIRE RD	Jefferson County	39.3500	-77.8759	Manually Digitized by Design Nine Inc.
7653	Water Tower	388 W BURR BLVD	JEFFERSON UTILITIES INC	39.3554	-77.8632	Jefferson Cty GIS

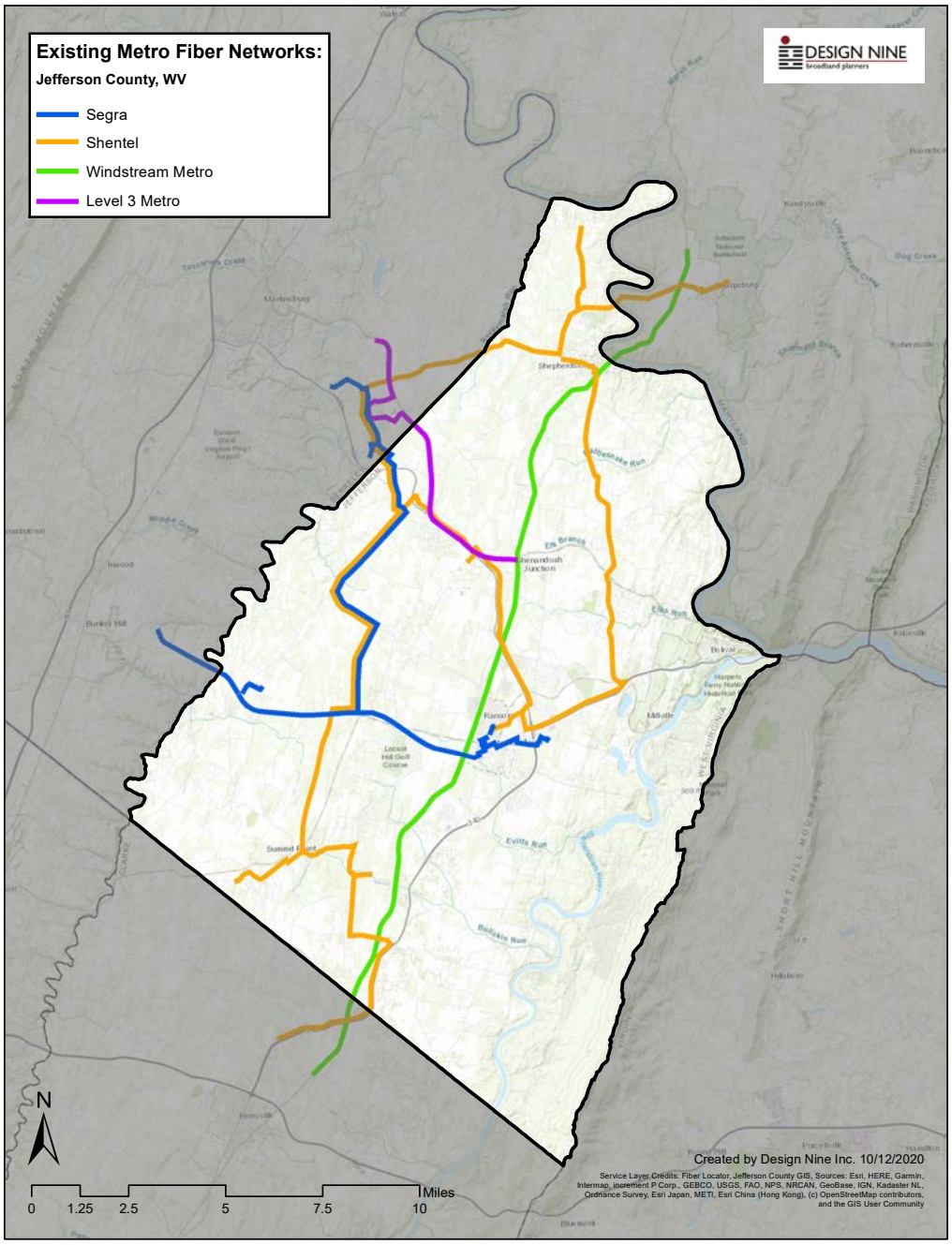
13486	Water Tower	213 E 6TH AVE	CITY OF CHARLES TOWN	39.2983	-77.8580	Jefferson Cty GIS
23865	Water Tower	355 16TH AVE	CITY OF CHARLES TOWN	39.3098	-77.8578	Jefferson Cty GIS
24423	Water Tower	511 UNION RIDGE DR	NVR MS CAVALIER HUNTFIELD LLC	39.2644	-77.8887	Jefferson Cty GIS
24516	Water Tower	410 E AVIS ST	CHARLES TOWN BUILDING COMM	39.2891	-77.8547	Jefferson Cty GIS
24612	Water Tower	148 OLD MARTINSBURG RD	CORPORATION OF SHEPHERDSTOWN	39.4362	-77.8318	Jefferson Cty GIS
24613	Water Tower	146 OLD MARTINSBURG RD	CORPORATION OF SHEPHERDSTOWN	39.4361	-77.8321	Jefferson Cty GIS
26394	Water Tower	414 OAK LEE DR	JEFFERSON UTILITIES INC	39.3202	-77.8446	Jefferson Cty GIS
26395	Water Tower	794 BORDER RD	JEFFERSON UTILITIES INC	39.3712	-77.8867	Jefferson Cty GIS
5214	Water Tower with Cellular Assets	1376 S GEORGE ST	CITY OF CHARLES TOWN	39.2738	-77.8496	Jefferson Cty GIS
6561	Water Tower with Cellular Assets	325 SAWGRASS DR	CITY OF CHARLES TOWN	39.2819	-77.9120	Jefferson Cty GIS
9632	Water Tower with Cellular Assets	307 W BURR BLVD	JEFFERSON UTILITIES INC	39.3571	-77.8651	Jefferson Cty GIS
9633	Water Tower with Cellular Assets	305 W BURR BLVD	JEFFERSON UTILITIES INC	39.3571	-77.8651	Jefferson Cty GIS
11105	Water Tower with Cellular Assets	475 KEYES FERRY RD	CITY OF CHARLES TOWN	39.2930	-77.8326	Jefferson Cty GIS
13240	Water Tower with Cellular Assets	215 E 6TH AVE	CITY OF CHARLES TOWN	39.2984	-77.8579	Jefferson Cty GIS
19054	Water Tower with Cellular Assets	217 PROSPECT AVE	CORPORATION OF HARPERS FERRY	39.3262	-77.7597	Jefferson Cty GIS
21263	Water Tower with Cellular Assets	426 OAK LEE DR	JEFFERSON UTILITIES	39.3201	-77.8442	Jefferson Cty GIS
A0600417	FCC Registered Antenna	Shepherdstown	UNITED STATES CELLULAR CORPORATION	39.4250	-77.8008	FCC Antenna Structure Registry(ASR)
A0497385	FCC Registered Antenna	ON OLD RT 340 .5 MI S	CAPSTAR RADIO OPERATING COMPANY	39.2731	-77.8653	FCC Antenna Structure Registry(ASR)
A0386421	FCC Registered Antenna	18 HITE ROAD	UNITED STATES CELLULAR CORPORATION	39.3428	-77.8939	FCC Antenna Structure Registry(ASR)
A0744889	FCC Registered Antenna	1.6 MI NORTH ON RAVENS ROCK ROAD (092816)	AMERICAN TOWERS, LLC	39.1379	-77.8327	FCC Antenna Structure Registry(ASR)
A0609939	FCC Registered Antenna	837 WHEATLAND ROAD, CHARLES TOWN WV 25414 ROUTE 340/2	SBA INFRASTRUCTURES, LLC	39.2371	-77.9112	FCC Antenna Structure Registry(ASR)
A0609941	FCC Registered Antenna	TEL FARMS, OFF LEETOWN ROAD, MIDDLEWAY SECTION ROUTE 51	SBA INFRASTRUCTURES, LLC	39.3151	-77.9668	FCC Antenna Structure Registry(ASR)
A0609978	FCC Registered Antenna	ROUTE 230 AND MELVIN ROAD	SBA INFRASTRUCTURES, LLC	39.3550	-77.8011	FCC Antenna Structure Registry(ASR)

A0757658	FCC Registered Antenna	201 MOTORSPORTS PARK	GLOBAL TOWER, LLC	39.2353	-77.9826	FCC Antenna Structure Registry(ASR)
A0733863	FCC Registered Antenna	0.6 MI NORTH OF CTY ROAD 9	UNITED STATES CELLULAR CORPORATION	39.2548	-77.7933	FCC Antenna Structure Registry(ASR)
A0736740	FCC Registered Antenna	1 MI EAST OF BLLUE RIDGE ELEMENTARY SCHOOL	CTI TOWERS, INC	39.2392	-77.7711	FCC Antenna Structure Registry(ASR)

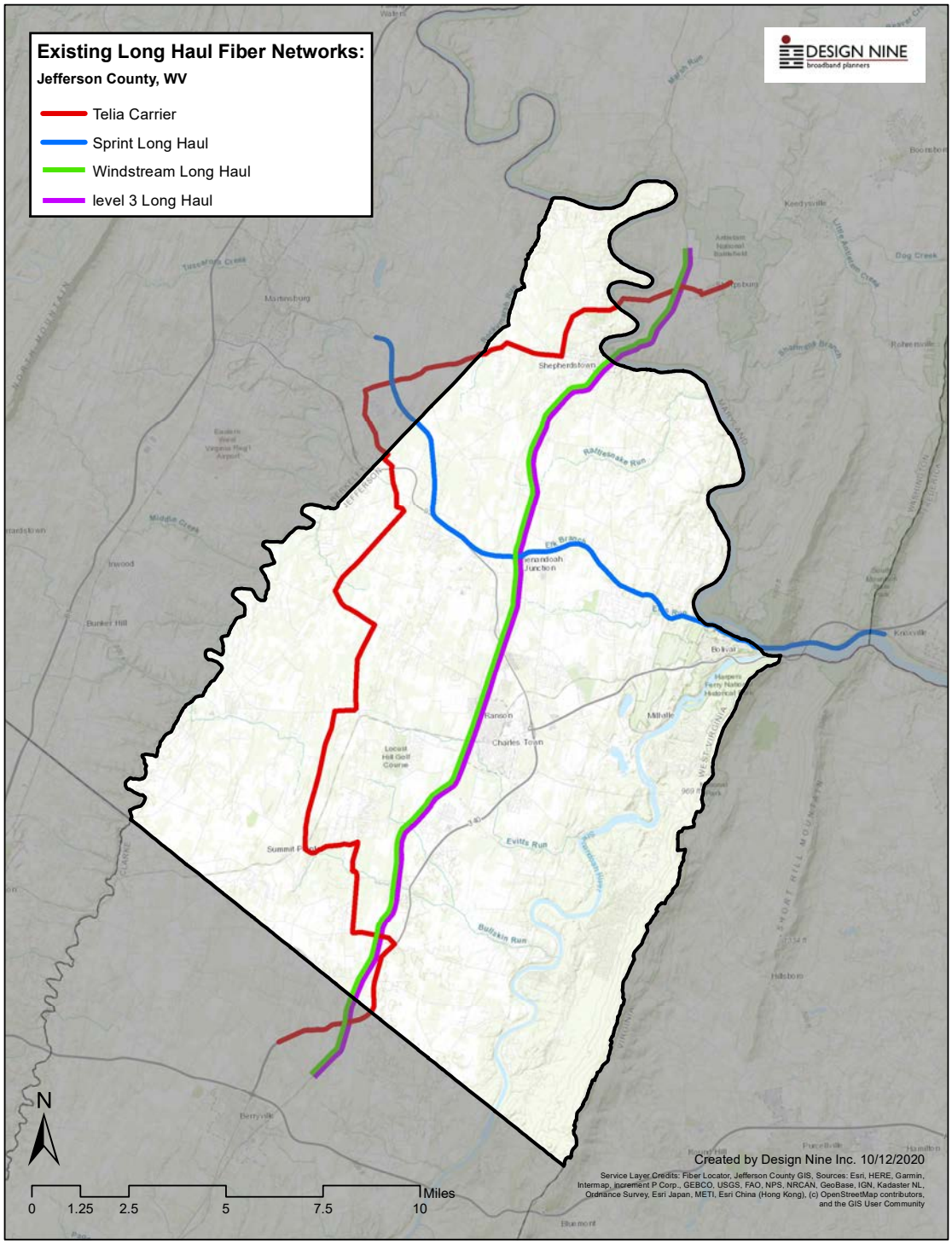
2.5 FIBER ROUTES IN THE COUNTY

Fiber route data is compiled from publicly available sources. Some telecom providers do not share their route data.

Most fiber routes, not only in the county but throughout the country have been designed as long haul point to point fiber routes between population centers. This means that even if a fiber cable passes down a rural road or a residential area, it has not been designed for residential or small business fiber to the premises.



The county has several long haul fiber through-routes. This gives the county a key advantage with respect to economic development, as Internet wholesale rates for local ISPs and WISPs will be lower than some other areas of West Virginia, western Maryland, and southern Pennsylvania.



2.6 SERVED, UNDERSERVED, AND UNSERVED AREAS

The areas on the map below have been identified using FCC (Federal Communications Commission) 477 data. The map also shows the three areas (outlined in red) where fiber pilot studies were done as part of this work (see Section 7). Service providers, including incumbent telephone and cable companies, file a 477 report with the FCC to identify where their service is available and at what speed, using the FCC designations :

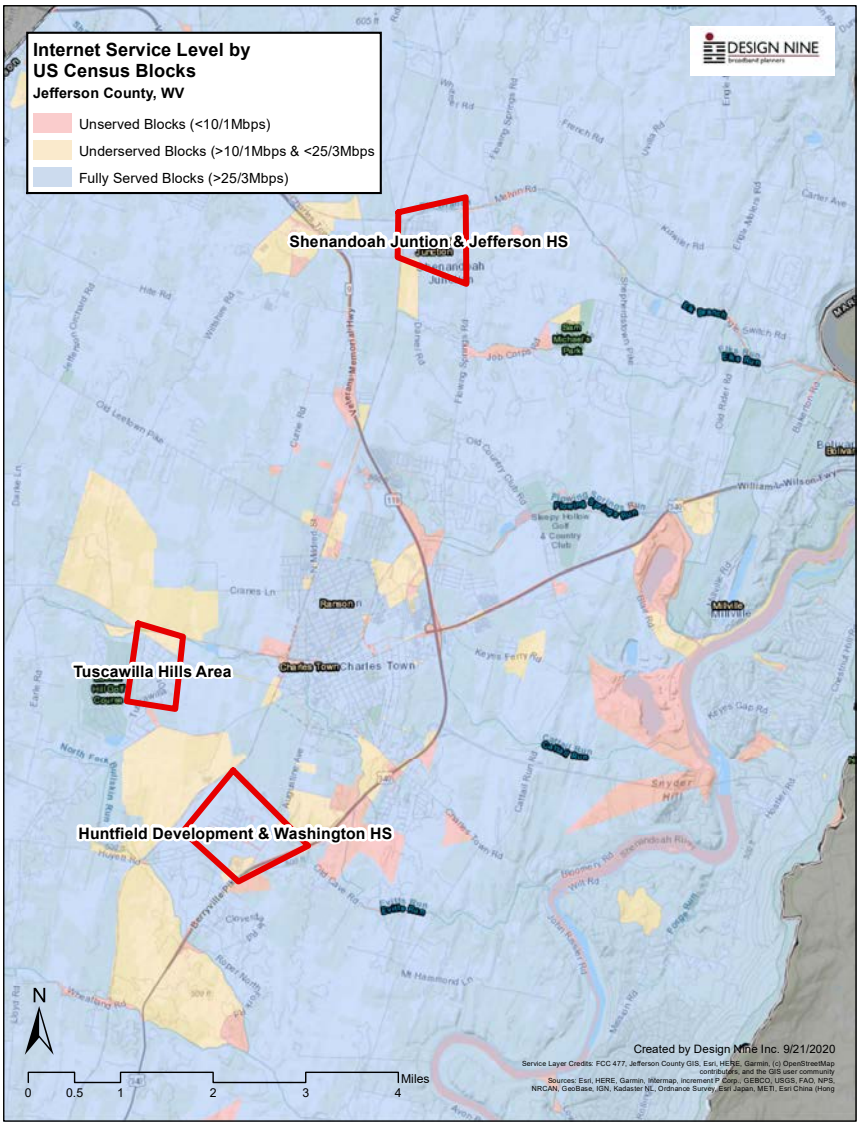
Unserved – Less than 10 Megabits down/1 Megabit up

Underserved – At least 10 Megabits down/1 Megabit up and less than 25 Megabits down/3 Megabits up

Served – Equal to or better than 25 Megabits down/3 Megabits up

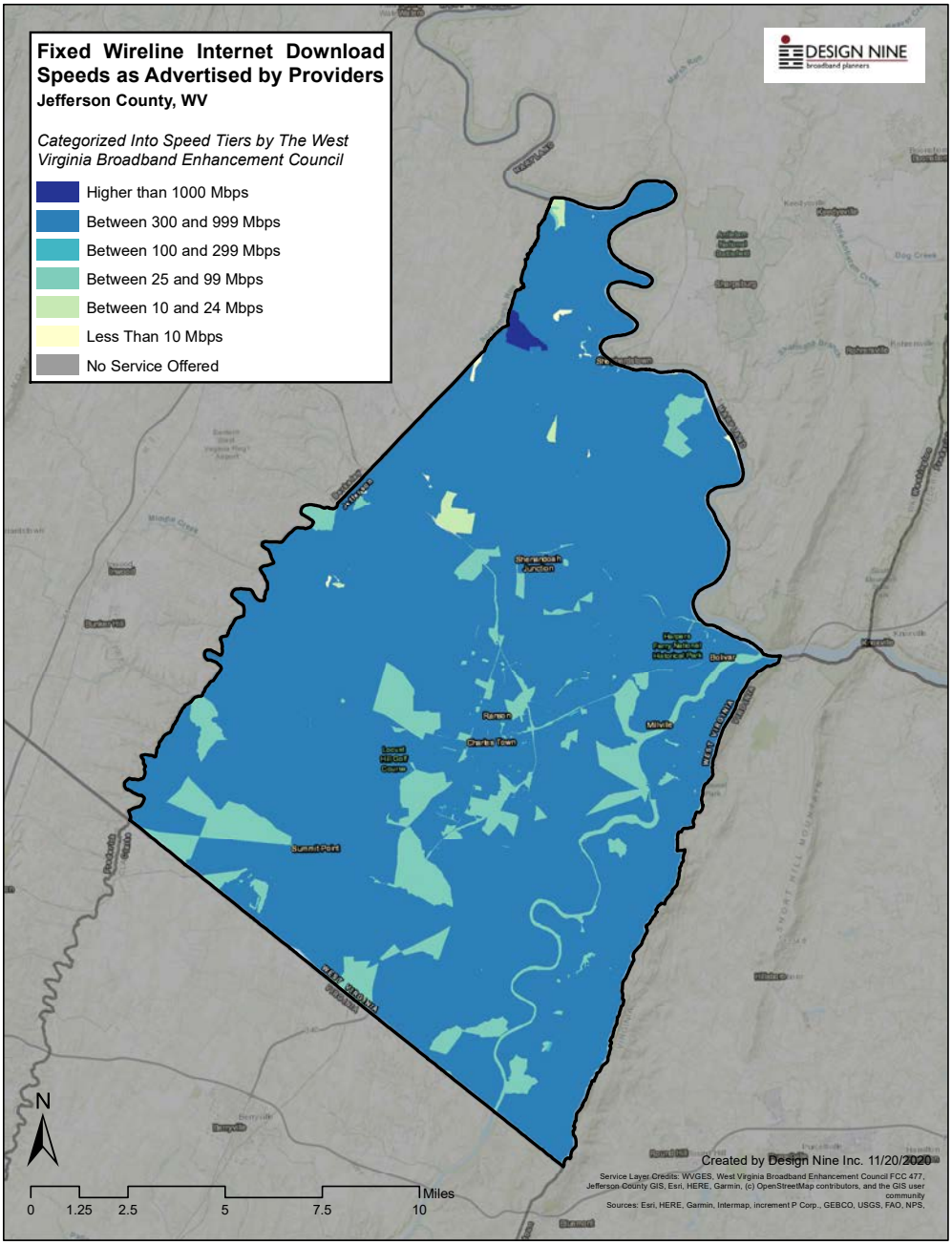
There are two problems with the 477 data:

- The data is self-reported by the providers, who typically report their most optimistic Internet speeds. In practice, customers may not always get the reported speeds.
- A single customer receiving service in a census block means that the provider can indicate that the entire census block is counted. So if one household receives 25/3 service, all households in that census block are counted as receiving that level of service.

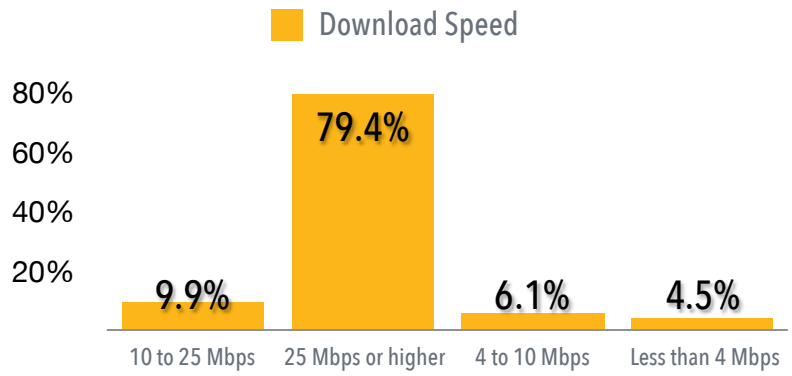


2.7 WV BROADBAND COUNCIL INTERNET SPEED DATA

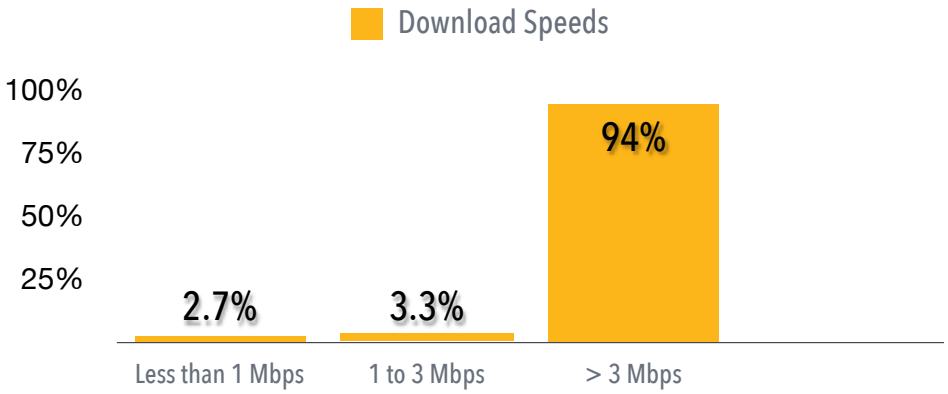
The map below shows Internet download speeds as reported by providers. This data is similar to the map on the previous page. The table on the following page provides actual speed test data submitted by county residents.



Based on comments received on the residential and business survey, it would appear that a majority of the speed tests may have come from areas of the county with cable Internet service.



Download Speed Category	Count of Speed Tests	Percentage
Download Speed 10 to 25 Mbps	715	9.95%
Download Speed 25 Mbps or Higher	5712	79.47%
Download Speed 4 to 10 Mbps	437	6.08%
Less than 4 Mbps	324	4.51%
Grand Total	7188	



Upload Speed Category	Count of Speed Tests	Percentage
Less than 1 Mbps	191	2.66%
Speed between 1 and 3 Mbps	238	3.31%
Speed greater than 3 Mbps	6759	94.03%
Grand Total	7188	

3 MARKET AND GAP ANALYSIS

3.1 DEMAND ASSESSMENT

In most areas of the county, many residents and businesses are limited to the FCC "underserved" bandwidth definition of 10 Mbps down/1 Mbps up. This slow-speed service is impacting economic and community development:

- It limits residents' ability to work from home.
- It limits the ability of Jefferson County to retain existing businesses and to attract new businesses and jobs.
- It limits school children's ability to access the K12 and higher education resources needed to complete homework assignments.
- It limits residents' ability to access cost-saving tele-medicine and tele-health services from home.
- It limits residents' ability shop from home to save money on gas and travel expenses.

The Jefferson County School System has been struggling since the start of the Covid crisis with a variety of Internet and bandwidth issues.

- All of the Jefferson County schools have a fiber connection from Frontier which was described as adequate. All but one of the schools have a Gigabit of bandwidth, and Page Jackson has a 100 Megabit connection.
- All of the schools are connected to a hub in Charles Town, and from there connects to the state Internet network. However, there is apparently a bottleneck in Morgantown that often has an impact on classroom Internet access.
- The schools also have a data storage issue, with the online teaching generating massive video files that have to be retained for some time.
- The Internet bottleneck issues creates performance issues with the online teaching, which uses Microsoft Teams. Problems that teachers typically see include drop out of the current session and not enough bandwidth to see all the students in the class at the same time.
- All students between third grade and twelfth grade get a Chromebook to use in the classroom and at home, but the school noted that there has been a chronic shortage of Chromebook since the Covid crisis began early in the year.
- The school system also noted that many students are at a severe disadvantage when trying to attend class from home and/or trying to do homework because of Frontier's poor DLS-based Internet service in many parts of the county. Using the Chromebook can make the problem worse because most of the Chromebook-based apps need a reliable Internet connection to work well.
- The schools are trying to address the rural Internet access issue with hot spots. All of the schools have a free Internet hot spot so that parents can drive children to the school after

hours to do homework. Some school buses have also been equipped with Internet hotspots, and more hotspots are planned.

In Jefferson, another issue as it relates to broadband speeds is the future of work. As many people have been forced to try to work from home during the Covid crisis, the inadequacy of Internet access in many parts of the county has become painfully obvious. The slow DSL service provided by Frontier is barely adequate for two way videoconferencing, and the speed is so slow that typically only one person can participate in a videoconference at a time. If two adults are trying to work from home while one or more children are trying to attend online classes, trying to be productive is a severe challenge.

The Jefferson County COVID-19 Committee is investigating methods to improve life in the time of pandemic. It has become apparent to committee members, as well as most of America, that broadband plays an important role in facilitating remote work/school from home, telehealth, streaming video and many other activities that have become day-to-day necessities rather than a luxury.

The committee asked many of the same questions posed by the Jefferson County Broadband Committee regarding the county initiative. Questions concerned broadband funding sources, possible structure of a county broadband entity, technology options, likely Internet service cost and public involvement in the broadband study. The committee was particularly concerned about poor broadband service within the student population. Dealing with remote schooling is difficult in the best of circumstances, but poor connectivity makes learning frustrating and may require parents to seek out any WiF hot spot within driving distance. Such desperate activities may compromise pandemic isolation and add more pressure to strained family life.

Poor connectivity is also affecting many county residents who are attempting to work from home. Being able to communicate with an employer remotely from home has become essential, especially among the professional groups. Even residents with broadband cable have reported difficulty sending large files or teleconferencing because the cable systems were designed for TV download and have difficulty uploading data (see the comments from the residential survey, which is available as a separate document due the immense number of comments received).

The committee was concerned that any new investment in broadband would be flexible enough to be responsive to future pandemics or any events which cause community isolation.

With respect to jobs creation, poor broadband is a limiting factor. In eastern Kentucky's rural Jackson and Owsley counties, the People's Rural Telephone Co-op deployed high speed fiber service, and the improved infrastructure brought more than 800 new work-from-home jobs to the two counties. Residents in Jefferson county will not have the opportunity to pursue the kinds of jobs that are now available without better and more affordable access to broadband.

Current usage patterns are not a good predictor of future broadband needs. Network investments in the county must be designed to scale gracefully to support future uses over the next thirty years. Those uses include K12 education, work from home opportunities, tele-medicine and tele-health services, home security, energy management, and many other emerging services and uses. The local governments should invest in infrastructure that will meet future needs, not current demand. A future-proof community includes:

- Abundant, inexpensive local bandwidth.

- Massive connections to the rest of the world.
- Network redundancy available in some areas of the county.
- Rich local content from a multitude of sources.

There are many areas and communities in Jefferson County that can be attractive to an emerging new group of businesspeople and entrepreneurs that typically are well-educated, own their own businesses or work for large global corporations, and are making choices about where they lived based on family needs and interests rather than business interests.

This new breed of entrepreneurs and workers places a high value on the kinds of amenities that contribute to a good quality of life, such as traditional neighborhoods, vibrant downtown areas, a wide range of cultural and recreation opportunities, 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 enables this new approach to personal and work life.

The FCC has defined the next broadband tier (fully served) to be 25 Mbps down and 3 Mbps up. The problem with the 25/3 definition is that the upload speed (3 Mbps) is not always going to be adequate to support work from home, especially where home-based workers need to connect to a corporate Virtual Private Network (VPN). Work-from-home and business-from-home activities should have at a minimum 10 Mbps down and 10 Mbps up speeds. Higher speed service could include service levels like 25 Mbps down and 10 Mbps up. The critical requirement is an upload speed that supports work from home.

If the goal is to enhance residential and business access to broadband, there can be no upper limit on the definition of broadband. Defining "broadband" as 10 Mbps or 25 Mbps of bandwidth is telling residents and businesses in the county that there will be limits on their work and job opportunities.

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 businesses and residents of Jefferson County need to be able to compete globally over the next thirty years?"

In short, Jefferson County has many areas hampered by low-end broadband in the form of DSL, very limited wireless, expensive satellite Internet, and and very limited cable modem service. They also have a very limited high-end broadband in the form of fiber to a few businesses and institutions.

If theCounty 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.

To close that gap between the FCC definitions and what the county needs to support future work opportunities and to support K12 and higher education school work, the county needs the following:

Broadband Services, Technologies, and Needs

BROADBAND SERVICE	TARGET DATE	TECHNOLOGY	WHERE NEEDED
25 Mbps download **3 Mbps upload**	2021	Wireless	As much of the county as possible, given funding constraints
25 Mbps download **10 Mbps upload**	2022	Wireless	In many locations in the county
1 Gbps download **1 Gbps upload**	2021	Fiber	In some key business and commercial areas
50 Mbps download **10 Mbps upload**	2022	Wireless & Fiber	In many locations in the county
100 Mbps download **100 Mbps upload**	2022	Fiber	Available to a minimum of 50% of residents and businesses in the county

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 the County government 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."

The economic impact on Jefferson County can include the following effects:

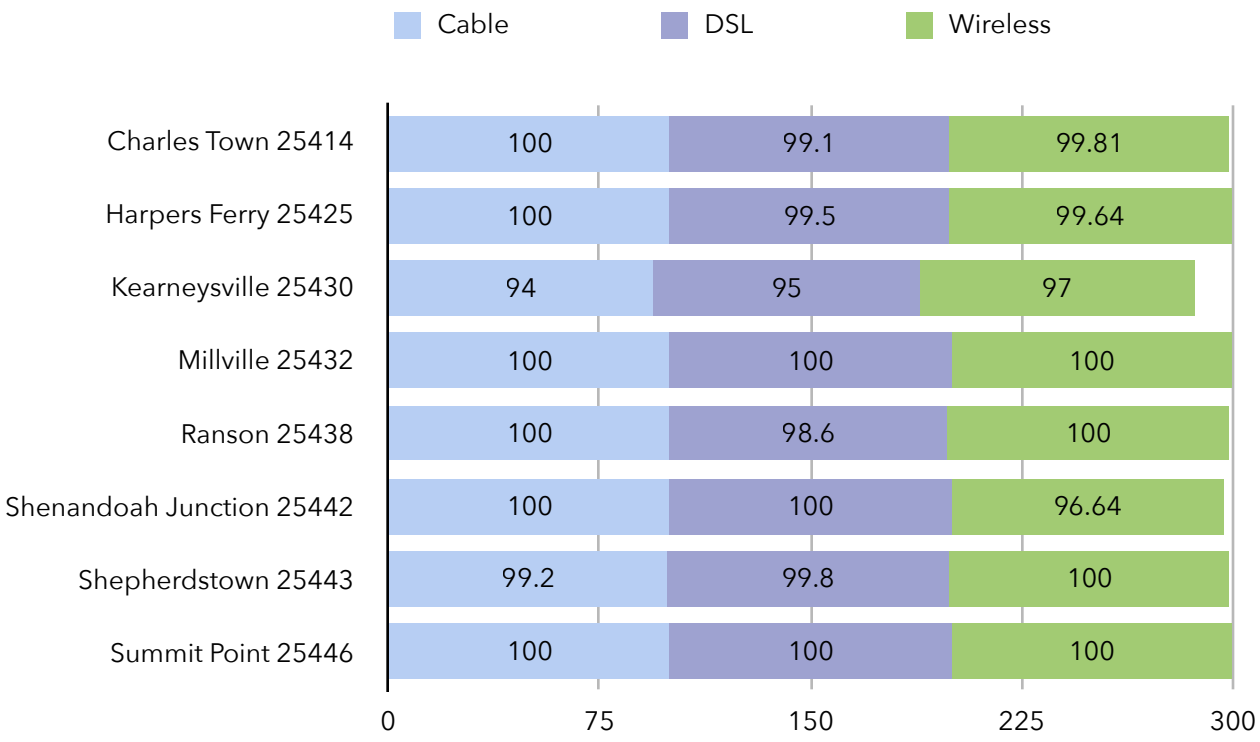
- Difficulty retaining some existing businesses. As business bandwidth needs continue to increase over the next several years, some businesses may need to move out of the area to ensure that they have the right bandwidth to support their business operations.
- Difficulty attracting new businesses. New businesses interested in some of the advantages of the county, like low cost of living, good recreational opportunities, and good workforce ethic, may be deterred by the cost and limited bandwidth available, and therefore choose other areas to locate.
- Difficulty keeping younger workers and families in the county. Younger workers and families tend to be heavy users of Internet services, and real-estate agents are reporting that younger house buyers are reluctant to live in areas with poor Internet service. **Note that a significant percentage of respondents to the residential survey (30%) indicated that Internet availability or lack of it was affecting where they choose to live.**

- Reductions in real estate value. Homes with poor Internet service are more difficult to sell, leading to lower prices, negatively impacting county income from property taxes.

3.2 LOCAL PRICING DATA

This section of the report provides key insights into the services currently available in Jefferson County. It provides data that show which zip code areas are most impacted by poor Internet service and/or the lack of Internet Service provider options. The chart below shows estimates of available broadband technology type in many areas of the county. This data is assembled from public sources, Decision Data which combines FCC data and data they collect from social media and Broadband Now. Also note that zip code boundaries are not aligned with local government jurisdictions, and some zip code data may include some areas outside the county. The information in these charts is current as of August 2020. Percentages of customers receiving different kinds of service can change.

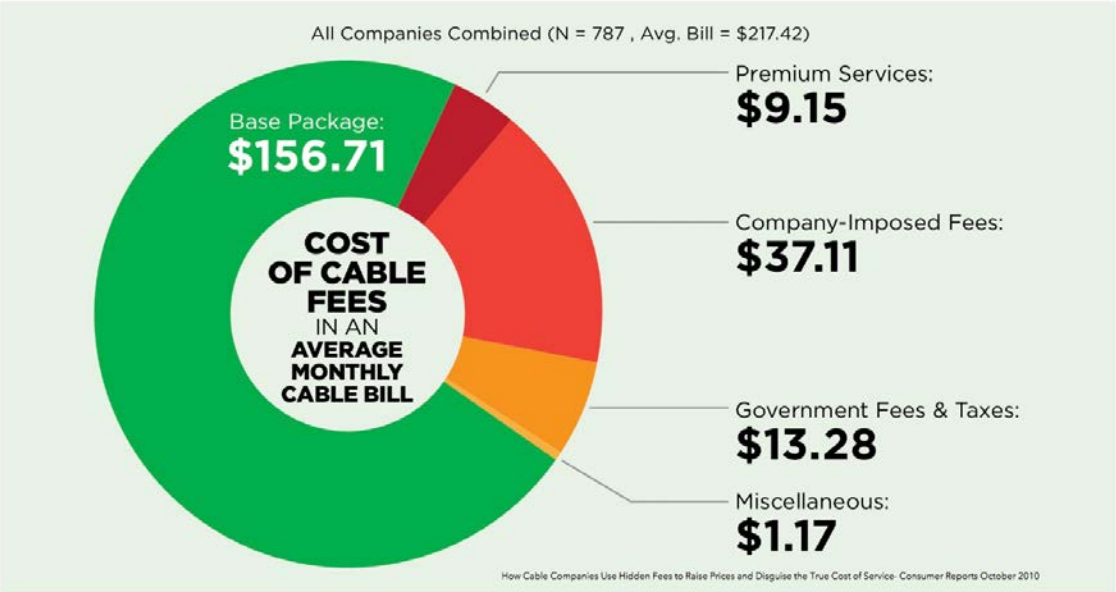
Access to Xfinity (cable services) in zip code 25432 was not verifiable. While both reporting services indicated between 86% and 100% cable availability in the Millville zip code, this is likely incorrect.



According to a recent Consumer Reports study the average advertised price for standard triple play services of Internet, television, and telephone across the country is $156.17. Because of hidden fees and taxes, the actual average bill is $217.42. Consumers get an average of 24% added to their bill mostly in fees created by the cable industry. Again according to Consumer Reports, the industry imposted fees average "$37.11 per month which adds up to an estimated $28 billion in revenue each year in fees created by the cable industry." Because of these high prices according to another Consumer Reports report, one in five households with traditional

triple play bundles will abandon them in the next year- with sixty-two percent saying they are cutting the cable TV cord because of rising prices.

Figure A: Cost of Cable Fees in an Average Monthly Cable Bill (2018)



According to Wireline, the average home used 271 GB of data in the second quarter of 2019. That was an increase of 25% over 2018.

While Wireline data for Q2 2020 are not available, OpenVault reports that Q2 2020 data usage was 308 GB which was a 14% growth over Q2 2019 but a decline from the 402 GB in Q1 2020 when more people were quarantined. Our new normal in broadband usage might be much higher than previously imagined. Another significant trend besides cutting the cable TV cord is using a smartphone as your sole Internet connection. Smartphones have become a substitute for wireline Internet services.

A single smartphone with an unlimited data plan can be found for $70 plus fees and taxes per month. According to a June 2019 Pew Research Center Report, "37% of Americans now go online mostly using a smartphone. Cost of regular broadband services is also one of the reasons people use their smartphones. However, few people want to watch a football game, a movie, or do their class work on their smartphone. When considering using a cell phone as an Internet only solution, the cost of the cell phone also has to be factored in since they rarely last over two or three years.

The table below illustrates the estimated telecom expenditures, public and private, over the next thirty years. Over that time period, **over $1.5 billion** will be spent on telecom services. This shows that there is money for broadband, but most of it is placed in envelopes every month and most of it leaves both the county and the state. Redirecting as little as 5% of those funds could build fiber to every home and business in Jefferson County.

Table 3.1: Telecom Expenditures - Jefferson County, WV

Jefferson County 30 Year Estimated Telecom Expenditures				
Total Households	20,895			
Businesses	872			
Estimated Internet Access Type	Households using Cell Phone for Internet	Households with "little" broadband DSL	Households with Cable Modems	Households with no Internet
Household Percentage	9%	42%	32%	17%
Number of households	1,881	8,776	6,686	3,552
Average monthly telecom expenditures	Cell Phone for Voice/Internet $90 Cable/satellite TV: $65 bundle	Cell Phone $70 Phone: $13 Satellite TV: $60 Broadband Internet: $45	Cell Phone $70 Phone $15 TV $43 Broadband Internet $45	Cell Phone, no Internet, $70 Cable/satellite TV: $65
Monthly Cost of Services	$155	$188	$173	$135
Annual household cost	$1,860	$2,256	$2,076	$1,620
Annual cost all households	$3,497,823	$19,798,430	$13,880,966	$5,754,483
30 year expenditure	$104,934,690	$593,952,912	$416,428,992	$172,634,490
Total residential expenditures	$1,287,951,084			
Total Estimated Cost of Hidden Fees	$189,870,859			
Total Business Costs	$54,151,200			
Total expenditures	**$1,531,973,143**			

Service Provider Data

This information provides pricing data and services available from providers in the Jefferson County. Prices, availability and promotional offers change frequently and sometimes vary depending on street address. Information was compiled using a variety of public sources and Internet Service Provider (ISP) websites including Decision Data which combines FCC data and data they collect from social media and Broadband Now. Exact availability requires customer names and specific street addresses. Internet Service Providers showing less than 1% coverage in the county are not shown in the following data.

Table 5.2: Summary of Service Provider Data - Jefferson County, WV

Prices include modem *Indicates promo rate Regular rate shown if possible	Least Expensive Internet Only Service	Least Expensive Internet Only Service Meeting 25/3	Least Expensive Triple Pay Package Meeting 25/3
Frontier DSL	$27.99 up to 6 Mbps plus $10 for WiFi	N/A	N/A
Xfinity Cable	$49.99 for 200 Mbps down/ 5 Mbps up for 12 months then $92.95	$92.95 for 200 Mbps down and 5 Mbps up regular price	$99.99 for 200 Mbps down/5 Mbps up with two year service agreement required. $129.99 after two years- extra fees may apply-Broadcast TV Fee (up to $14.95/ mo.), Regional Sports Fee (up to $8.75/mo.) and other applicable charges extra
Telegia - Wireless	$61.25 for 10 Mbps down - 2 Mbps up	N/A	N/A
All Points	$79 for 4 Mbps down and 1 Mbps up	$299 for 25 Mbps down and 3 Mbps up	N/A

Table 3.3: Wireline Internet service provider comparison for Jefferson County, WV

Provider	Monthly Cost	Promo Rate & Contract Length	Other Monthly Fees	Down-load Speed (Mbps)	Upload Speed (Mbps)	Data Cap (GB/ Month)	One-Time Fees	Services & Incentives
Xfinity	$92.95	First 12 months $49.99/mo, After promo period $92.95/mo.	Modem rental $14 per month unless you supply your own modem	200	5	None	Unknown	Internet only. Option to add Flex 4K streaming device + Voice Remote at no extra cost. Includes Peacock Premium.
Xfinity	$97.95	$69.99 First 24 months promo, w/ one year service agreement $79.99 without service agreement	Modem rental $14 per month unless you supply your own modem	300	10	None	Unknown	Internet only. Option to add Flex 4K streaming device + Voice Remote at no extra cost. Includes Peacock Premium.
Xfinity	$107.95	$89.99 First 36 months promo, w/ two year service agreement $99.99 without service agreement	Modem rental $14 per month unless you supply your own modem	1000	35	None	Unknown	Internet only. Option to add Flex 4K streaming device + Voice Remote at no extra cost. Includes Peacock Premium.
Xfinity	$77.95	No service agreement required	Modem rental $14 per month unless you supply your own modem	100	5	None	Unknown	Internet only. Option to add Flex 4K streaming device + Voice Remote at no extra cost. Includes Peacock Premium.

Provider	Monthly Cost	Promo Rate & Contract Length	Other Monthly Fees	Down-load Speed (Mbps)	Upload Speed (Mbps)	Data Cap (GB/ Month)	One-Time Fees	Services & Incentives
Xfinity	$102.95	$79.99 First 24 months promo, w/ one year service agreement $89.99 without service agreement	Modem rental $14 per month unless you supply your own modem	600	15	None	Unknown	Internet only. Option to add Flex 4K streaming device + Voice Remote at no extra cost. Includes Peacock Premium.
Xfinity	$199.99	$159.99 First 24 months promo, w/ two year service agreement $169.99 without service agreement	Modem rental $14 per month. Phone service will likely require renting a modem.	1000	35	None	Unknown	Internet, 10+ channels Phone: Nationwide with some International calls free- Canada, China, India, Mexico, South Korea, Hong Kong, Singapore, and Puerto Rico
Xfinity	$129.99	$99.99 First 24 months promo, w/ two year service agreement $109.99 without service agreement	Modem rental $14 per month. Phone service will likely require renting a modem.	200	5	None	Unknown	Internet, 10+ channels Phone: Nationwide with some International calls free- Canada, China, India, Mexico, South Korea, Hong Kong, Singapore, and Puerto Rico
Xfinity	$134.99	$104.99 First 24 months promo, w/ two year service agreement $109.99 without service agreement	Modem rental $14 per month. Phone service will likely require renting a modem.	200	5	None	Unknown	Internet, 10+ channels Phone: Nationwide with some International calls free- Canada, China, India, Mexico, South Korea, Hong Kong, Singapore, and Puerto Rico

Provider	Monthly Cost	Promo Rate & Contract Length	Other Monthly Fees	Down-load Speed (Mbps)	Upload Speed (Mbps)	Data Cap (GB/ Month)	One-Time Fees	Services & Incentives
Xfinity	$139.99	$109.99 First 24 months promo, w/ two year service agreement	Modem rental $14 per month. Phone service will likely require renting a modem.	200	5	None	Unknown	Internet, 10+ channels Phone: Nationwide with some International calls free- Canada, China, India, Mexico, South Korea, Hong Kong, Singapore, and Puerto Rico
Xfinity	$159.99	$109.99. First 24 months promo, w/ two year service agreement $119.99 without service agreement	Modem rental $14 per month. Phone service will likely require renting a modem.	600	15	None	Unknown	Internet, 10+ channels Phone: Nationwide with some International calls free- Canada, China, India, Mexico, South Korea, Hong Kong, Singapore, and Puerto Rico
Xfinity	$189.99	$139.99 First 24 months promo, w/ two year service agreement $149.99 without service agreement	Modem rental $14 per month. Phone service will likely require renting a modem.	1000	35	None	Unknown	Internet, 10+ channels Phone: Nationwide with some International calls free- Canada, China, India, Mexico, South Korea, Hong Kong, Singapore, and Puerto Rico
Xfinity	$89.99	$64.99/mo First 12 months No agreement required		200	5	None	Unknown	Internet, 10+channels

Provider	Monthly Cost	Promo Rate & Contract Length	Other Monthly Fees	Down-load Speed (Mbps)	Upload Speed (Mbps)	Data Cap (GB/ Month)	One-Time Fees	Services & Incentives
Xfinity	$139.99	$99.99 First 12 months promo, w/ two year service agreement $109.99 without service agreement		300	10	None	Unknown	Internet, 10+channels
Xfinity	$169.99	$129.99 First 12 months promo, w/ two year service agreement $139.99 without service agreement		600	15	None	Unknown	Internet, 10+ channels
	For all above Xfinity services these extra fees may apply: Broadcast TV Fee (up to $14.95/mo.), Regional Sports Fee (up to $8.75/mo.) other applicable charges extra, subject to change during and after the promo.							
Frontier DSL	$27.99		$10 WiFi Router	6	n/a	None	Activation, taxes & other fees apply.	Internet
Frontier DSL	$34.99		$10 WiFi Router	12	n/a	None	Activation, taxes & other fees apply.	Internet
Frontier DSL	$37.99		$10 WiFi Router	6	n/a	None	Activation, taxes & other fees apply. known	Internet & phone-US and Canada
Frontier DSL	$34.99		$10 WiFi Router	12	n/a	None	Activation, taxes & other fees apply.	Internet & phone-US and Canada

Table 3.4: Wireless Internet service provider comparison for Jefferson County, WV

Provider	Monthly Cost	Promo & Contract Length	Other Monthly Fees	Down-load Speed (Mbps)	Upload Speed (Mbps)	Data Cap (GB/ Month)	One-Time Fees	Incentives & Notes
All Points	$79	1 Year		4	1	100 GB	$199	Internet only- Telephone available $35 mthly
All Points	$99	1 Year		8	2	None	$149	Internet only- Telephone available $35 mthly
All Points	$199	1 Year		15	3	None	$99	Internet only- Telephone available $35 mthly
All Points	$299	1 Year		25	3	None	$99	Internet only- Telephone available $35 mthly
Telegia	$61.25			10	3		$149 installation	
Telegia	$71.25			15	5		$149 installation	
Telegia	$81.25			20	5		$149 installation	

All Points Wireless also appears to be another name for Virginia Everywhere Wireless. All Points Wireless has no website. Virginia Everywhere Wireless pricing is from a third party source. Their website provides no pricing.

Table 3.5: Satellite Internet service provider comparison for Jefferson County, WV

Provider	Monthly Cost	Promo & Contract Length	Other Monthly Fees	Down-load Speed (Mbps)	Upload Speed (Mbps)	Data Cap (GB/Month)	One-Time Fees
HughesNet	$59.99	24 month commitment required. Up to $400 ETF	$14.99 equipment lease it you don't purchase	25	3	After 10 GB (speeds drop to 1-3 Mbps)	Purchase and lease options. Latest pricing is $249.99 to purchase or $99 lease activation

Provider	Monthly Cost	Promo & Contract Length	Other Monthly Fees	Down-load Speed (Mbps)	Upload Speed (Mbps)	Data Cap (GB/Month)	One-Time Fees
HughesNet	$69.99	24 month commitment required. Up to $400 ETF	$14.99 equipment lease it you don't purchase	25	3	After 20 GB (speeds drop to 1-3 Mbps)	Purchase pricing is $249.99 to purchase or $99 lease activation
HughesNet	$99.99	24 month commitment required. Up to $400 ETF	$14.99 equipment lease it you don't purchase	25	3	After 30 GB (speeds drop to 1-3 Mbps)	Purchase pricing is $249.99 to purchase or $99 lease activation
HughesNet	$149.99	24 month commitment required. Up to $400 ETF	$14.99 equipment lease it you don't purchase	25	3	After 50 GB (speeds drop to 1-3 Mbps)	Purchase pricing is $249.99 to purchase or $99 lease activation
Viasat	$50	24 month contract	$9.99/ month (modem)	12	3	12 GB priority data	Setup Fee- Unknown-equipment purchase instead of lease $299.99-Setup Fee-Unknown
Viasat	$75	24 month contract	$9.99/ month (modem)	12	3	25 GB priority data	Setup Fee- Unknown-equipment purchase instead of lease $299.99-Setup Fee-Unknown
Viasat	$100	24 month contract	$9.99/ month (modem)	12	3	50 GB priority data	Setup Fee- Unknown-equipment purchase instead of lease $299.99-Setup Fee-Unknown
Viasat	$150	24 month contract	$9.99/ month (modem)	25	3	After 100 GB (priority drops)	Setup Fee- Unknown-equipment purchase instead of lease $299.99-Setup Fee-Unknown
Starlink*	$99	Limited Public Beta by invitation as of 10/26/20	Unknown	Up to 100	Up to 40	None	$499 for the Starlink Kit, which includes a mounting tripod, a WiFi router, and a terminal to connect to the satellites

* Starlink is currently in beta test and is only available in certain areas.

4 JEFFERSON COUNTY RESIDENTIAL SURVEY RESULTS

During the Summer of 2020, a broadband survey was conducted in Jefferson County, West Virginia as part of a county wide study in broadband needs. The online (Web) version of the survey was publicized on social media and paper surveys were distributed by local libraries. Residents were encouraged to complete the survey online or fill out and return the paper version by surface mail. Businesses were encouraged to complete a separate business-focused survey, and the results of that are included later in this report.

A total of 2,344 responses were collected in the residential survey. Not all responders answered every question. Note that because of rounding, not all percentages sum exactly to 100%. Many comments were received. Because of the volume of replies, these comments can be found in a separate document (Residential Comments).

Some of the key findings from the results are listed below.

89% of respondents are interested in faster and more reliable Internet service

44% of residents are "dissatisfied" or "very dissatisfied" with current Internet service

97% of respondents believe that local government should help facilitate better Internet access

82% of residents have 5 or more Internet-connected devices in their home

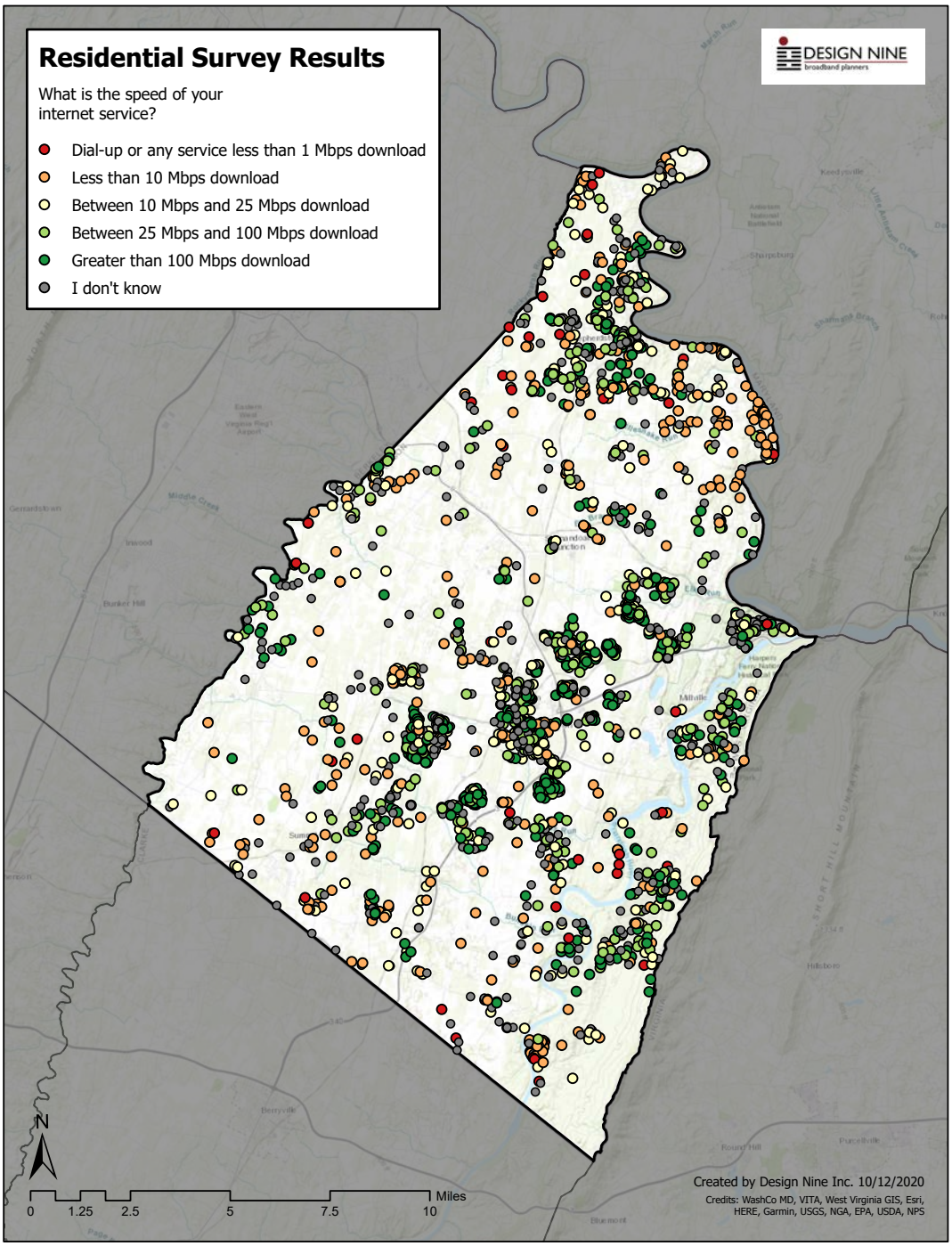
63% of respondents report they have trouble using common Internet services

55% indicate that availability of broadband Internet is affecting where they choose to live

4.1 DISTRIBUTION OF SURVEY RESPONSES

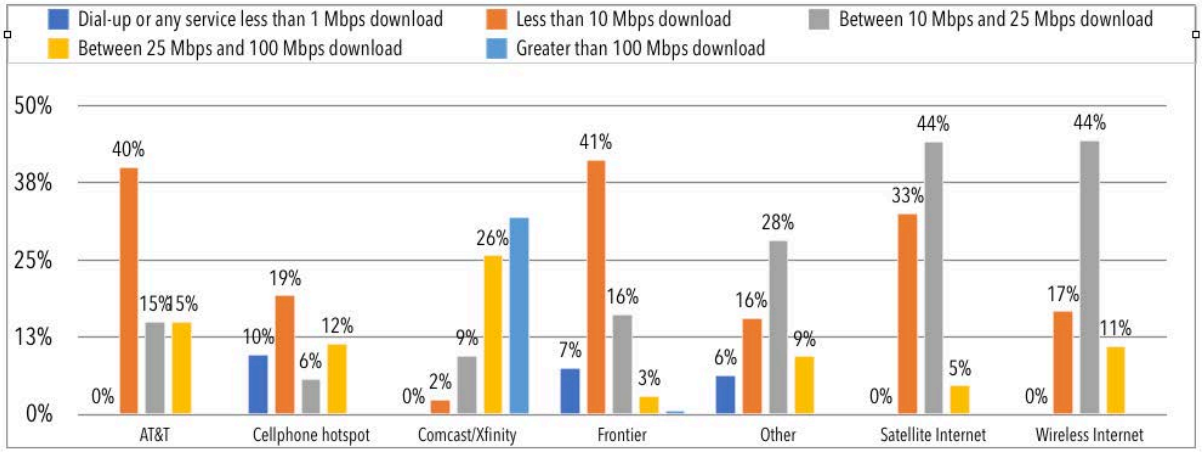
The map below shows the geographic distribution of responses to the residential survey, coded according to the speed of their Internet connection (Question 8).

The map below shows the geographic distribution of responses to the residential survey, coded according to their satisfaction with their existing Internet service (Question 11).

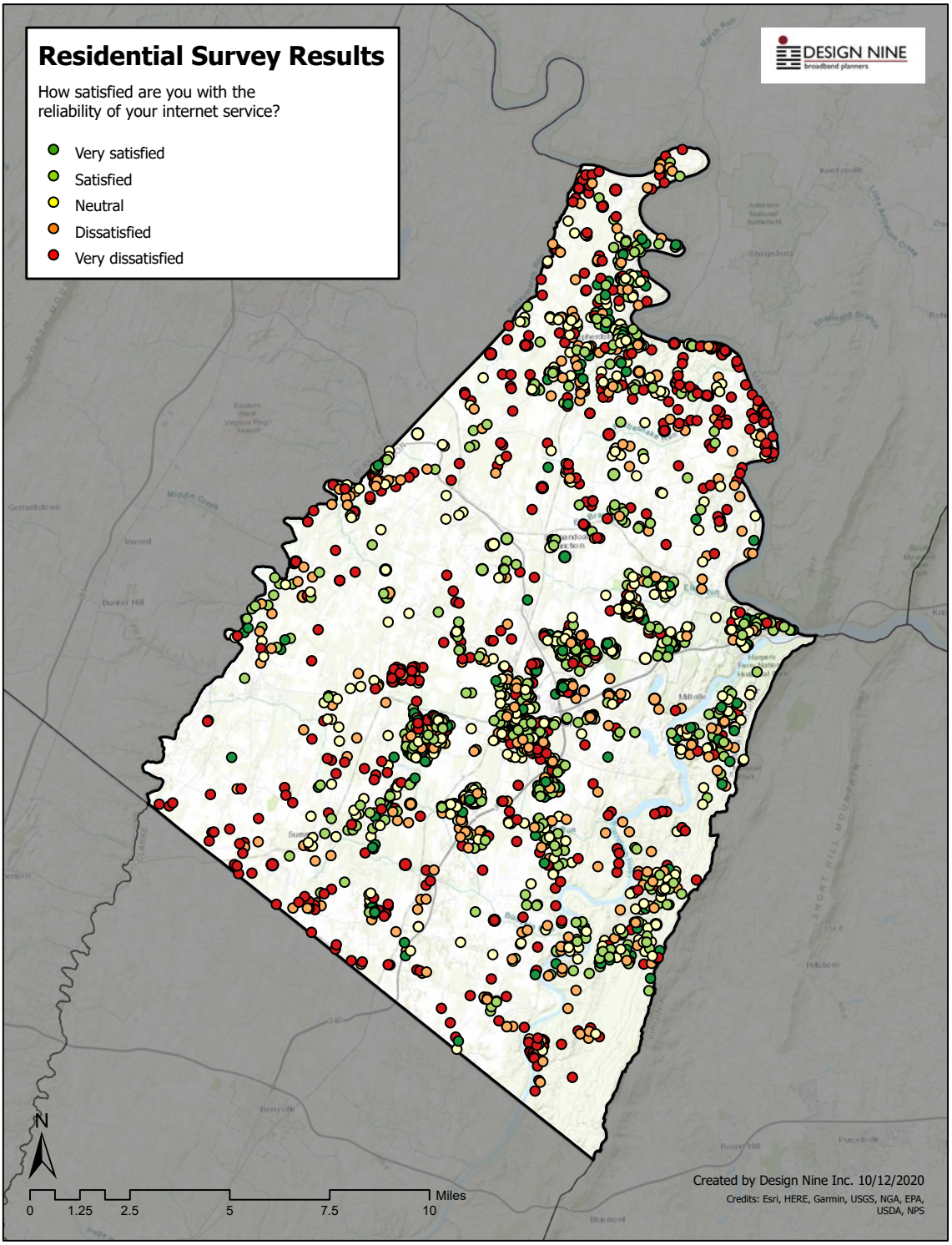


Service Provider Speed Comparisons

The chart below provides a between-providers comparison of speed offerings.

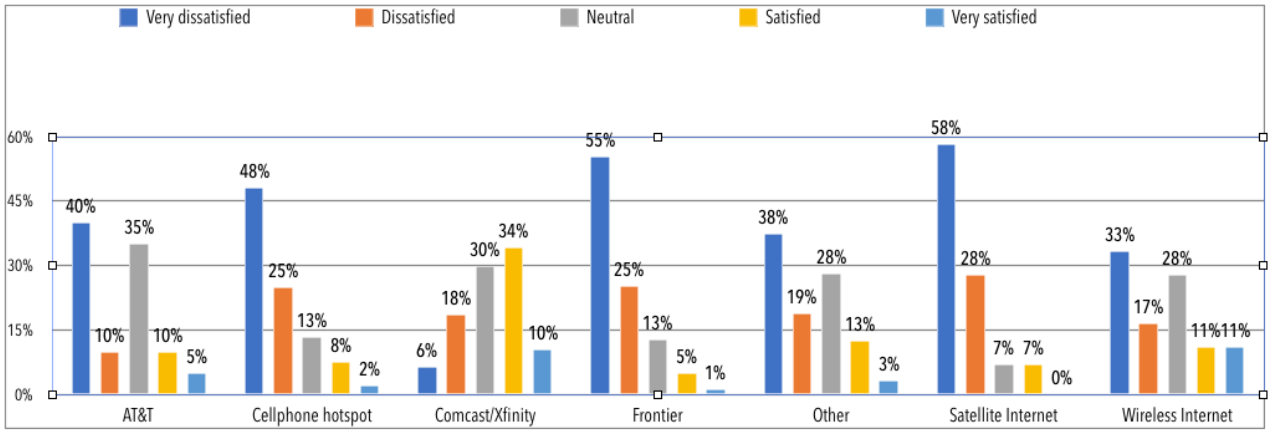


The map below shows the geographic distribution of responses to the residential survey, coded according to their satisfaction with their existing Internet service (Question 11).



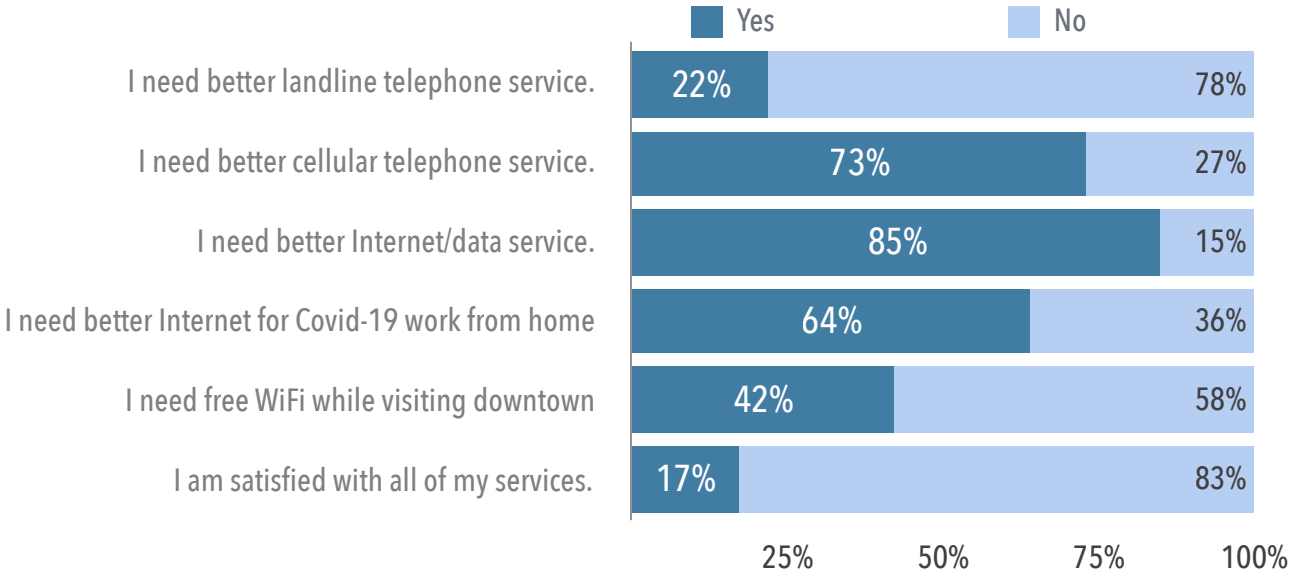
Service Provider Satisfaction Comparisons

The chart below provides a between-providers comparison of satisfaction with providers.



4.2 RESIDENTIAL SURVEY SUMMARY DATA

1. Select the items you agree with below



2a. Total number of adults in household

1	2	3	4	5	6	7+
374	1455	314	133	35	13	8
16%	62%	13%	6%	2%	1%	0%

2b. Total number of K-12 Students in the house hold

1	2	3	4	5	6	7+
384	273	88	33	13	1	5
48%	34%	11%	4%	2%	0%	1%

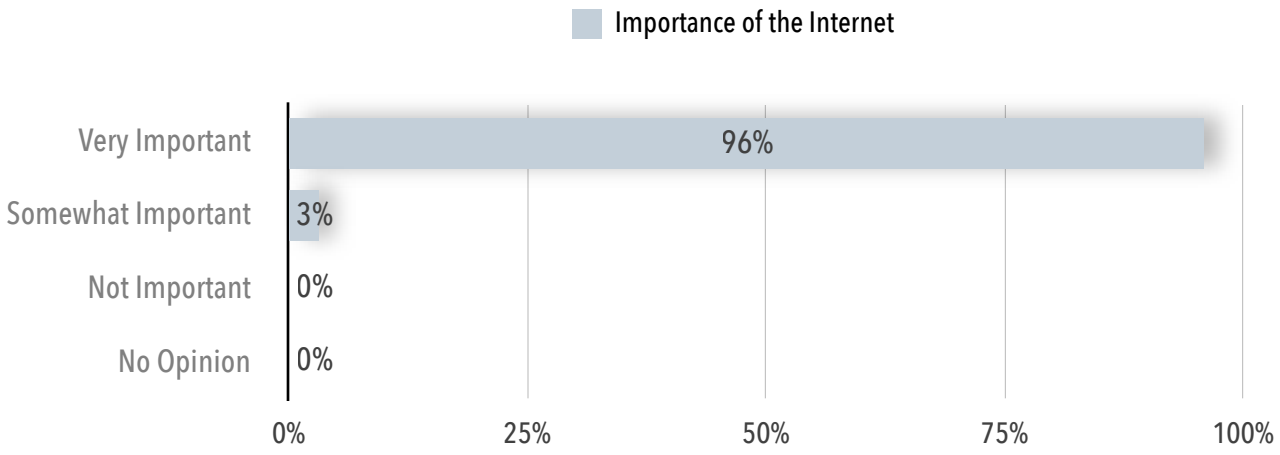
2c. Total number of college students in household

1	2	3	4	5	6	7+
370	82	17	3	0	0	2
78%	17%	4%	1%	0%	0%	0%

2d. How many total Internet users in household

1	2	3	4	5	6	7+
260	805	368	387	169	66	57
12%	38%	17%	18%	8%	3%	3%

3. How important is Internet access to you or your household?



4. For your household, how much do you spend each month for local and long distance telephone , TV, and/or Internet? Do NOT include cell phones.

$50 or less	$50-75	$75-100	$100-150	$150-200	More than $200/month
122	148	246	497	489	817
5%	6%	11%	21%	21%	35%

5. How much do you pay now for at home Internet access each month?

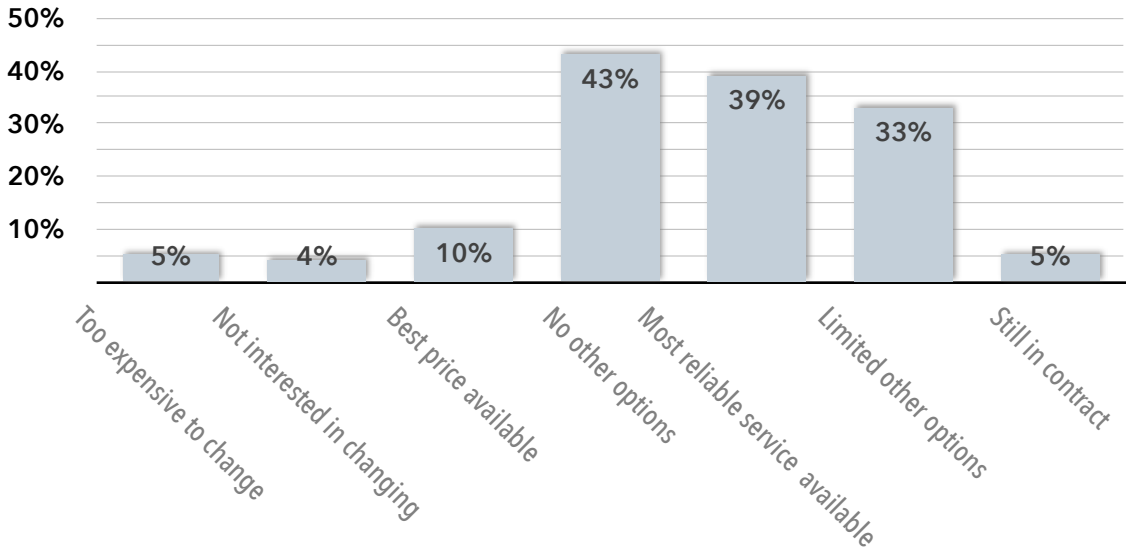
No Internet	I only use free hotspots	$10 to $20	$21 to $40	$41 to $60	$61 to 80	More than $80/ month	I don't know
43	11	20	135	352	488	1,107	141
2%	0%	1%	6%	15%	21%	48%	6%

6. What type of Internet do you have at home?

Dial-up	9	0%
Cable modem	1,298	56%
DSL line	507	22%
Fiber	40	2%
Satellite	68	3%
Cellular wireless	82	4%
Wireless ISP	123	5%
I don't know	111	5%
No Internet	29	1%
Other	58	2%

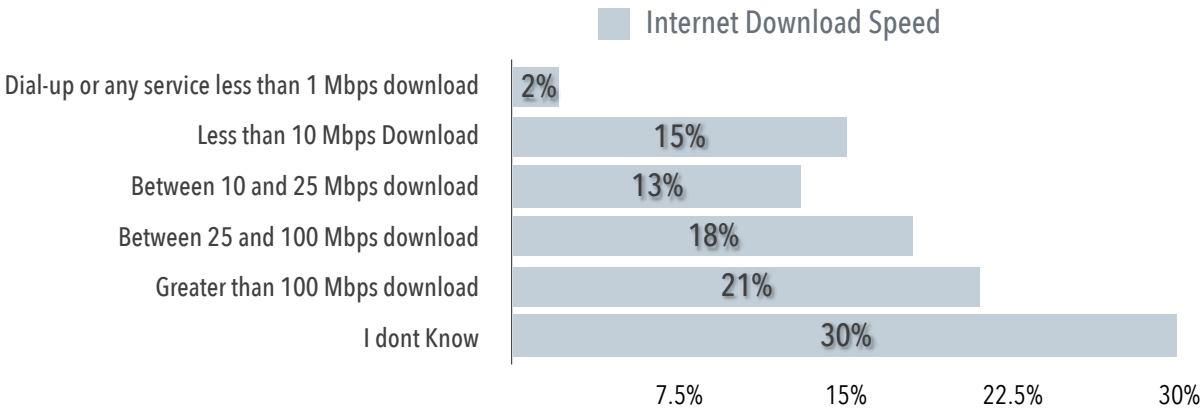
7. Based on the type of Internet connection you selected above, why do you still have it? (select all that apply)

43% of respondents indicated they have no alternative to their current Internet provider



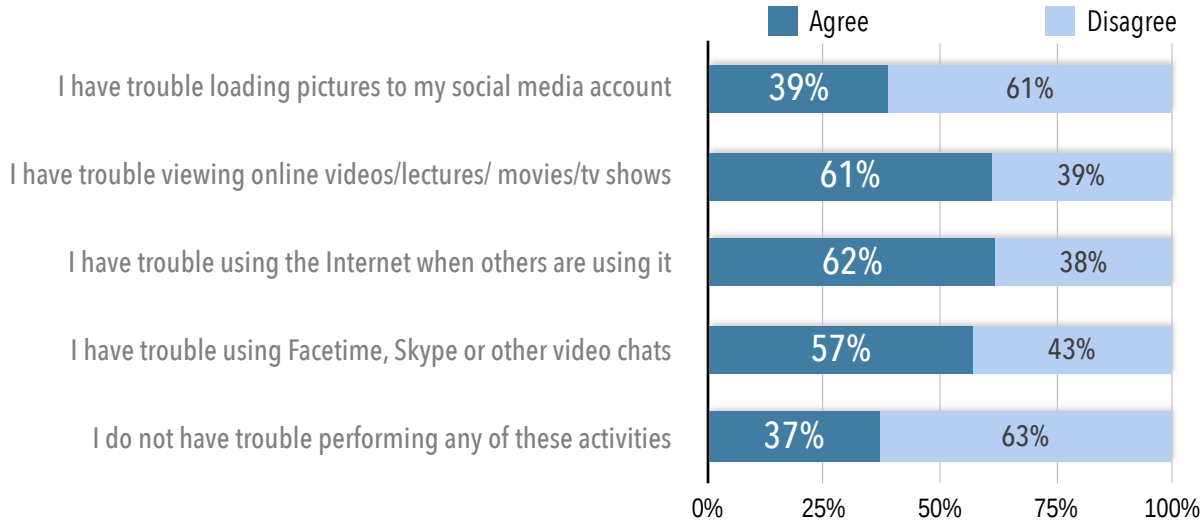
8. What is the speed of your Internet Connection?

As few as 25% of residents have Internet service that meets the FCC definition of adequate broadband service (25 Meg down, 3 Meg up). It is not unusual that many respondents do not know their exact Internet speeds.



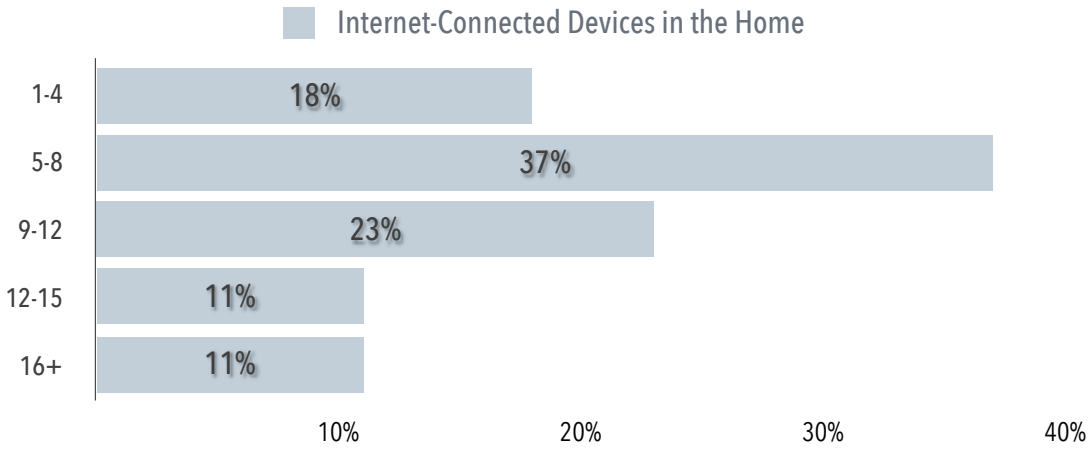
9. Select the items you agree with below

63% of respondents report they have trouble using common Internet services



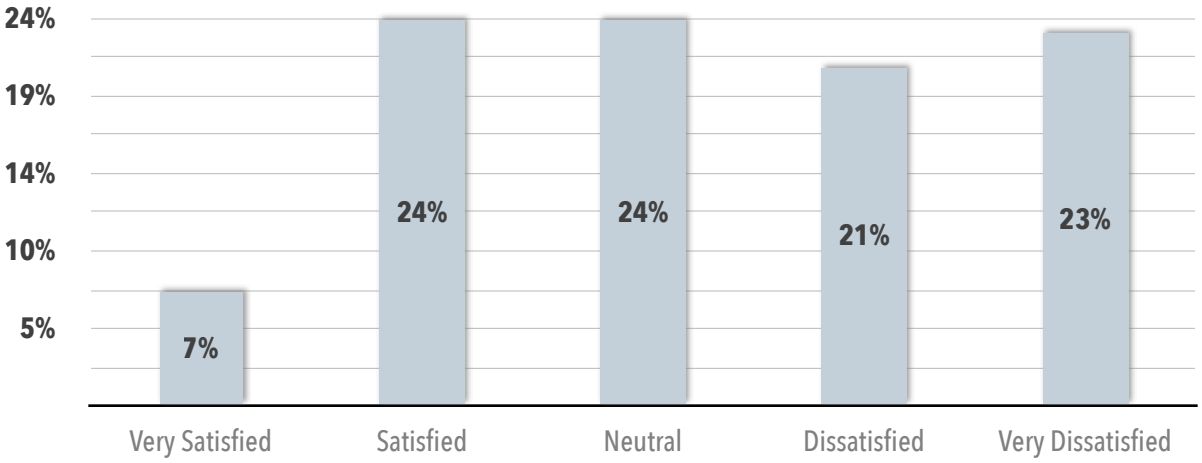
10. How many devices (for example computers, cellphones, smart TVs) connect to the Internet in your household?

45% of residents have 9 or more Internet-connected devices in their home



11. How satisfied are you with the speed and reliability of your Internet Service?

Only 31% of residents are "satisfied" or "very satisfied" with their current Internet service.



12. Select all items you use the Internet for now

Email	2,312	99%
Access news and current evens	2,141	91%
Learn about Covid-19 pandemic issues and information	1,751	75%
Homework/Schoolwork/Distance learning	1,234	53%
Work from home during Covid-19 pandemic	1,503	64%
Download or listen to music or audio books online	1,667	71%
VoIP Internet phone (Vonage, Skype, FaceTime, etc.)	1,410	60%
Online Backup (files, photos, music)	1,587	68%
Telemedicine or tele-health	1,296	55%
Online gaming	834	36%
Social media and social networking(Facebook, Instagram)	1,931	82%
Online Shopping	2,144	91%
Online banking	2,088	89%
Home security(e.g. cameras, video doorbells, etc)	883	38%
Smart speakers(e.g. Alexa, Google Assistant, etc)	993	42%
TV and Streaming video(Netflix, Hulu, Disney, etc)	2,008	86%
Other	121	5%

Other uses for the Internet

Thermostats, light bulbs, outlets
Work from year round, regardless of Pandemic

Communication with the only family I have left.....the marvelous grandchildren
need alternative to Comcast and frontier
Have Comcast internet, the service is decent when if works, but does not even come close to meeting the specs that I am paying for. Glitches sometimes, requiring cable modem reset every day or two.
Tele work
Business. I'm a local business owner and 75% of my work is done at home and nearly half of that in my truck in my driveway because my internet is down or drops so often is useless.
Home automation elements like wi-fi enabled washer/dryer & water heater.
I am a photographer and need to transfer large files via the internet. This is VERY difficult.
Thermostat, garage door openers, smoke detectors
I work from home regardless of the pandemic as an event producer that needs to run large arrays. I have lost work because of bandwidth issues that do not allow me to guarantee I can deliver. I cam from a technically advanced city and NEVER expected to walk into the 80s version of the internet connections. Honestly, it has felt like the state has been actively preventing this from happening in a veiled effort to keep commuters out and informed educated populations down and limited to certain regions of the state. I have considered moving because of the poor service
WORK!! (I ALWAYS work from home.)
Paying bills
Work from home.
Work from home not during the pandemic. We have to rent an office in Charles Town to have enough bandwidth to work on sunny days. We have even less on cloudy days. We had Frontier for years and would go weeks at a time without service at all. Our cell phone hot spots are strong enough either. So, add another $700 a month to our internet fees to cover the cost of our office. All so we can continue to earn money to support our family.
Work for home all the time.
VPN into corporate offices.
I will be teaching 1st graders distance learning from home and/or school.
work from home (not only for COVID)
Work
I use it for everything
Telework.
Smart lights
Pay bills
Smart home devices like thermostat and lights which enable energy usage control when not home.
work from home on a regular basis. Worked at home before covid
Do not have the bandwidth or reliability to use for important things such as working from home, virtual learning for my children, telehealth appointments, and home security.
I have a home based office/business and work from home.
building maintaining social media sites -- my current upload speed is too slow.
I teach in Virginia and am currently teaching online. I had to rent an office space from which to teach because my home doesn't have the bandwidth. That's an extra $500.00 a month.
No 5G!!
Volunteer services using Skype and Zoom. This service includes providing tutoring for adult education students and involvement in non-profit committees and board meetings.

Zoom
Uploading files for my Shepherd class that I teach and difficulty uploading photos for news media sites I shoot for.
Take surveys...
Yes. No really, everything. I'm a network engineer.
Run small business from home.
Work from home 75% of the time pre-COVID.
Everything
Obtaining government information, services, filing taxes. Scientific research. Publishing and editing Creator media content.
Home office
Church services
I would love to be able to stream video services or use Home Security and Smart Speakers but they do not work. The Ring doorbell could not find the internet despite being right next to it, purchasing the Ring extender and every other option that was available. We barely get Netflix to work most days. Dropping satellite or cable for streaming is not an option. Video conferences cannot be steady, meaning we have to deactivate the video/camera feature and dial-in in order to have a continuous connection. Covid-19 and working from home has been ex
wi-fi calling
My husband is on a heart monitor. He has a defibrillator inserted in his chest and readings are transmitted daily to his cardiologist. Any time there is a problem with the wifi his life is in danger. So Frontier is not a good company and we need to bring some competition and better service in Jefferson County for older citizens. Also fiber optics were supposed to be installed on our road and despite a generous 80 millions allocated to West Virginia by Congress it never reached Kabletown Road...
Zoom teaching
full time work from home
Farm business
On Demand and You Tube
Manage small business out of home
contact with volunteer activities and family AND church
Business activity
Work
Staying in touch with family in other states.
Work from home all the time, not just during Covid-19
working from home predated the COVID pandemic.
Monitoring for Solar Array
Work from home all the time.
Internet radio
Safety & Security, Thermostat
The option of "Work from home during Covid-19 pandemic" isn't enough. I work from home full-time as a Helpdesk Analyst for the Veterans Administration. I need fast, reliable, always-up internet.
Church and volunteer work, Zoom, Google meet, YouTube, etc.
Home IT lab and remote development.
uploading videos
miscellaneous research

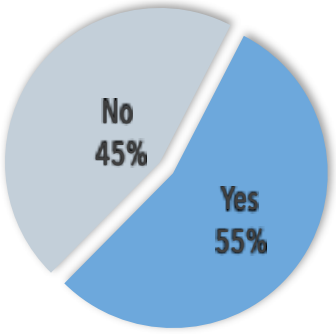
A lot of volunteer work that requires being able to download massive image files and work with data hogs like Adobe Creative Suite. Need to transfer same types of files via Internet. Need to back up same types of files OFF the internet.
cloud-based software
Full time working from home need access to meetings
Our daughter and her husband came to our home to use the internet service here b/c service at their residence in Jefferson County was inadequate to perform college class work and zoom meetings.
I do freelance, remote work and require good internet service
Livestream classes, Zoom meetings, online anatomy programs
Eco-bee HVAC energy savings system
I use my Internet all the time. I depend on it for everything, and even more since Covid.
Internet browsing, other online services
Publishing books on WWII for schools. I have a 501c 3, WW2 History Archive. We interview Veterans. Sadly the service is not good enough even for a phone interview. no sound keeps cutting off. The internet is so bad or non-existent, no chance to Skype or never send e-mails in a normal time frame.
Home Theater Room
printer
smart refrigerator
I am a teacher so I am on the internet at home all the time for work.
Online meetings with Zoom and Microsoft Teams.
Thermostats and lights use wifi.
FCC
video meetings like Zoom
I work from home daily
I own and operate 2 child development centers one in Harpers Ferry and one in Ranson, because of COVID 19 and virtually learning we have between the two centers 35 children that need internet.
Ritual band rehearsal using Jamkazam
CaptionCall phone
Work from home all the time.
Everything
Online teaching
Weather
Everything
ebooks, language study
I do a great deal of volunteer work including helping other seniors and church activities. During this Covid 19 period I have had to stay home but have been able to continue work and socializing because I am using Zoom and Face time. I also have been using telemedicine.
My parents live with me... 96 year old Mother and 85 year old Father. When I am not home I use the cameras to help watch them incase the would fall or someone comes to the door.
Unfortunately we can't use it for what is above, let alone anything else :-(
Cannot use any other because speed is not fast enough.
Hosting web conferences for work.

All my Internet services too slow to stream videos from Netflix (+ etc.), even YouTube is hard to watch anything even a lower resolution video!
I would telework everyday if i had the reliable Internet needed. This is not a COVID19 issue, it was an issue before COVID19, and will be afterwards unless some decides that Riverside/ Rolling Ridge should be welcome to the connected world.
Factual Research, Agricultural Research, Political/Voter Education, Family History Research
Access to services offered by Jefferson County: Notably the county courthouse, County Clerk's Office, County Assessor's office, etc.
PORN!!!
Monitoring water conditioner, monitoring and operation of garage door opener
I work out of my home, even before Covid-19.
printing, research recipes, cloud services, manage devices at cabin in another state
printing, cloud services
Bit-torrent/game server
Zoom videoconference/meetings
Amateur radio connections to alternate communications. (Echolink)
online research
church - Zoom
scheduling work, accepting shifts
I use the internet so much, I am willing to sell body parts to have an implant installed in my head to connect me 24/7
Continuing education
They said can't hook up
Work at home all the time
Zoom
Online stock trading
Unpaid volunteer activities during retirement.
Contact with children and grandchildren
Telehealth is questionable
Pay utilities
work from home (self-employed)
Zoom
We have to use our hotspot thru our cellphone in order to have internet. Due to Frontier not completing their work and not being able to afford the up front cost to get Comcast to run their line to our home.
Various meeting platforms: WebEx, Google Meet
I make podcast to teach others and talk about computers
Needed for work, communication to firm network
Pay some bills directly to company
Work from home all the time
Virtual reality
Research info I really want to know
zoom meetings
Pacemaker checks
Volunteer work

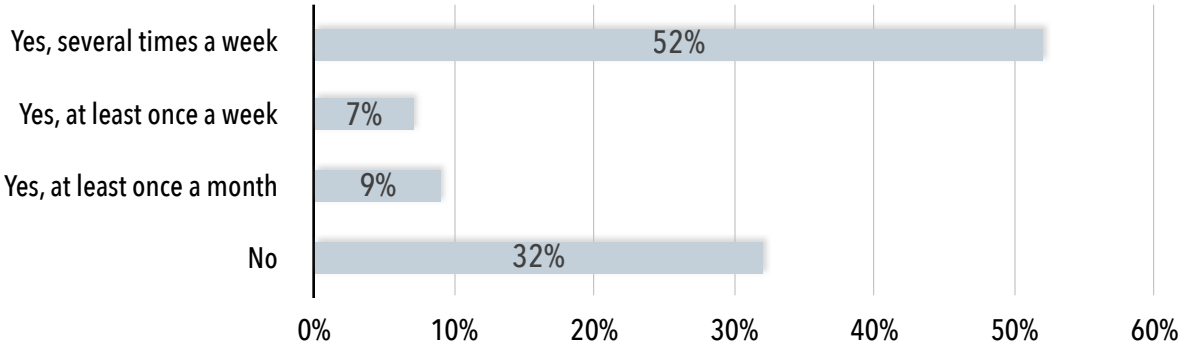
A host of IoT devices and smart controls, only some of which can be run on a LAN without an active internet connection, and all of which lose some degree of functionality/remote access without one. This includes smart bulbs, smart outlets and switches, thermostats, smart air quality sensors/purifiers/humidifiers, numerous kitchen appliances, smart garage door entry. More I'm likely forgetting.
Home business
Business
Trying to contact agencies whose phone access is fibrillating like a failing heart
Online continuing education hours for work
Unable to use any form of streaming due to limited amount of internet.
BBC World
Occasional work from home

13. High speed, affordable Internet influences where I choose to live?

Availability of broadband Internet is affecting where people choose to live. This is the highest number (55%) we have recorded in more that thirty county level surveys we have conducted. A more typical number is in the range of 30% to 35%.



14. Does anyone in your household use / need the Internet to complete school assignments or job training course work?

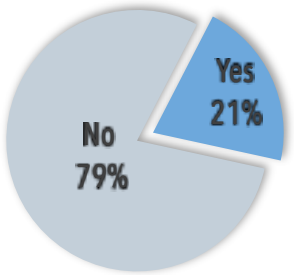


15. Who is your Internet Service provider?

Some responses included more than one provider.

Frontier	658	28%
Shentel	0	0%
AT&T	20	1%
Comcast/Xfinity	1,493	64%
Wireless Internet	18	1%
Cellphone hotspot	52	2%
Satellite Internet	43	2%
Other	32	1%

16. Do you have data caps on your current Internet service?

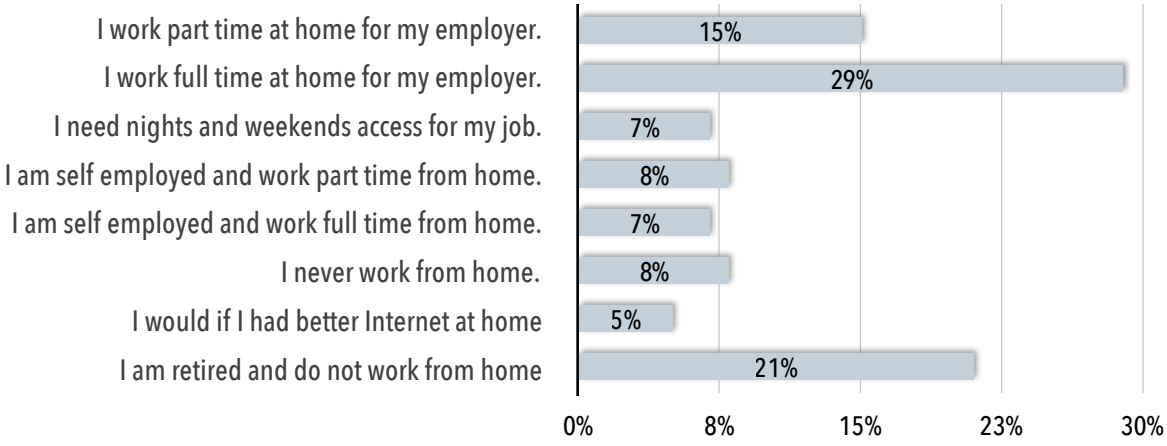


17. If you have data caps, have you exceeded those caps?

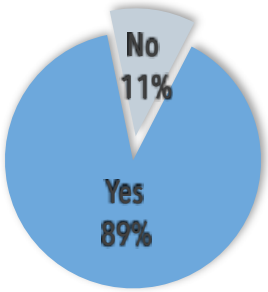
Yes	15%
No	51%
I don't know	33%

18. Do you work from home?

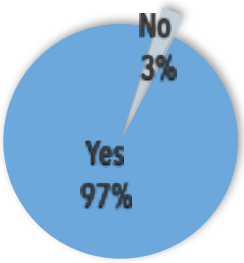
66% report working from home part or full time–the Internet has made residential neighborhoods into business districts. Home-based jobs and businesses reduce traffic congestion and reduce road maintenance. This is also a high number relative to past surveys we have conducted, and undoubtedly the Covid crisis has caused this number to rise.



19. Are you interested in Gigabit fiber Internet Service?



20. Should your county government help facilitate better and more affordable broadband services?



21. Any Other Comments

Many comments were received. Because of the volume of replies, these comments can be found in a separate document (**Residential Comments**).

5 JEFFERSON COUNTY BUSINESS SURVEY RESULTS

During the Summer of 2020, a broadband business survey was conducted in Jefferson County, West Virginia as part of a county wide study in broadband needs. The online (Web) version of the survey was publicized on social media and paper surveys were distributed by local libraries. Businesses were encouraged to complete the survey online or fill out and return the paper version by surface mail. A total of 104 responses were were collected from businesses in Jefferson County. Not all responders answered every question. Some key findings from the results are listed below.

86% of business respondents want better Internet access

97% of business respondents say the local government should help facilitate better and more affordable broadband service

99% indicated that the Internet is important to the success of their business over the next five years

Only 28% of businesses are "satisfied" or "very satisfied" with their current Internet service

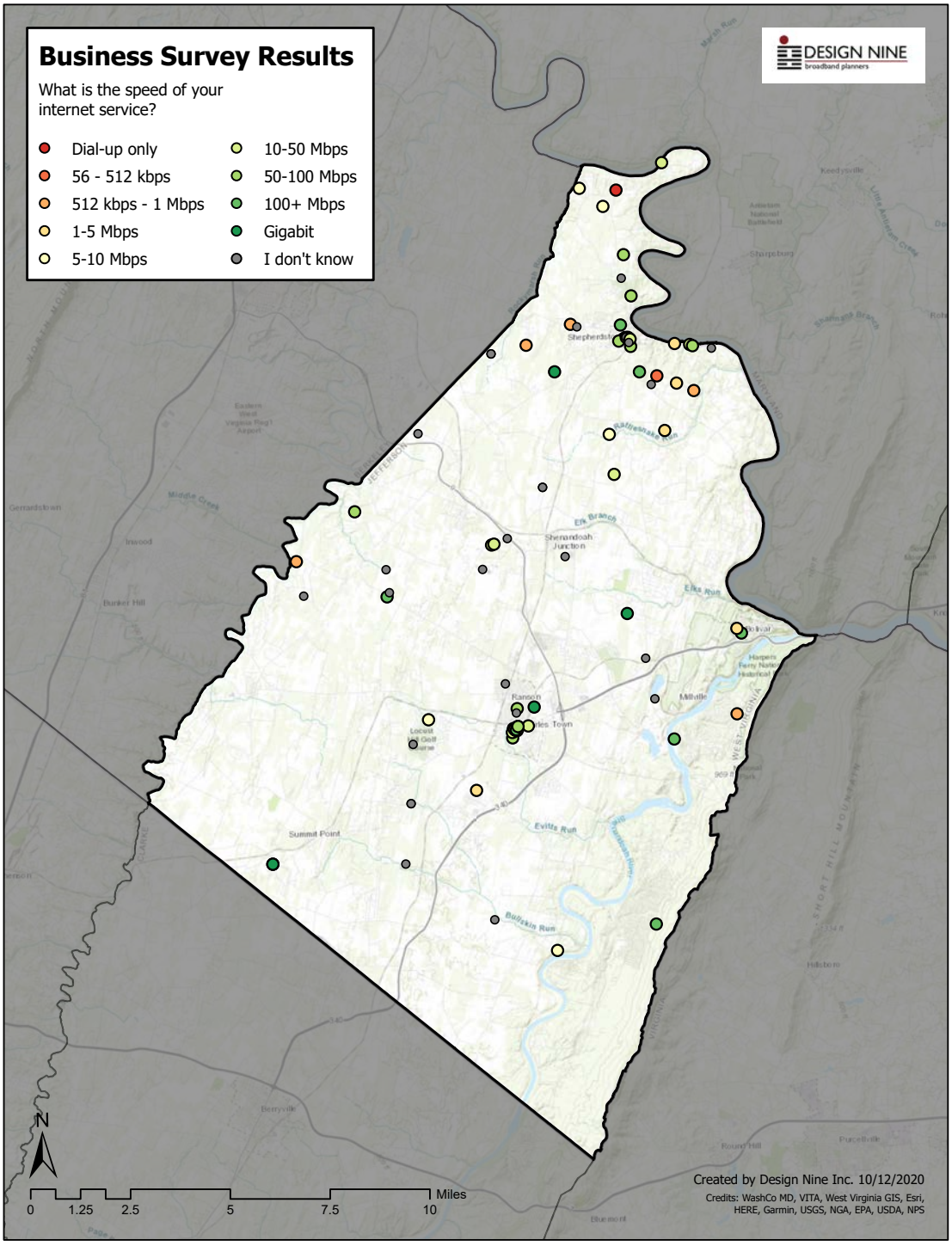
33% of the businesses that responded are home-based

88% of businesses that responded need employees to be able to work from home

Home-based workers and businesses need affordable Internet access

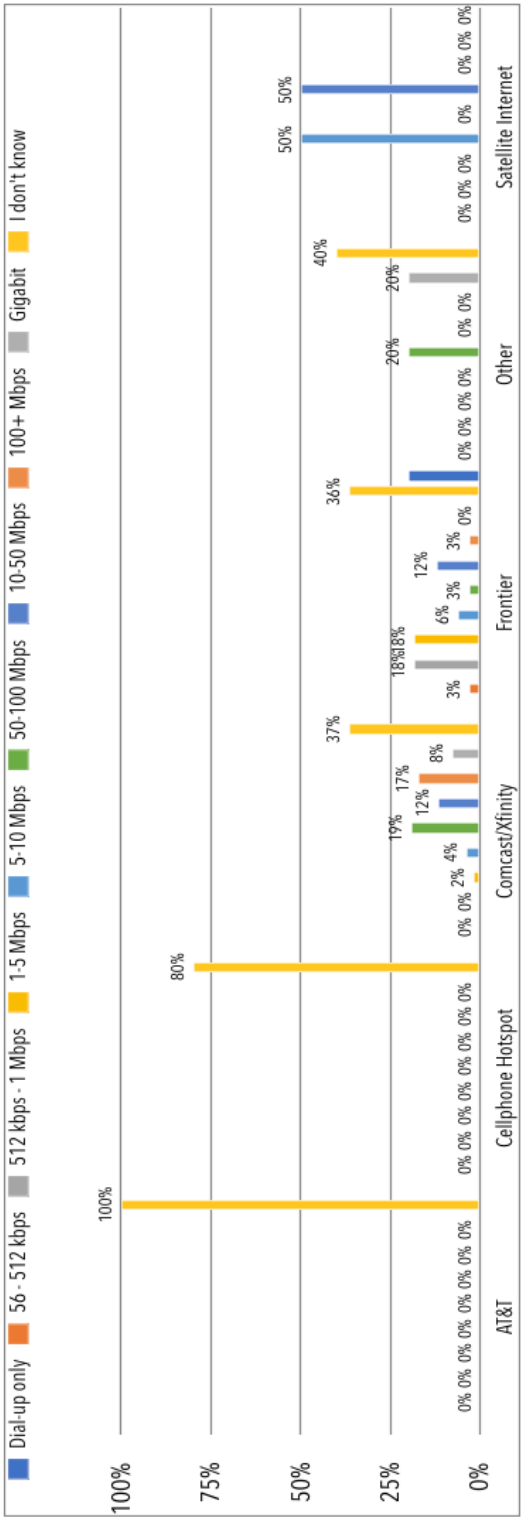
5.1 DISTRIBUTION OF SURVEY RESPONSES

The map below shows the geographic distribution of responses to the business survey, coded according to the speed of their Internet connection (Question 9).

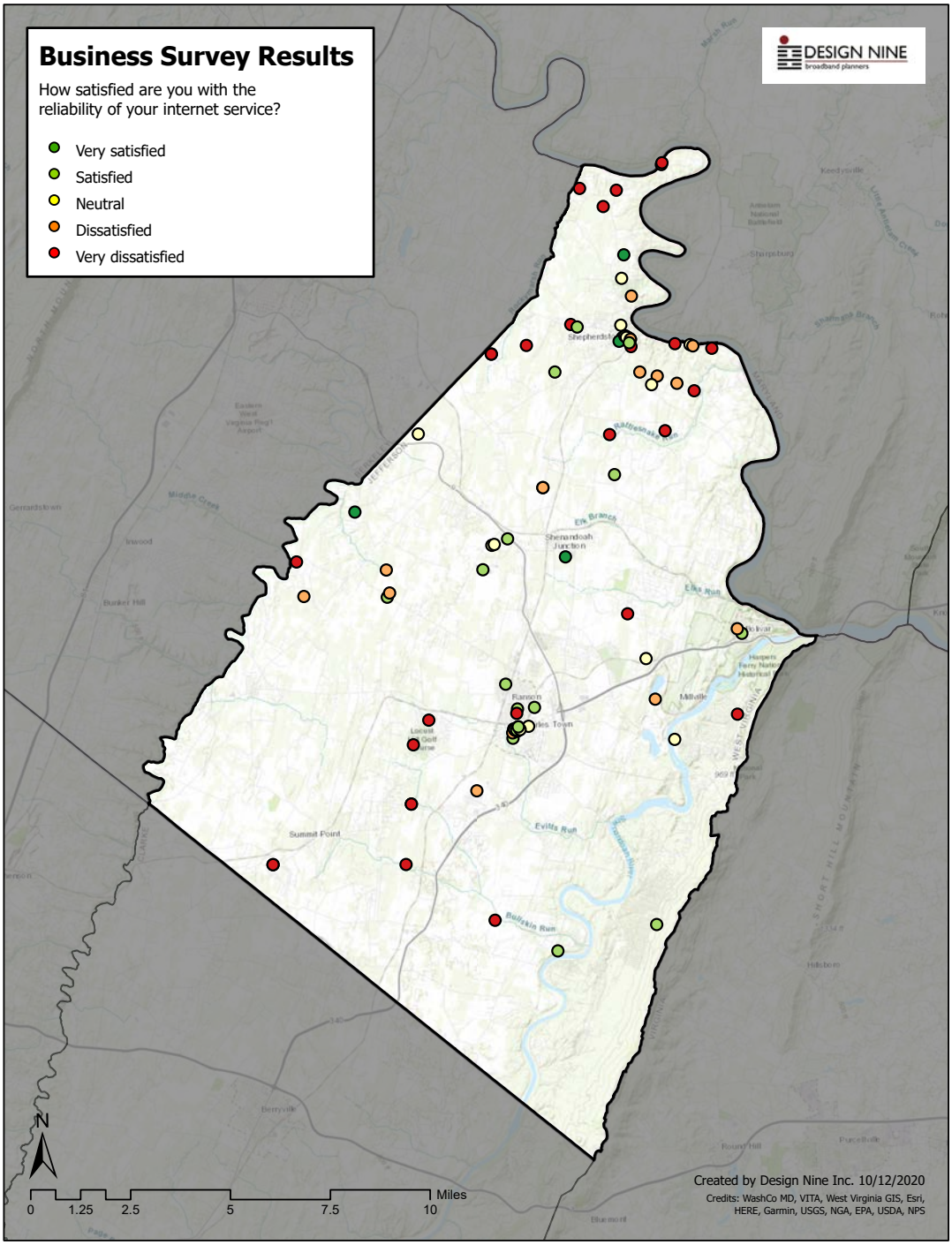


Service Provider Speed Comparisons

The chart below provides a between-providers comparison of speed offerings.

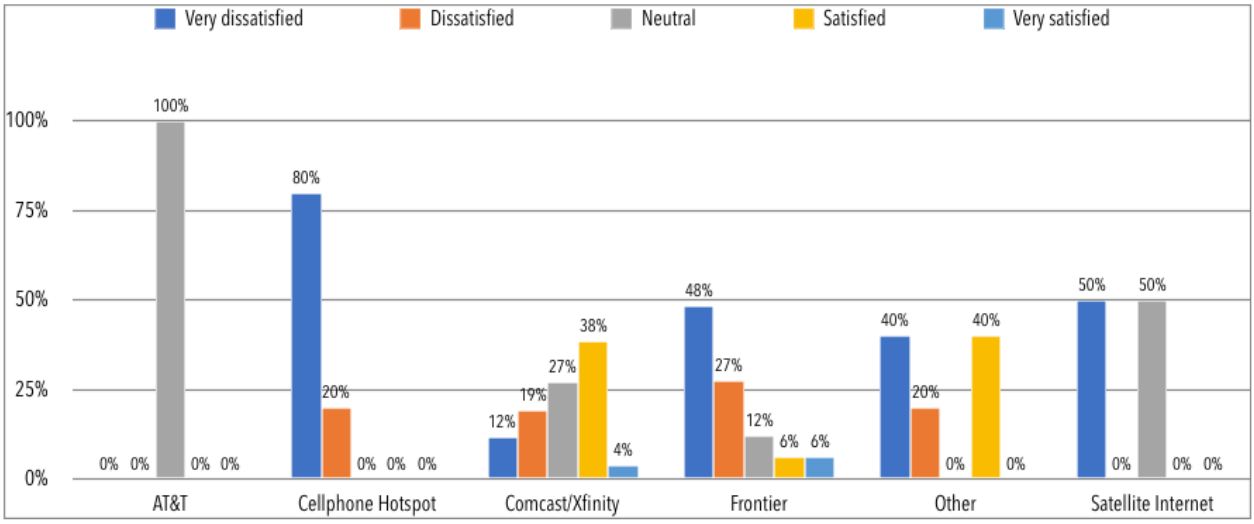


The map below shows the geographic distribution of responses to the business survey, coded according to their satisfaction with their existing Internet service (Question 10).



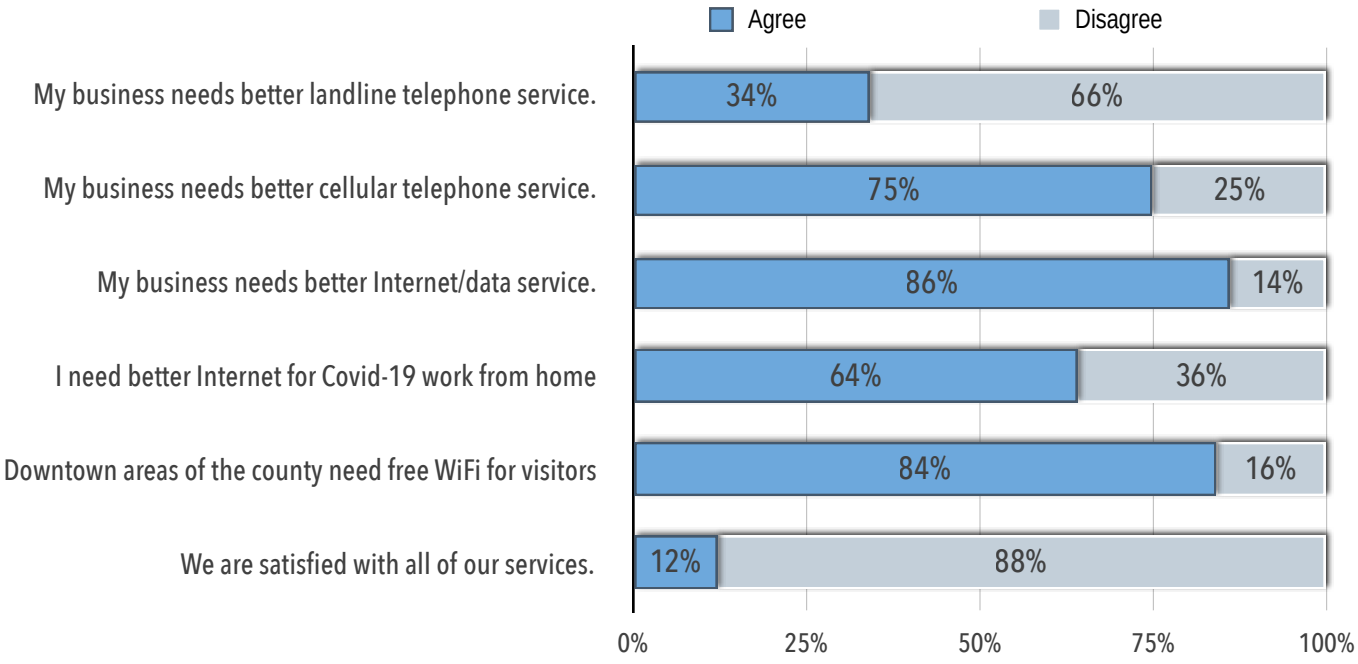
Service Provider Satisfaction Comparisons

The chart below provides a between-providers comparison of satisfaction with providers.

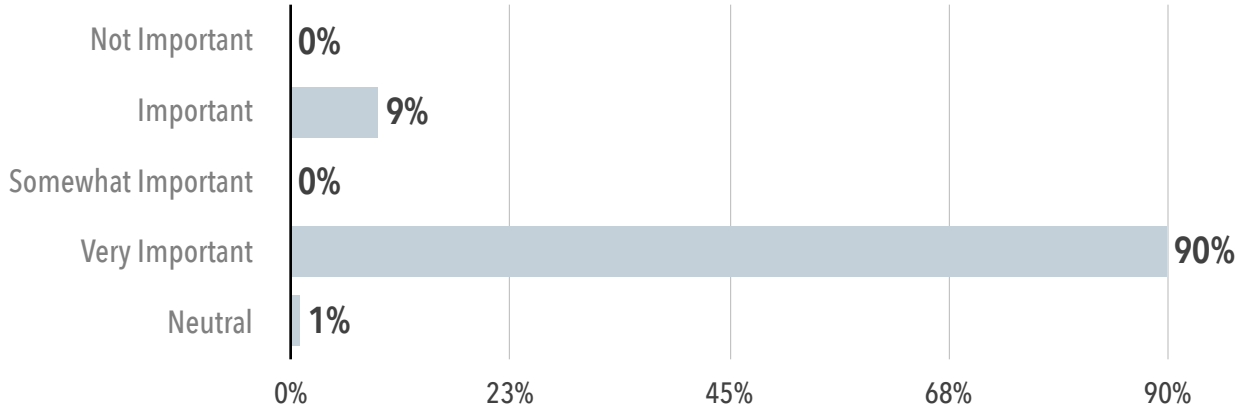


5.2 BUSINESS SURVEY SUMMARY DATA

1. Select the items you agree with below



2. How important do you think Internet technology will be for the success of your business over the next five years?



3a. Total number of employees

1 to 10	86%
11 to 40	5%
41 to 80	4%
81 to 150	1%
Over 150	4%

3b. Total number of Internet users

1 to10	75%
11 to 40	12%
41 to 80	4%
81 to 150	3%
Over 150	6%

4. If you are a business, what type? (select all that apply)

Retail / Wholesale	19	19%
Professional / Office	23	23%
Government	6	6%
Educational	11	11%
Medical	6	6%
Non-Profit	16	16%
Restaurant/Food Service	4	4%
Communications/Technology	5	5%
Agriculture/Forestry	7	7%
Manufacturing	3	3%
Construction / Maintenance/ Repair	7	7%
Home Based	34	33%

Other types of businesses

Arts/Entertainment
Marketing.
Hospitality
Technology/Family Entertainment
Independent contract for services
Independent contract for services
Real Estate Investing
Photography
Service sewing alterations and repairs
Service oriented in the construction business.
Day Spa
Motorsports
vacation rental
Utility and Appliance Sales
Tour
Hospitality (Casino, Restaurants, Hotel, Horse Racing)
Recycling and transportation
In addition to rehabbing and selling homes, we also buy, hold, and manage rental properties.
Arts & Entertainment/Publishing
AirBnB
Rental
Racing Car Prep
Wedding, Reception, Special Event Venue
Transportation
The Spirit of Jefferson is a weekly newspaper serving Jefferson County and the surrounding areas. The newspaper is published each Wednesday, in addition to a full-scale website and Facebook page.
Entertainment
Not a business
I am a title abstractor and I work for several attorneys to research the real estate records in the county clerk's office.
Short Term rental / Vacation Homes
Lodging
Personal Service
Public Library
Custom Software development and cybersecurity services, with an emphasis on healthcare IT
Retreat and Conference Center for non-profit education

5. Is this a home-based business?

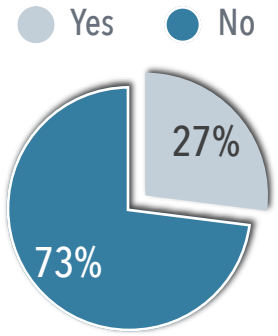
Yes	No
41	59
41%	59%

41% of the county businesses that responded are home-based

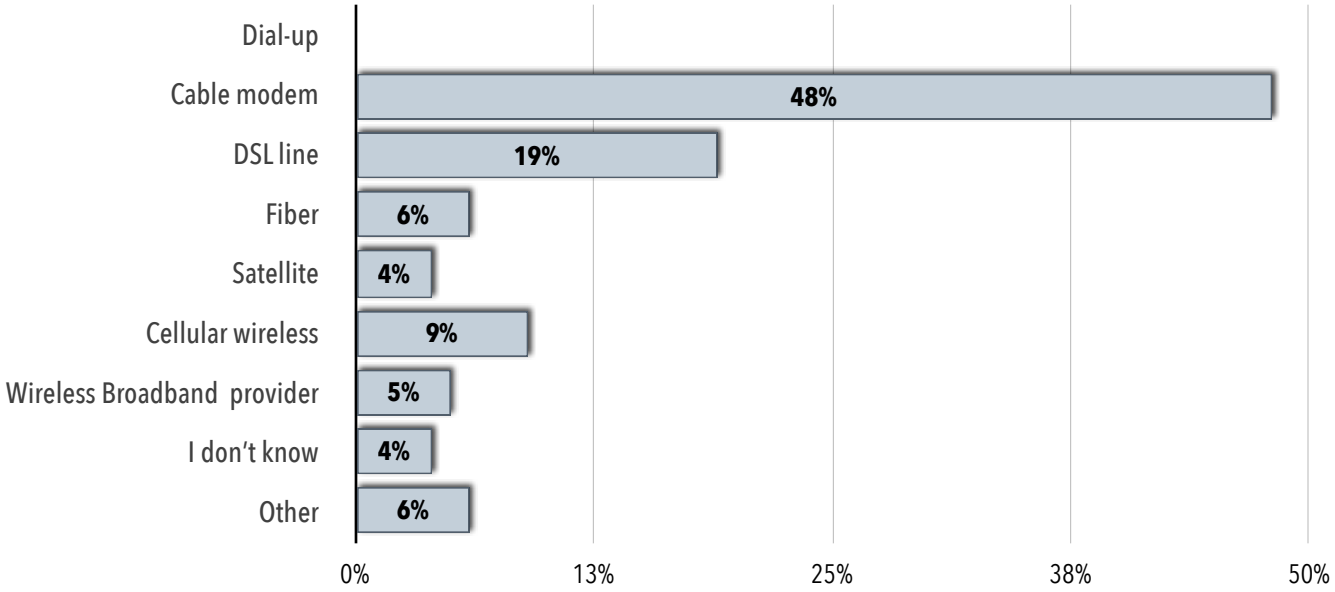
6. How much do you pay now for Internet access each month?

No Internet	$0 to $100	$101 to $150	$151 to $300	$301to $500	$501 to $1000	$1001 to $5000	$5000	I don't know
6	24	27	28	7	0	1	2	6
6%	24%	27%	28%	7%	0%	1%	2%	6%

7. Are you satisfied with what you pay for Internet service?

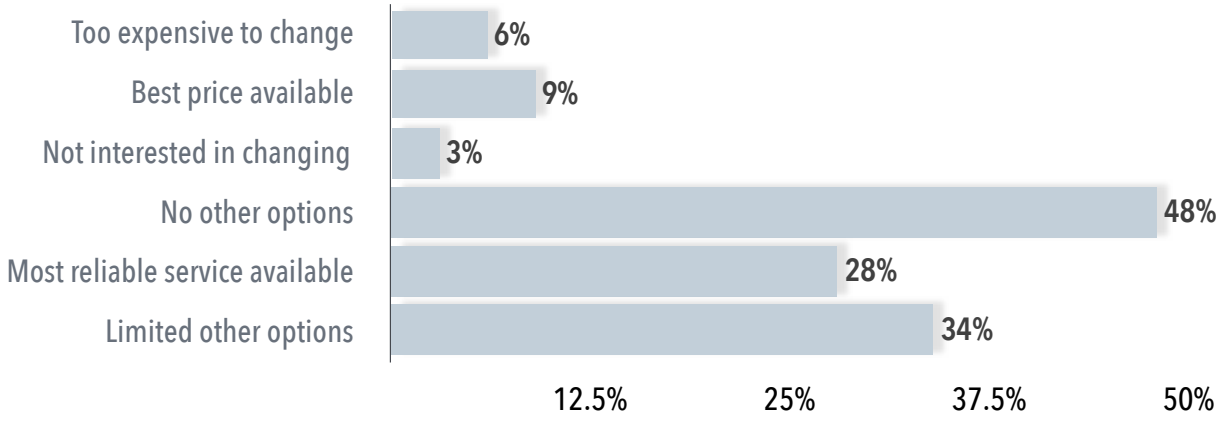


8. What type of Internet do you have?



9. Based on the type of Internet you selected above, why do you still have it?

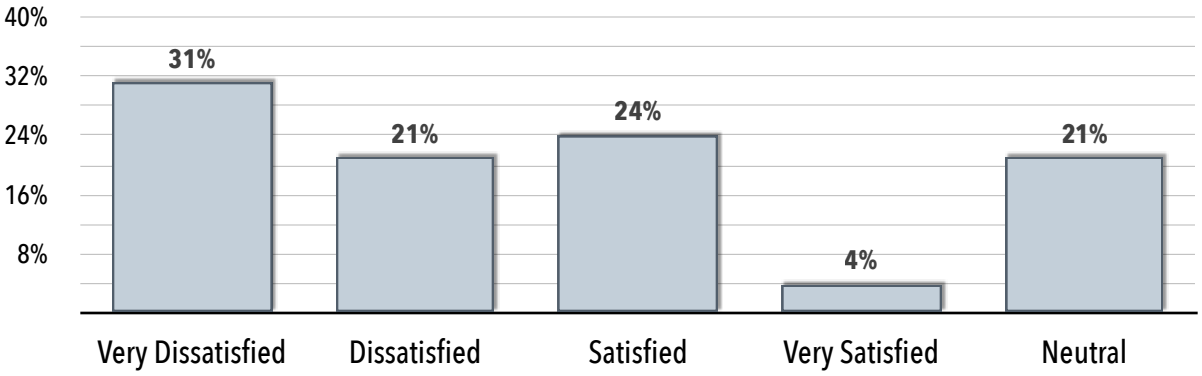
Respondents could choose more than one option.



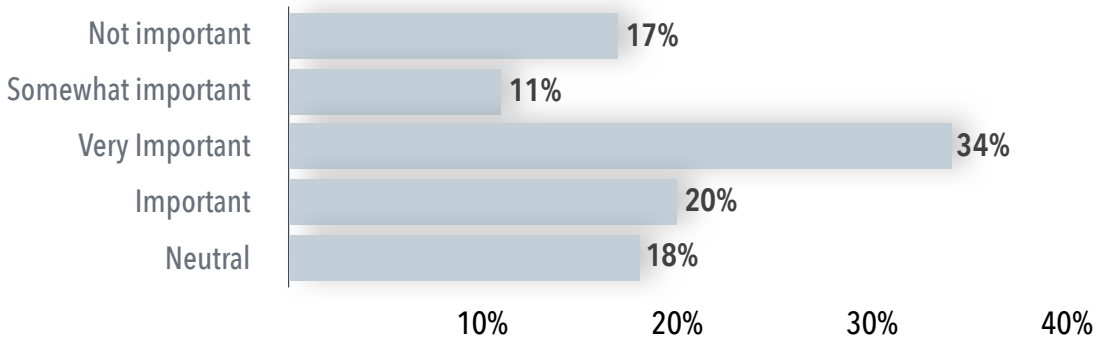
10. What is the speed of your Internet connection? (A Gigabit is 1000 Megabits (Mbps)

Dial-up only	56-512 Kbps	512 Kbps-1 Mbps	1-5 Mbps	5-10 Mbps	10-50 Mbps	50-100 Mbps	100+ Mbps	Gigabit	I don't Know
1	1	6	7	5	11	12	10	6	0
2%	2%	10%	12%	8%	19%	20%	17%	10%	0%

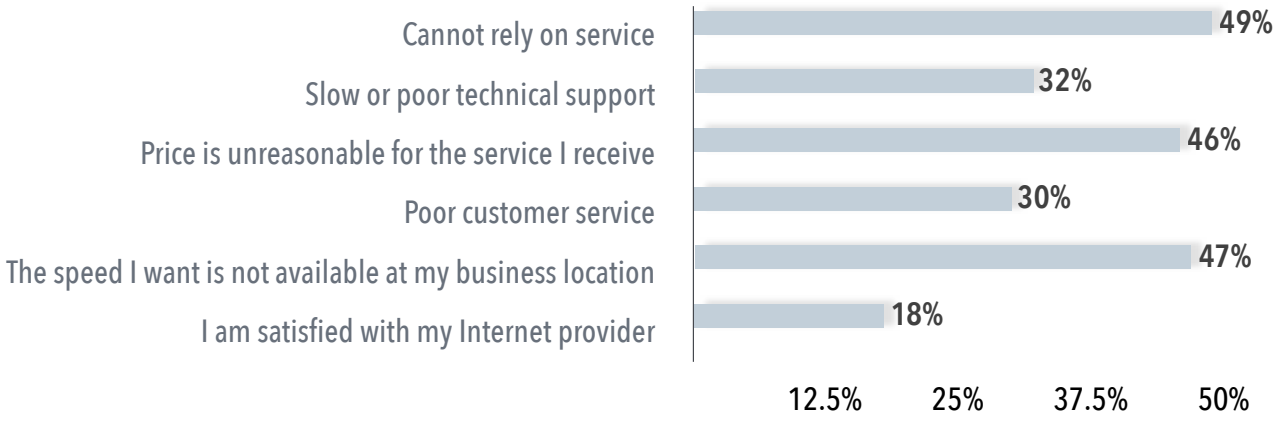
11. How Satisfied are you with the speed and reliability of your Internet service?



12. How important is a redundant or second Internet connection to your business?



13. Please select all that apply to your current Internet provider



14 . Select all the items you use the Internet for now(Select all that apply)

Email	99	98%
Communication between headquarters and remote sites	62	61%
VoIP Internet Phone(Vonage, Skype, etc.)	50	50%
Provide free WiFi service to customers	34	34%
Online Backup (files, photos, music)	81	80%
Transfer large files	68	67%
Monitor / control security, alarms, health, processes, etc.	47	47%
Processing credit card / debit card transactions	64	63%
Ordering / managing inventory	57	56%
Maintaining a Web presence, or blog	77	76%
Social media (Facebook, LinkedIn, Twitter, etc.)	86	85%
Receiving and processing online orders	58	57%
Cloud-based business, accounting or other services	46	46%
Other	8	8%

Other comments

Video conferencing
Virtual Reality, software development
Web conferencing/ meetings

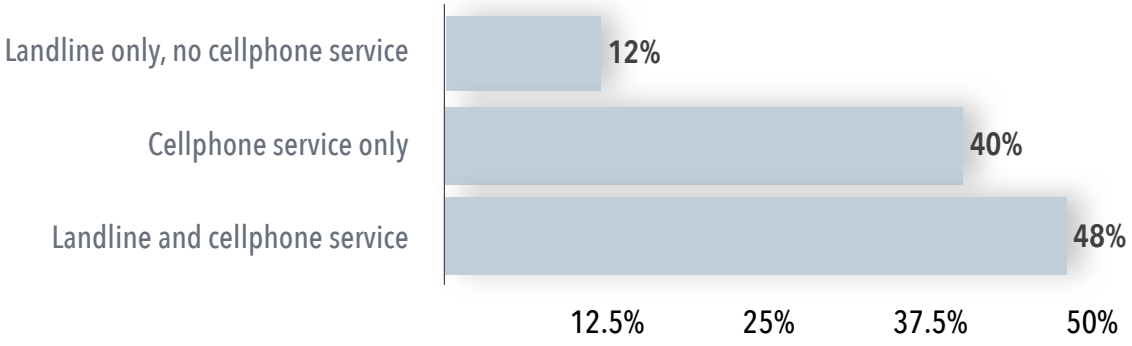
EMS software in Ambulances, which we have to use cellular at times, due to low signals at tracks.
I am currently unable to upload files or to reliably moderate webinars, both of which are very important for my business. I currently have to drive to a location in Berkley County to access reliable and fast internet! I have been trying to get new service from Comcast since October 2019 and am even willing to pay $10,000 they say is required to get the service (about 700 feet away) to my property! But still no progress - ridiculous indeed!
live streaming & video uploads
Our Directv Service now goes through our internet service, it is so bad we can not even watch a movie without constant buffering
Zoom, Webex, video conferencing
Patrons use the computers. Need the connection for printing. Programs.
Patient search/applications

15. Who is your Internet Service provider?

Some responses included more than one provider.

Comcast/Xfinity	53	52%
Frontier	34	34%
Satellite Internet	2	2%
Cellphone hotspot	6	6%
At&T	5	5%
Other	1	1%

16. What kind of telephone service do you have?

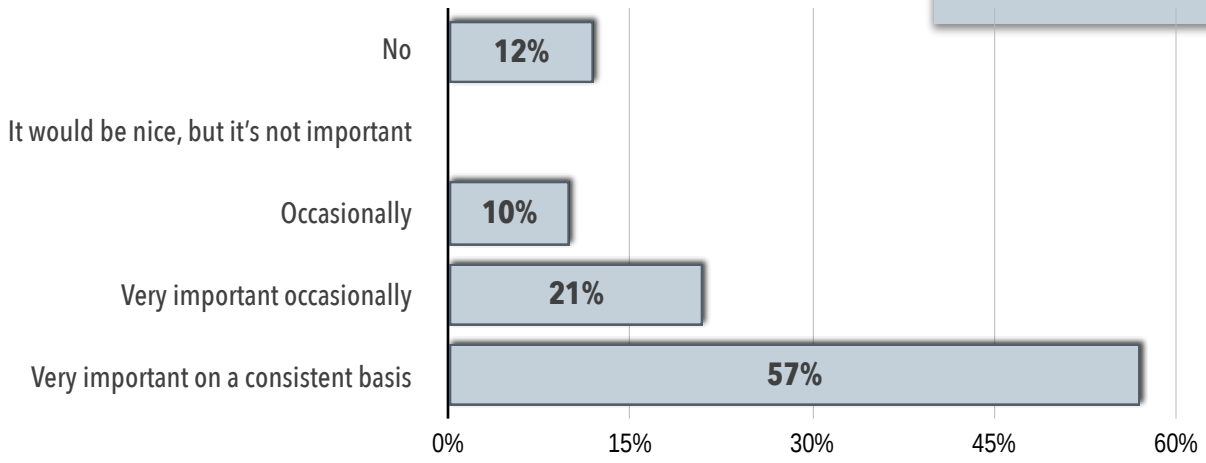


17. Do you or your employees use a VPN (Virtual Private Network) to obtain remote access for your work or to a company network?

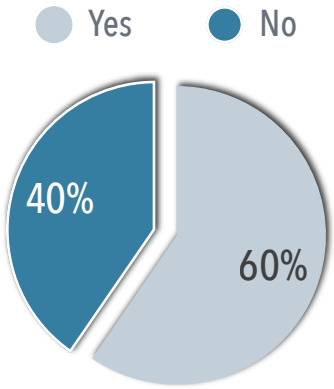
Yes	No	I Don't Know
31	60	10
31%	59%	10%

88% of businesses that responded need employees to be able to work from home

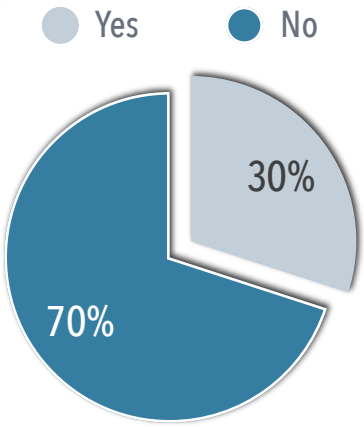
18. Do you or your employees need or want to work from home?



19. Does limited Internet access at employees' residences impact your business?order



20. Do the existing internet service options impact your business's decision to relocate or stay in the County?



If yes, briefly state why:

XFinity is the leading broadband provider in the area. Should they leave, the county would be adversely affected as the alternatives are Frontier/DSL and Dish. Neither alternative options offer premium reliable speeds required to implement critical I.T. infrastructure in the county

Hotspot is too weak to do email most of the time

Hotspot is too weak to do email most of the time

If we are unable to maintain a stable internet and phone connection we are unable to serve our customer base many of whom purchase their goods over the phone while employees process their order online.

I would like to have internet wifi for customers

I really want fiber connection.

Wherever we go we will need excellent internet service because our entire operation depends on it. There are some areas in the county that are limited to the internet providers or the ways of getting internet service. Our customers have difficulty being able to call in or use their phones for consultations in our store too.

We'd love to move elsewhere, but being closer to home helps, and having no other high-speed alternative makes it hard to move forward.

I would say that internet reliability is one of, but not the only factor that would influence a move of our business. Since most of our income is a result of managing assets, we could do most of that from a different location, especially if reliable, affordable internet was available.

Yes or no is insufficient to explain! In short, my entire business is online, and the only reason I can live in Shepherdstown is that I can work from my home via the Internet. Since I'm still here, this has obviously not been such a problem that I need to relocate! But it would be nice to have more options, cheaper options, and more reliable connections & speeds. (I have Comcast/Xfinity, Frontier is the only other option I'm aware of, and I had it over a decade ago, and it was terrible. Thus I would say we only really have one provider option in town.)

WV

The nature of our business requires a redundant connection.

When I called Frontier for faster and more reliable service, I was told my present service as the best thy could offer.When I asked if there were any other options, I was told 'You could move'. I have never forgotten this poor response.

Without reliable and sufficiently fast internet, I am finding it very difficult to run my business in Jefferson County. I moved to the county in 2020 without realizing what the internet situation would be. I may be forced to rent office space in Inwood.

If I can't get the speed equivalent of cable internet, then I would be very unlikely to choose to locate at that location.

Require internet for communication and zoom/microsoft team meetings.

Too costly, too slow, and no backup connection for online meeting and training demands of my company.

Dropped call on a consistent basis makes it hard to hold a conversation with my customers. Exceptionally slow internet often makes it impossible to download files and to review them for my customers. Considering selling and moving to another state to keep my business going.

I live in the Junction and I work from my house .I am not going to move my business to another location .I can either work from home or go into the Courthouse and work. With Covid however, I primarily work from home.

It is crucial that we have reliable dependable system. The current system is not at all reliable and does not work more often than it works. I hope that we can get a new system up and running soon..

it is a consideration

Frontier's DSL internet is too slow and unreliable. Much of our coaching is done via the internet (Zoom, Facetime, WebEx) and the connection is so slow that it makes it difficult to do these sessions. Additionally, the connection often drops entirely interrupting our coaching sessions.

We are a farm operation. We cannot move.

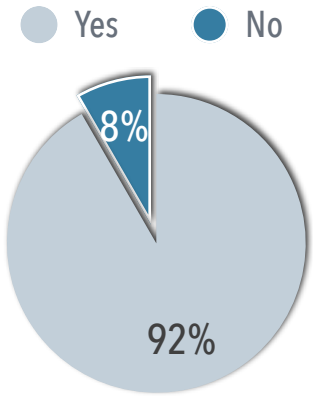
Must travel to access internet

We have been here for so long that moving would reduce the value of our operation.

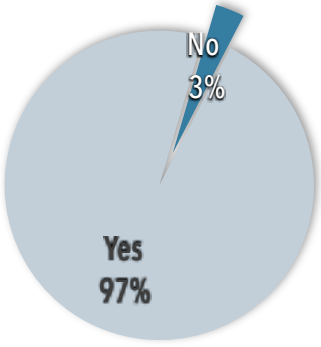
WV.

Poor internet, landline and cell service is prohibiting me from being able to even consider locating more of my business activities to Jefferson County.

21. Are you interested in faster/more reliable Internet Service.



22. Should your county government help facilitate better and more affordable broadband services?



23. Any other comments?

- I have Frontier at home and only one available unless I go to a satellite dish service for internet access. It is very slow and buffers a lot. It sucks. Here it cost for Comcast over $230 per month

for internet and phone which is big expense not only for small businesses but also for non profit that needs it. Would be nice to pay part of a city wide network that gave high speeds as well as voip phone access and thus reduced costs but better service.

- There are places in Jefferson County where there is no cable for TV or Internet access. At our house, we have three choices: Frontier DSL (ugh), dial-up (bigger ugh) or satellite service. Considering how often our DirecTV feed is scrambled or interrupted by weather, satellite Internet is probably not the answer either. The solution is a county-wide fiberoptic scheme. We live on Old Cave Rd between 340 and Augustine Ave. The lower part of Old Cave Rd has cable, but not us.
- WV has a bad reputation for having the infrastructure white collar businesses need to grow. Anything we can do to make that ground more fertile for businesses can only help increase revenue for the state and better our community.
- We have lost business because we cannot provide adequate high-speed internet for our guests who want to come here and work. On-line reviews, which are so important to our success, have mentioned the unreliable internet. As owners we frequently have trouble uploading email attachments or performing backups to the cloud. Frankly I do not see how the county can expect substantial growth over the next 5-10 years without county-wide broadband access. People will relocate somewhere else where their kids can do schoolwork assignments and parents can work from home. Jefferson County, being a bone-fide exurb of metropolitan DC much like Loudoun County VA 20 years ago, really needs to step up its game in this area. The online world today is being built assuming users have reliable high-speed access, those that don't will get left behind. Thanks.
- As mentioned in question 22, it's critical have high speed (100mps+) reliable infrastructure in place. The County is in dire risk should Comcast/Xfinity ever decide to cease services in the area. It is even more dire in a "Covid world" where technology services are critical to support the needs of teleworkers, students who are unable to access online video sessions. My only suggestion if the intention of this survey is to build out an open public wi-fi network is to ensure proper security controls are in place to limit risk. Proxys, audit logs, access control, encrypt data in transit, inactivity timeouts etc...
- Internet access is becoming a question of equity as well. With businesses and students who need access while in their places of business/school but also the ability to get work done at home internet services should be accessible to EVERYONE not just those who can afford to pay for them.
- Just don't hinder or direct it to particular locations.
- Most internet providers focus on download speeds. I pay for the fastest speeds possible but the upload speeds are killing me. At times I can’t get jobs uploaded in a timely fashion because of how much traffic is sharing the bandwidth. This was an issue pre-Covid. I now often stay up late or wake up at midnight to upload jobs. I would be willing to pay more for fios if it meant faster upload speeds. I am hardwired into our connection to ensure the fastest speeds possible (no wifi for my primary work station).
- Internet in houses is even more important as people are able to work from home. We are starting to see “internet provider available” impacting home values. People can’t work without high speed Internet. It makes many areas of the county an economic impossibility. Cell service,

especially in downtown areas is also a huge issue for commerce and needs to be corrected to continue to attract and retain high paying jobs and tax payers.

- Some of our funding comes from rental of building. Having internet access is a service but no option to be able to turn on when needed and off when not and being billed $220 is high. Also used for community events such as health or historical presentations. Frontiers pay as you go service is not reliable and seldom works properly. It would be great to have an internet service in town that could be billed like other utilities such as water that was a shared resource that everyone paid for and you could be charged for usage or pay for higher service but run by the city
- We sponsor and or help wit many vendor events located on Washington or Charles streets. Cell service is bad except for a couple of carriers. Frontier's pay service does not work well, Comcast's service is unreliable when there are many people trying to use it. It is hard for them to process sales and I have used my own cellular devices to provide working hotspots to help the vendors. There should be a reliable and secure downtown internet service that can be used even if there is a nominal fee for its use. Even though we are not a metropolitan it would be great to have something like a MAN that provided internet service for the area as one high speed network that was then billed much like water service.
- Somehow there needs to be a better way to provide better cell service/internet for visitors to be able to call us if lost or if they have arrived for curbside pick up, they also cannot make calls in our building because of no service if they are trying to consult about a purchase with someone else. Our customers also need to be able to use their phone/internet access/data to retrieve photos for consultation. We help customers with home design, color coordination, etc. Many cell phone users have the ability to use WiFi calling, which is how our cell phones operate in our building but the signal isn't strong enough to reach the front of our building so it would be helpful to be able to keep calls toward the front and outside our door. Our best option is Comcast right now and there are many times where it's not working or it keeps kicking us out and we can't process transactions or do anything with customers.
- Thank you for the survey!
- I currently reside in Berkeley County, but will be building soon in Jefferson County on Persimmon Lane. Comcast does NOT currently provide service to the area of my property. There is only DSL provided by Frontier, but that is not even an option. We would like to see Comcast start providing service to our area, since both my wife and I are small business owners and do work from home quite often. Internet is a MUST for us.
- Fiber would be nice but is not necessary, higher speed without capacity limits is. Hughesnet has a 50GB capacity limit and a lot of lag that limits video conference calls. comcast should come down river rd and to most homes but is not building out their network. We have a home is a much more rural area of Virginia (covington) and have fiber to the home with much more bandwidth and lower cost than comcast from Lumos.
- Our Internet service within the Burr is acceptable (Frontier), however we have had SEVERAL outages, and any outage effects our business. MOST importantly though is access from our rural homes to manage the business in the evenings, weekends, etc. Frontier DSL service is horrible, low bad speeds, service interrupts and outages. THIS is our major concern, we need to be able to work from home and not forced to drive to business every time something is needed.

- At Hollywood Casino, we have numerous internet providers for redundancy so one ISP failure doesn't impact our business. If it wasn't for Comcast's internet service we would struggle with the usages mentioned above. Frontier Communications has become a major disappointment and literally unusable. Their ethernet solution for businesses is incredibly expensive and their technology outdated.
- I was a county commissioner from 2005-2010. I took the lead in successfully establishing a gis department in the county and the creation of the it committee that functions today. I was very involved in the negotiation of the cable franchise agreement back at that time from a really awful ten page agreement that pre4ceded it. I obtained franchise agreements from Loudoun and Frederick county MD to help in the writing. I have researched this problem. The county commission always hides the fact that there is a capital expenditures account which has always been more than about $8 million. If you go to the county commission website under budgets and esp state audit look for the balance sheet and you will the mentioned capital expenditures account. It is not attached to any function. It is not dedicated. To take any of the funds out the county commission would have to have three of five votes to vote out some of it for a capital expenditure. A project with comcast to extended fiber to poorly served areas would qualify at a "capital expenditure" so it would only need three votes. I suggest the ICDA recommend to the county commission that they vote to have the gis department make recommendations on 1. Parts of the county that can receive presently no fiber service 2. Find out the lowest possible cost given their high population and density of housing and distance of feet cable required to provide the service ---- this is cross analyzing population, density, absence of fiber service, with how much new feet of fiber cable are required and for how much. I think you should contact nance briscoe of cloverdale and ask if the hoa's or any HOA would like to go in as a complete group to partner and get fiber to their community. They would pay as a group but their numbers help from the standpoint of comcast and making money. I wonder how many subdivisions have lousy service. Nan is a key peerson in a pandhanle wide organization of homeowners associations that grew out of a six times a year breakfast i started with hoa's during my tenure/ the cost would be a joint venture with the county and comcast and can be justified given their existing legal partnership in the form of the cable franchise agreement. The ICDA should determine if the franchise agreement renewal is being negotiated and if this could be brought into their negotiations. I spoke with a construction manager at the clarion hotel from Texas. I think he regretted talking about something that was supposed to be sort of quiet --- point is the ICDA should contact a person at a higher level of spring to determine if they will have 5g in the county anytime soon. This man told me they are working to install five g here and needed more workers. This was last fall. So sprint offering 5-g and comcast partnering with the county to pay for the creation of needed fiber. Having the gis department makes it very possible for the ICDA to come up with great data. To negotiate from. also track down nick gageby for ideas he has been working with apus and worked with comcast
- Sprint cell phone service has gone downhill greatly.
- I would be delighted to have any entity, county or otherwise, with power/leverage to help in securing better, more affordable internet services to help strengthen our businesses so we are able to operate without interruptions that cause damaging communication issues with any predominantly based communication business.
- EPTA has internet provided through Berkeley County. However, EPTA vehicles serve Jefferson County and the City of Charles Town. As technology advances, EPTA is currently implementing

tablet integration for both passenger counting on the route buses and scheduling purposes on the Demand Response/Non-Emergency Medical Transportation (NEMT) vehicles. These tablets will rely heavily on a cellular signal to receive accurate location information and to transfer important passenger data between the driver and EPTA. Without a cellular signal, EPTA will not be able to accurately utilize the tablet and advance its operations.

- We are 1/2 mile from the ComCast PoP, they want $25k to run service in our community.
- I have been operating my Internet training and consulting business, HARK/INTERNET-HELP, INC., from home since 1995. Why my service/options have always been "third world quality" and inadequate, I can not understand. Internet access has been and now, with Corona, is even more is now as critical, just as phone and mail service have always been. For the love of God, help get broadband to us in the county, to this end I would help any way I can. David J. Hark HARK/ INTERNET-HELP, Inc. P. O. Box 201 Shepherdstown, WV 305-443-0201 304-876-2607 304-283-213 dhark@fred.net davidhark@gmail.com http://www.dhark.com
- It is ridiculous how much Comcast requires for line extensions and even more unbelievable their lack of interest in acquiring new customers! I have been speaking with Morgan Wireless and am hopeful they can provide an adequate solution. This has been extremely frustrating as a self-employed business owner. I would be happy to speak with anyone in Jefferson County government and appreciate any efforts to remediate the current situation which I'm sure has a huge impact on economic development in the county. I can be reached at 301-944-4145.
- Competition would be good and it seems Shepherd University could benefit dramatically from fiber. Remote work is here forever now. Please help us catch up to compete and grow. Monte Cole 540-338-1122
- Question 16 has limited selections. I currently have cellular and Voice Over Internet Protocol (VoIP) service for multiple phone lines.
- I would not call what the county currently provides a service. It is down more than it is up. I know nothing about fiber optics and what is involved in setting it up. I have a 1/4 mile driveway and if it involves installing a cable of some sort, then No I can't afford that.
- The problem with Satellite is NOT the speed but the huge lag inherent in satellite service which makes Video calls not work. Another issue is the LIMITED data restrictions. Many wireless solutions like satellite and cellular have fast service for a small amount of data then it is rate limited to a much slower speed. The county should be holding the contractors responsible for the existing contracts for example comcast does not service River Rd and told me and all the many potential customers in Pack Horse ford development that the closest cable connection is 3 miles away. This is a lie, as my house is less than a mile from town were there is cable but also up on the hill at Trough Rd about a half mile via the telephone poles behind my house are several homes with cable. Comcast is supposed to bring cable if there are more more than a set number of homes within a mile of a cable feed but they are not doing so and have not for years. Fiber to the house would be nice but is not required. That said, I have another house in a more remote section of VA (bordering WV) just outside of Covington VA, that has Fiber to the house with much higher data rates from Lumos in VA, that is far cheaper than we have and faster than comcast at our residence in Jefferson county via comcast.
- We have a weird situation here, we have Comcast for wifi in the house, but the Comcast line somehow doesn't extend the extra 50 feet to the garage where my office is located. I use Frontier for the office phone service plus DSL -- but the speed is low.

- It's the 21st century - give us better more affordable service, Thanks!
- Frontier is the only service available for us. The quality of service is terrible. There are internet interruptions multiple times per day. When we are bidding online, we always have a second line somewhere else open so we do not miss bidding on what we want. It is outrageous that our service is so bad especially from a company with a monopoly! The service any continuous connection like attending a meeting or going to school extremely difficult.
- If someone could call me about this to further discuss that would be great.
- Dial up from Frontier is not adequate internet service since 1990.
- Beginning with the Covid shutdowns and continuing until today, our staff has been working from home. Only our employees who live out of the County have had consistent internet service without disruption. Our employees who live in rural parts of the County have the worst internet. High speed internet everywhere in the County is the single most crucial piece of infrastructure for the County to grow and grow well.
- We are a family farm with two additional rental houses on our property. We have no internet access except through our cell phones. We desperately need internet access. Until we have internet, we cannot work from home and have to go into DC to work.
- It would be nice when I have a table on the Washington Street or Charles Washington Hall or some other location or event I still have Wifi service with out having to rely upon my cellular service which may unavailable in parts of town. It would also be nice for my customers to have wifi access with out putting them my network because their cellular service does not work in our area. I don't want to pay additional money to my network carrier in order to have a separate guest network for the few when that is needed. I have verizon as my cellular mainly because they work mostly through out town and especially on main street.
- The internet in our office is very slow and often unavailable during business hours. It's very frustrating to be unable to work online.
- Business needs better internet than what is offered.
- As things stand now, I am forced to operate from different locations in order to have reliable phone and internet service. Even though I rent space in downtown Washington DC, the costs associated with the services you are inquiring about (internet, phone and cell) are far higher than rent or any of the other costs I now pay. And ironically, the costs in Jefferson County are the highest and worst of the lot.

6 CONNECTIVITY SOLUTIONS

6.1 OVERVIEW OF THE TECHNOLOGY

In large portions of Jefferson County, broadband wireless will be an important strategy for improved Internet access for businesses and residents. But both fiber and wireless technologies and systems are going to be important to meet the goal of improving access to broadband. The rest of this section provides more detail and some specific build out strategies.

Businesses and residents may obtain Internet service:

- With a small radio directly attached to their home or business that receives a signal directly from a towers owned by a private provider, from a County-owned tower (e.g. shared with public safety use), or from a community-owned tower (e.g. a coop).
- With a small radio attached to a utility pole (60 or 70') to improve line of sight to a tower.
- With a small radio directly attached to their home or business that receives a signal from a "community" utility pole. The "community" pole will receive a signal from a distant tower and redistribute it locally to a cluster of customers (typically within a half mile).
- With a fiber connection to the fiber installed in areas where economic development is important, and in other areas as additional fiber network segments are added.

The table below summarizes how fiber and wireless can work together in a variety of ways.

Distribution Type	Access Type	Capacity
Wireless	Wireless	Typical customer connection starting at 5 to 10 Megabits, can be higher, with 50 Meg connections common. More dependent on the capacity of the wireless Distribution link.
Wireless	Fiber	Users can have fiber Gigabit connections locally, but total throughput dependent upon the capacity of the wireless link, which can be up to a Gigabit, depending on distance and budget.
Fiber	Fiber	Any amount of bandwidth needed, with standard connection typically a Gigabit (1,000 Megabits).
Fiber	Wireless	Typical customer connection starting at 5 to 10 Megabits, can be higher, with 50 Meg connections common.

6.2 WIRELESS TECHNOLOGIES

WISPs (Wireless Internet Service Providers) use a wide variety of radio frequencies to deliver fixed point wireless broadband. By "fixed point," this means that these systems are not designed to support roaming in the way that cellular voice/data radios are (that is, mobile phone and data services).

Fixed point broadband is broadcast from a tower to individual homes and businesses (fixed points). Most of the frequencies used require clear line of sight between the tower and the

location where service is desired. In West Virginia and many parts of the east, tree cover is often an obstacle to getting good service.

The hilly topography of of the area can work for or against good wireless broadband service. Towers located on the tops of hills and mountains can provide service over a larger area than a tower in relatively flat terrain, but hills also block the signal. A residence can be a short distance from a large tower, but heavy tree cover or an intervening hill will block service. The solution to this can be addressed in several ways:

More larger towers of 180' to 300'

The taller the tower, the wider the coverage, but as tower height increases, the cost of the tower also increases. Towers taller than 199' require a light at the top to make them visible to low-flying aircraft, and lighted towers are more expensive to erect, and the bulbs have to be changed periodically at significant expense. Many broadband towers are 180' to avoid the additional cost of lighting.

Small cell broadband utility poles

Small cell broadband utility poles, often called community poles, are shorter towers or utility poles of typically 60' to 80', located in or very near a cluster of homes. The towers can be wooden utility poles or relatively low cost steel monopoles or steel lattice towers. These towers are located to get above local tree cover so that clear line of sight to a distant taller tower is available. Local access point radios provide service to homes and businesses with line of sight to the pole. In many parts of Jefferson, these are going to be an important part of a strategy to get better broadband to rural residents and businesses.

Variety of radio frequencies

WISPs are beginning to deploy a wider range of licensed and unlicensed radio frequencies to overcome distance, bandwidth, and line of sight issues. Traditional 2.4 Ghz and 5.7 Ghz WiFi and WiMax frequencies are being supplemented or replaced with LTE broadband radios that provide better bandwidth and will tolerate light tree cover better (2.5 Ghz, 3.5-3.7 Ghz). Some WISPs are also using lower frequencies (e.g. 900 Mhz) that will travel farther and will also provide better penetration in light tree cover.

6.3 EMERGING WIRELESS TECHNOLOGIES

MIMO Wireless

MIMO (Multiple Input, Multiple Output) describes a variety of technologies that can be summarized as using more than one receive and transmit antenna for wireless data applications. Wireless protocols that are using the MIMO concept include IEEE 802.11n (Wi-Fi), IEEE 802.11ac (Wi-Fi), 4G, LTE (Long Term Evolution), and WiMAX. Each of these protocols use the MIMO technology to increase the amount of available bandwidth in a given section of radio frequency spectrum.

New hardware is required to make effective use of MIMO. While the technology increases wireless bandwidth, the typical amount of bandwidth being used by wireless devices is also increasing rapidly. Some applications where MIMO is likely to provide noticeable improvements are in home wireless routers, where the effective throughput will be able to better handle the demanding

bandwidth requirements of HD and 4K video streams. MIMO is slowly being developed for use with cellular smartphones, but both the phones and the cell tower radios have to be upgraded to support MIMO.

LTE/4G/5G

LTE (Long Term Evolution) is a set of protocols and technologies designed to improve the performance of voice/data smartphones. Like MIMO, both the user phone and the cell tower radios have to be upgraded to support LTE improvements. In 2013, only 19% of U.S. smartphone users were able to take advantage of LTE speeds, although that percentage has been increasing rapidly since then, and more than 85% of the U.S. cellular towers have been upgraded to LTE. As noted previously, the actual bandwidth available to a smartphone user is highly variable and depends on distance from the cell tower, the number of smartphones accessing the same tower simultaneously, and the kinds of services and content being accessed by those users.

The primary purpose of cellular bandwidth caps is to keep cellular users from using too much bandwidth and degrading the overall service. While LTE and MIMO improvements will improve overall cellular service, these technologies are not going to replace fiber to the home and fiber to the business.

In 2017, new fixed broadband wireless systems entered the marketplace using LTE frequencies, and many WISPs have begun to replace existing wireless radio systems with LTE equipment. These LTE systems do not provide any cellular voice services; they are designed specifically to support only broadband/Internet service.

Reports of performance have been mixed. In our conversations with both vendors of these systems and WISPs that have begun testing them, we get two very different stories. The vendors have been conservative in discussing the improvements, while some WISPs have been taking single user test results and suggesting that they will be able to deliver higher speeds at greater distances to all users.

There is little debate that the LTE equipment offers higher bandwidth, at somewhat greater distances, and with somewhat better penetration of light foliage and tree cover. Over the next two to four years, most WISPs will change out most of their existing radio systems for the improved LTE radios. Perhaps the most significant advantage of LTE fixed point broadband is its ability to provide better performance when clear line of sight between the customer and a tower is not available. LTE provides better penetration of light to moderate tree cover and other line of sight obstacles.

To achieve the full benefit of 5G technology, more fiber is needed.

The much touted 5G wireless technology, as of 2019, is still largely marketing hype. The official standard for 5G radio technologies is planned for release later in 2019, although some companies, like Verizon and AT&T, have begun trials of the equipment with locations largely limited to major metro areas.

5G does bring much higher speeds to wireless broadband (e.g. it might be able to deliver 30 to 50 Meg of bandwidth consistently). But 5G has significant limitations that do not make it a good solution in rural areas of the U.S.

The fact that 5G can deliver much higher bandwidth means that 5G cell sites will require fiber connections. This is going to effectively limit 5G deployments to denser urban environments where both customers and fiber are plentiful.

There is no free lunch in the physics of radio frequencies. The higher bandwidth of 5G means that cell sites need to be closer together because the 5G frequencies do not travel as far as existing 4G/LTE frequencies currently being used by the cellular industry. Most users will have to be within 500 to 1,000 feet to receive 5G service.

Some experts estimate that more than a million miles of new fiber will have to be deployed just to support the 25 largest metro areas in the U.S. 5G will not appear overnight.

As many as 60 cell sites per square mile may be needed to make 5G widely available in a given area. If, as an example, about 25%, or 53 square miles of Jefferson County is underserved, very conservatively, three thousand or more cell sites would be needed to provide good coverage.

For rural areas, the cost of 5G service may be one of the most significant obstacles. The cellular carriers see the increased customer bandwidth use possible on 5G networks as a major revenue opportunity. While they will increase the "standard" bandwidth package for monthly service, bandwidth caps and rate limiting is likely to keep 5G cellular customers bills high.

White Space Broadband

White space broadband uses some of the frequencies that were formerly used by analog TV channels. These lower frequencies travel farther and provide better penetration of light foliage. Microsoft has been supporting a number of community white space experiments, and has promised much wider support for this technology, but there are few other users, equipment is still relatively expensive, and few WISPs have ventured into this still largely experimental technology. The Microsoft white space project in southern Virginia, although still underway, serves less than three hundred households and is still regarded as experimental. Other white space pilot projects have reported good results. River Valley Internet has indicated that their trials with white space equipment has been able to deliver 50 Meg/50 Meg service.

Low Earth Orbit (LEO) Satellite Internet

The Elon Musk-funded Starlink effort recently began offering "beta test" service. There is a one time equipment and installation fee of $499, and a monthly fee of $99. The company is promising download speeds of between 50 Meg/sec and 100 Meg/sec. Latency is lower than traditional satellite Internet services. If the prices remain reasonable, this is likely to become a much better alternative to the older satellite Internet services.

6.4 DARK FIBER AND LIT FIBER

About Dark Fiber

Dark fiber is installed in conduit underground and/or hung on utility poles. It is called "dark" because no network electronics are installed to "light" the fiber (using small lasers in a fiber switch). For small municipal/local government fiber installations, dark fiber has a significant advantage in terms of management–very little ongoing operational responsibility is required.

Dark fiber is leased out to service providers, who install their own network electronics in cabinets or shelters attached to the fiber cables. The providers typically lease fiber pairs between the

cabinet and their customers, and are responsible for all equipment-related management and maintenance. Dark fiber networks can be used by service providers to provision either Active Ethernet or GPON services to their customers.

Dark fiber networks do not generate large amounts of revenue, but this is offset by very low maintenance costs—primarily an emergency break-fix arrangement with a local or regional firm qualified to splice fiber. Emergency break-fix contracts are usually based on a time and materials basis, so there is little or no expense if there are no fiber breaks.

Other costs include "locates," which are called in to West Virginia 811 (Miss Utility) and are performed by either the local Public Works department or a private sector contractor. For small fiber networks, locate costs are generally modest.

About Lit Fiber

A "lit" fiber network includes the network electronics needed to transmit data over the fiber (using the small lasers in a fiber switch, hence there is light traveling over the fiber cable). In a lit network, "lit circuits" are leased out to service providers rather than fiber pairs. The muni/local government/ community network provides the network electronics, which reduces costs for the service provider —meaning they are able to pay higher lease fees for the circuits they use to deliver services (like Internet) to their customers. Lit networks generate more revenue, but also have higher expenses because the network electronics have to be monitored and managed on a 24/7/365 basis (this task can usually be outsourced at reasonable cost). However, very small fiber deployments often do not pass enough homes or businesses to generate sufficient revenue to cover the higher costs.

Like dark fiber, a lit network incurs break-fix and locate costs as well.

6.5 THE MEET-ME BOX CONCEPT

In some of the larger towns, some smaller communities, rural neighborhoods, and subdivisions, "meet me" boxes could be installed. A meet me box is a telecom cabinet with fiber cables installed between the cabinet and nearby homes and/or buildings. Providers only have to reach the meet-me box, lowering their costs. Both wireline and wireless providers can use this infrastructure. This approach can also be used to provide fiber services in business and industrial parks. A small Virginia county installed five miles of fiber in their business park and was able to attract a Tier One provider to provide service to an existing business (a manufacturing plant that was going to leave if the county did not help them get better Internet service).

The dark fiber approach minimizes operational costs. Service providers would install their own equipment in the cabinet and would pay a small monthly lease fee for the fiber strands they use to connect customers to their services.

For a meet-me box installed in a "main street" area (e.g in an alley behind commercial/retail buildings) with relatively inexpensive and short fiber drop cables into nearby buildings, the lower end of an installation might start at $35,000. For a box installed in a rural sub-division that requires

distribution conduit/fiber and drop cables, the cost to connect 25 homes might start at $175,000 on the low end and increase as the number of homes connected increases. Larger numbers of homes or businesses will each add to the cost, but adding more connected premises also increases the value of the infrastructure and increases the revenue potential.

6.6 TERRAIN CHALLENGES

The propagation study map studies that are included later in this report illustrate the challenge of providing adequate fixed point wireless Internet service in Jefferson. The mountainous terrain throughout the county shows that many towers and community poles will be needed to near an adequate solution using fixed point broadband wireless. In some areas, the difficulty of obtaining line of sight for a radio link between two locations may dictate using fiber in place of wireless.

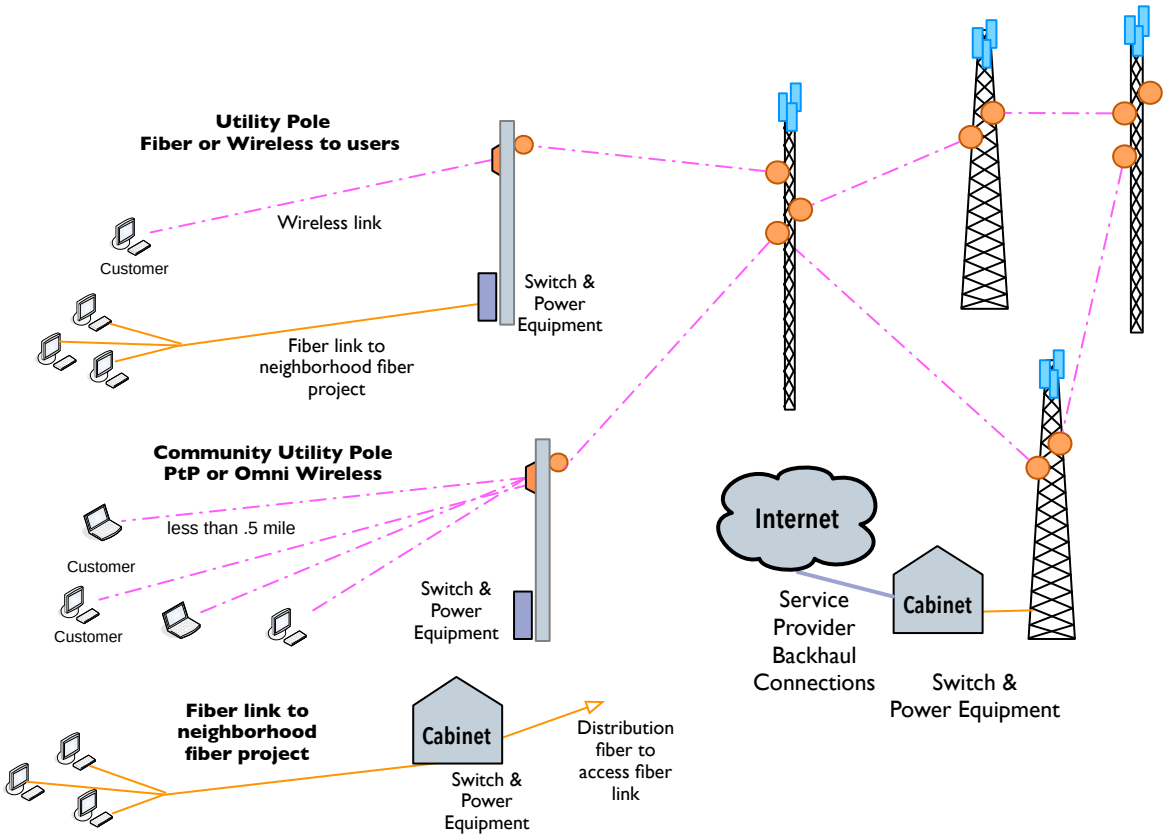
As an example, in Richwood, West Virginia, a group of about seventy-five homes along two and a half miles of road led to a fiber to the home solution that was less expensive than broadband wireless, primarily due to the cost of bringing electric service to many community poles. A combination of taller towers and shorter community poles may be needed to provide good service to most areas of Jefferson.

6.7 CONNECTIVITY SOLUTIONS

Both wireless and fiber networks, as well as legacy copper-based networks, all share three primary components. How these are designed and deployed can vary greatly, but all networks have these three parts in some form.

- The **Core Network** provides access to the Internet, a place for service providers (ISPs) to distribute their services locally on the network, and for larger institutional and business customers to meet service providers. Jefferson has both landline and wireless service providers, but there are still areas that are underserved. Each of these providers has their own Core Network, but wireless broadband could be more widely available if additional county-owned towers were available to the private sector providers.
- The **Distribution** portion of the network connects the Core Network with collections of users. A Distribution network can include both fiber and wireless portions of a network.
- The **Access or Last Mile** portion of the network connects residential users and businesses to the network, and like the Distribution network, that connection will be by fiber or by a wireless link.

The illustration below shows the full range of technology options (fiber and wireless) and how they can be connected together in various ways to meet the diverse needs of the county. More detail is provided on the following pages.



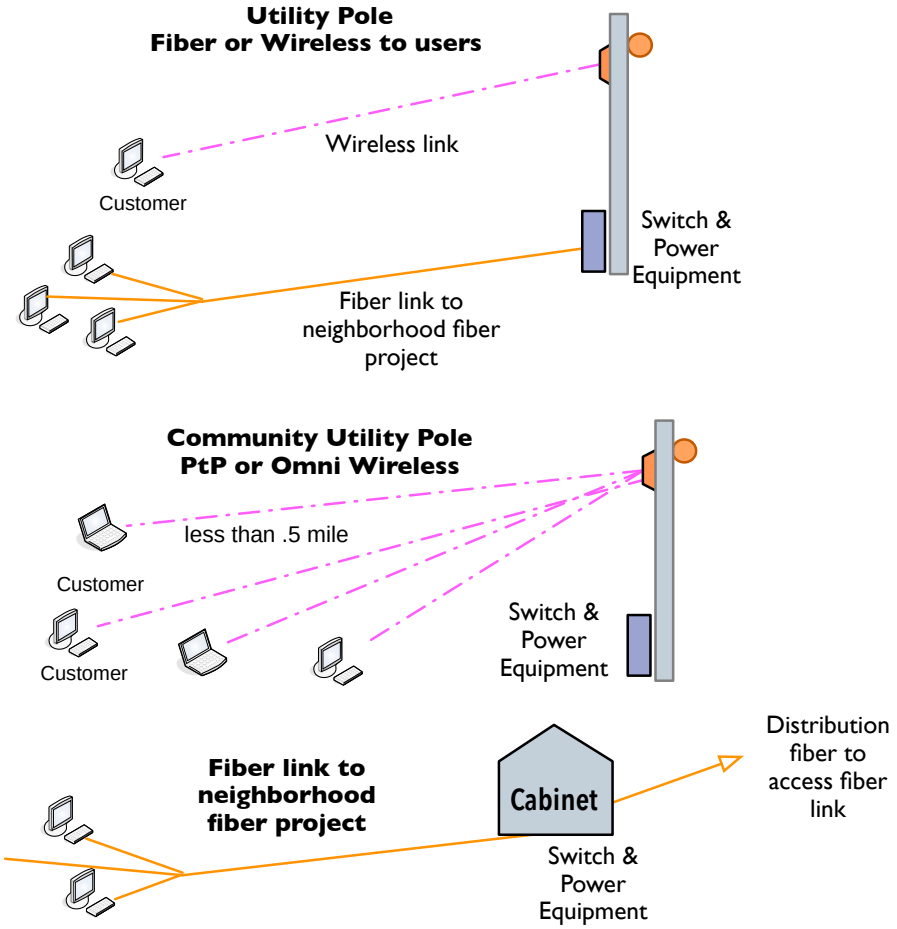
Last Mile Access

The Last Mile Access is the portion of the network that connects customers to their service provider and the Internet. Both broadband wireless and fiber links can be utilized to provide service. There are several ways that customers can receive service:

- Service providers can install their own local access radios on the Distribution towers, using both point to multi-point and point-to-point radios to deliver service to their customers.
- A single user utility pole (or inexpensive steel lattice tower) can be installed on the property of a single resident or business. A radio at the top of the pole receives service from another tower site (typically one of the Distribution towers).
- A utility pole (or inexpensive steel lattice tower) can be installed near a cluster of homes (e.g. a rural residential sub-division, several homes in close proximity on a rural road). Service providers can install their point to multi-point radios on this pole and provide economical service to several customers from a single pole.
- A utility pole (or inexpensive steel lattice tower) can be installed in a rural subdivision. A service provider installs a point to point radio on the pole, and fiber cable can be run from the pole past several homes to offer fiber service with wireless backhaul.
- Customers near existing fiber can have a fiber drop installed directly to their home or business.

Distribution Network

Distribution is the portion of the network between the Distribution sites to the Last Mile Access portion of the network. It is desirable for each distribution site to have a connection back to more than one Distribution site (tower) on a redundant ring. This ring topology protects against hardware failure at the port level and does provide some protection if one of the tower to tower wireless links is disabled by an equipment failure.

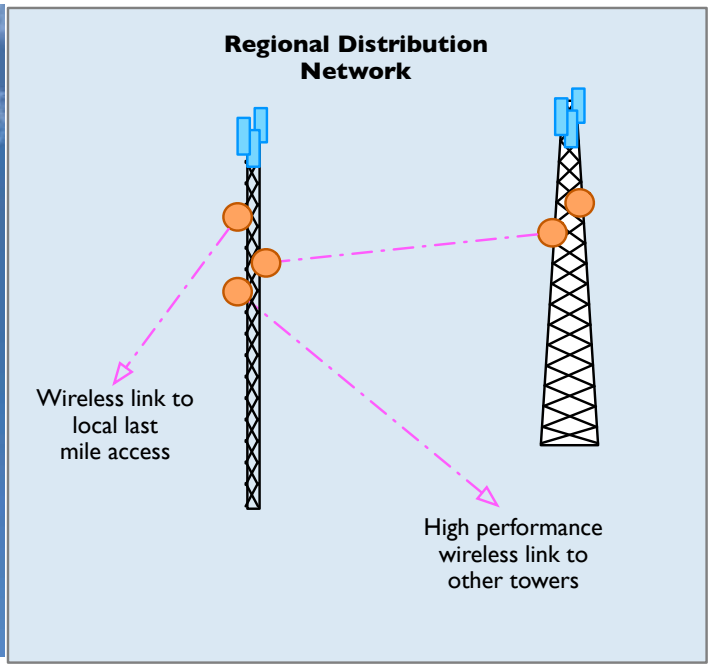


These tower sites are typically 120' to 180' tall to provide the height needed to enable Line Of Sight (LOS) between towers, and for local access, to enable service providers to mount point to multi-point radios on the towers.

Towers taller than 199' become subject to FAA regulations because the height can be a potential hazard to airplanes. Towers that exceed 199' usually have to be painted (alternating red/white) and have a blinking light at the top. These requirements increase the long term maintenance costs, but the taller towers can improve line of sight to other towers.

The towers can provide two functions:

- Space for backhaul connections to other towers in the county.
- Space for local access radios to provide Internet access within 2-3 miles of the tower (or farther with good Line Of Sight).



Core Network and Service Providers

In the past, the telephone company switch office (Central Office, or CO) has provided that function. Today, many communities have either a community-owned data center or a privately owned data center that offers an affordable range of options for customers of broadband services.

The Co-Location facility provides a meet point for various public and private fiber cables and networks to inter-connect. A local facility with space available for both public and private uses could help attract additional private sector investments (e.g. a long haul fiber provider wants connect to this facility because of increased access to customers).

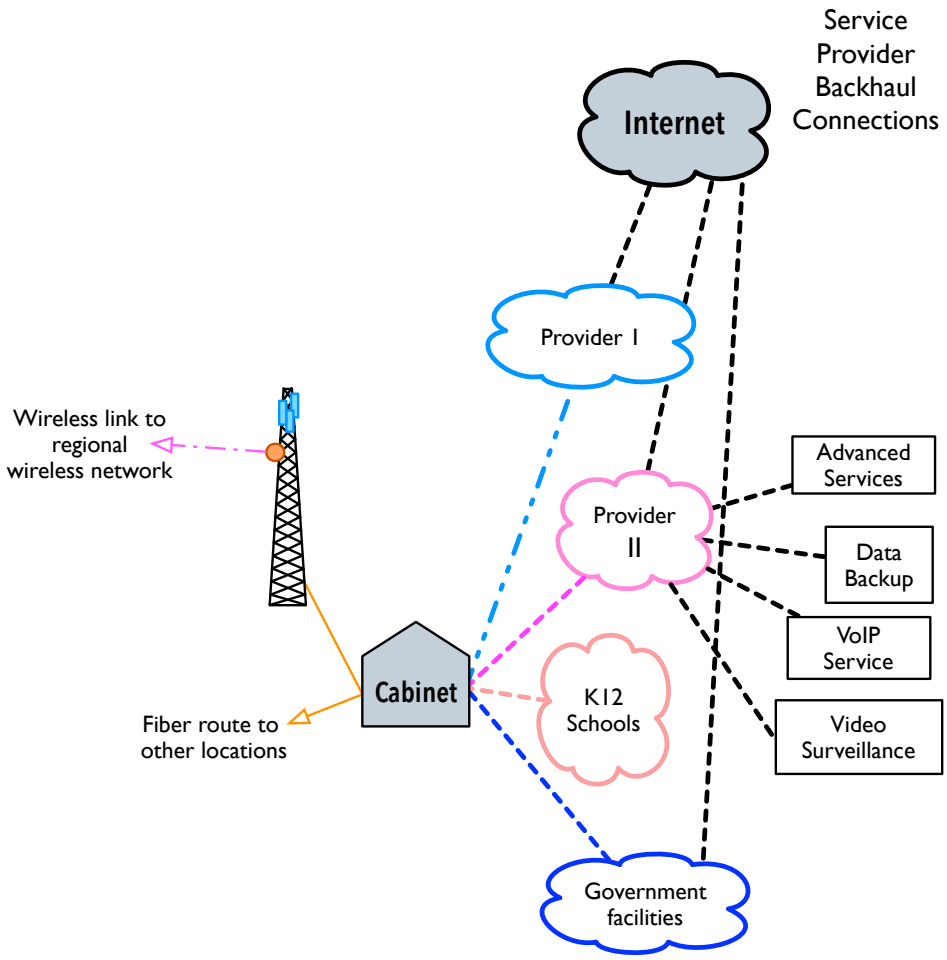
A colocation facility is a controlled environment (i.e. secure, heated, and air-conditioned) room with Internet access through wired and/or wireless systems. The colocation facility is a place where fiber, wireless, and copper-based network facilities meet. It is equipped to house high-end network equipment, servers, and other electronic gear.

A variety of middle layer network components and services can be located within the co-lo including, for example, directory services, replicated content servers, routing services, and other elements needed to deliver new multimedia services to the home and small office from multiple, competing providers.

Characteristics of the colocation facility are:

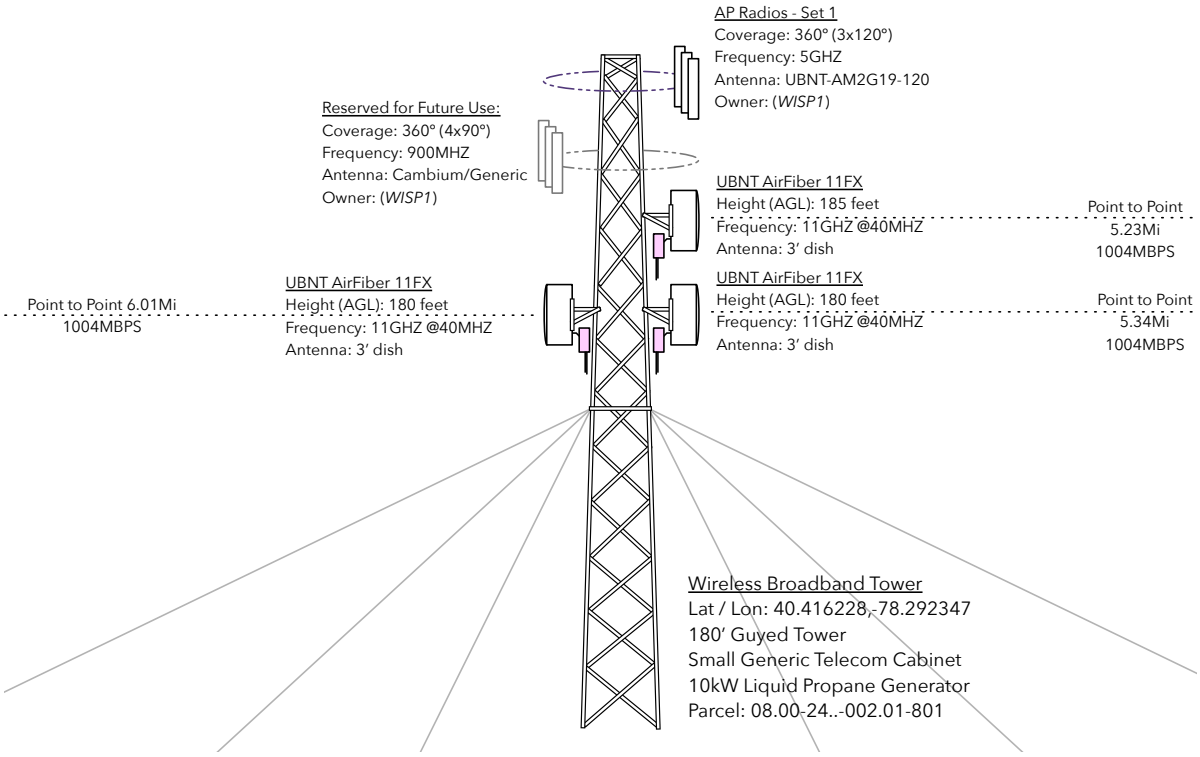
- A reliable source of AC electric power is required, with backup UPS (Uninterruptible Power Supply) service, and additional power backup available by an onsite generator is desirable.
- Controlled access to the facility (e.g. by electronic keycard) 24 hours/day, seven days a week. Service providers need to be able to gain access to the equipment room as needed, and work activities performed at night or on weekends is common.

- Racks for locating network equipment and servers, and optionally locked cages for equipment racks.
- Sufficient cooling capacity for the network's current and long-term needs. Equipment rooms require both a cool air input vent and an air return vent.



6.8 WIRELESS NETWORK ARCHITECTURE

The diagram below shows an example of the equipment typically placed on a tower, and details about the equipment that is planned. Several sets of Access Point radios can be placed on a tower operating in different frequencies, and can be owned/operated by multiple WISPs. Point to point radios link this tower to several other sites.



When developing wireless networks there are several categories of costs at each site. Construction of the network will incur site related costs at each tower site including:

- Site development - clearing the site of trees and vegetation, construction of a tower road for access to the site, and strict adherence to all erosion and sediment control measures required by the Owner.
- Passive site equipment - In most cases, a network cabinet will be installed and a new power service will need to be run to it. At each site there will be a generator and most likely a propane tank also installed. Reliable power systems will be installed inside the cabinets, and other equipment management solutions will be installed in the cabinet for network equipment.
- The tower itself - new towers in this estimate are designed as 180' guyed towers. A guyed tower is usually a small profile lattice type tower that is supported by guy wires at several points on the tower. Guyed towers usually have a smaller visual profile than self supporting towers because they are narrow from the top all the way to the base. Self supporting towers will have the same lattice type structure but the tower widens as you get closer to the base. If the tower base is obscured by trees all around, a self supporting tower may be preferred.

Some sites may require design changes based on site conditions. Other types of towers such as monopoles could be considered for this project, especially if the owner is working with cellular providers on developing a site.

- Network equipment such as Point to Point radios, routers, switches, and access point equipment will be installed during the construction of this network. Since the network has built in redundancy the configuration will need to support automatic failover and other high-level network functions. In addition to the networking expertise needed to configure large networks such as this the contractor(s) configuring the network will need to understand spectrum management, wireless signal propagation, and other physical aspects specific to wireless networks.
- Permitting - depending on the locality developing a wireless site usually requires extensive permitting processes that require a relatively long timeline and professional services.

6.9 SMALL CELL BROADBAND POLES

Line of sight issues are a constant problem for rural residents and businesses, as clear line of sight (or near line of sight) is required for fixed wireless Internet services. Even newer technologies like white space and LTE systems work better with clear line of sight to distant towers.

The increased use of wooden utility poles is already common in some other areas of the country, and increased use of this technique to get the customer CPE radio/antenna above tree cover is a relatively simple solution.

Ownership and Governance

The utility poles would normally be placed on private property, subject to existing or updated ordinances governing the placement of wooden utility poles. The local government would have no responsibility for maintenance and repairs.

Cost Discussion

The cost of placing an eighty foot pole can range from a low of about $2,000 to $7,000 or more, depending on permitting, engineering requirements, and the location of the pole. Some municipalities provide "by right" permitting of these poles if they are placed on private property, which can reduce the cost of installing them.

Funding Options

Because these are placed on private land, local government would not have to provide any direct funding. However, the localities could encourage wider use of this option with a public awareness campaign developed in partnership with wireless providers. Local banks could be encouraged to provide low cost financing of the poles so that property owners could make a small interest and principal payment monthly over several years to reduce the financial impact.

Recommendation and Next steps

This strategy requires minimal financial support from the County and that it has the potential of improving broadband access in rural areas of Jefferson quickly. The County should work with WISP partners to promote this option to improve access to new and existing wireless broadband towers.

6.10 NANO-CELL AND WIFI CALLING SERVICE

A common complaint in Jefferson is the poor cell service in many areas. In some parts of the county, there may be adequate broadband service via DSL or cable modem Internet, but poor cellular phone/data service. There are now two solutions to improving rural cellular service that do not involve the expense or difficulty of attracting and/or building more cellular towers.

WiFi Calling – This approach takes advantage of the WiFi Calling feature that is now common in many late model cellphones. Once the phone is connected to a WiFi network (e.g. in the home using the home's broadband Internet service), the phone will automatically route the call over the WiFi network–phone calls and text work normally, as if the phone is connected to a cellular tower.

Nano-cell Calling – Poor or no cellular service in rural areas can be addressed by promoting the wider use of "nano-cell" devices. These small pieces of equipment are connected to the DSL or wireless broadband connection and provide improved cell service in the home or business. The working distance of these devices is limited, and service generally drops off once you leave the house itself (it may work for some short distance in the yard). These devices work very well and do not require an upgrade to a newer phone.

The cellular providers do not always promote the use of these devices, so many cellular users who would benefit from their use are not aware that this option is available. The device averages around $200 retail, but the cellular providers often provide substantial rebates (50% discount or more) and in some cases may provide them at no charge.

The improved wireless broadband service will also support use of WiFi calling and/or nano-cell devices.

This strategy is important because improved broadband service can also improve cellular service without the need for more cellular towers, especially in parts of the county where cellular providers have not been able to make the business case for more towers.

7 PRELIMINARY DESIGN AND COST ESTIMATES

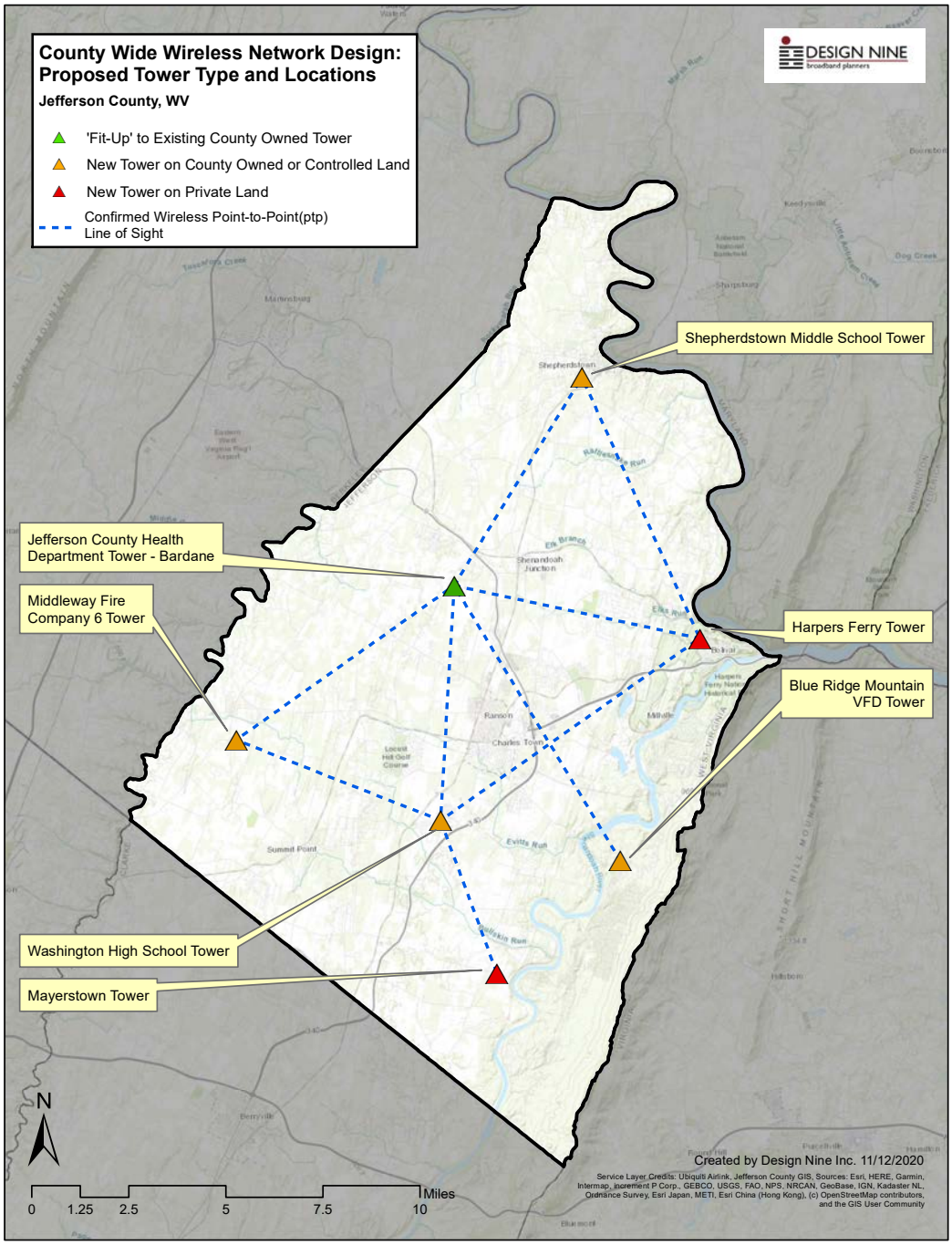
This section describes a county-wide fixed point wireless solution for Jefferson County. The network design provides an affordable county-wide network that could serve a significant portion of the county and eventually be expanded provide improved broadband coverage to most homes and businesses in the county. Wireless propagation studies were used to calculate coverage areas, and those studies included calculations that evaluated terrain and foliage coverage in the county. This solution could provide improved service to nearly 80% of households in the county. Where line of site to the proposed towers is poor, additional households and some small unserved pockets could be added by placing inexpensive utility poles.

This design assumes Wireless Internet Service Providers will space on these towers and supply their own access radios. Connectivity between towers would be provided by high performance microwave links and would enable providers to use those links to create a single county-wide broadband wireless network that would provide wireless customers with 25 Meg down and 3 Meg up meeting the FCC "fully served" definition.

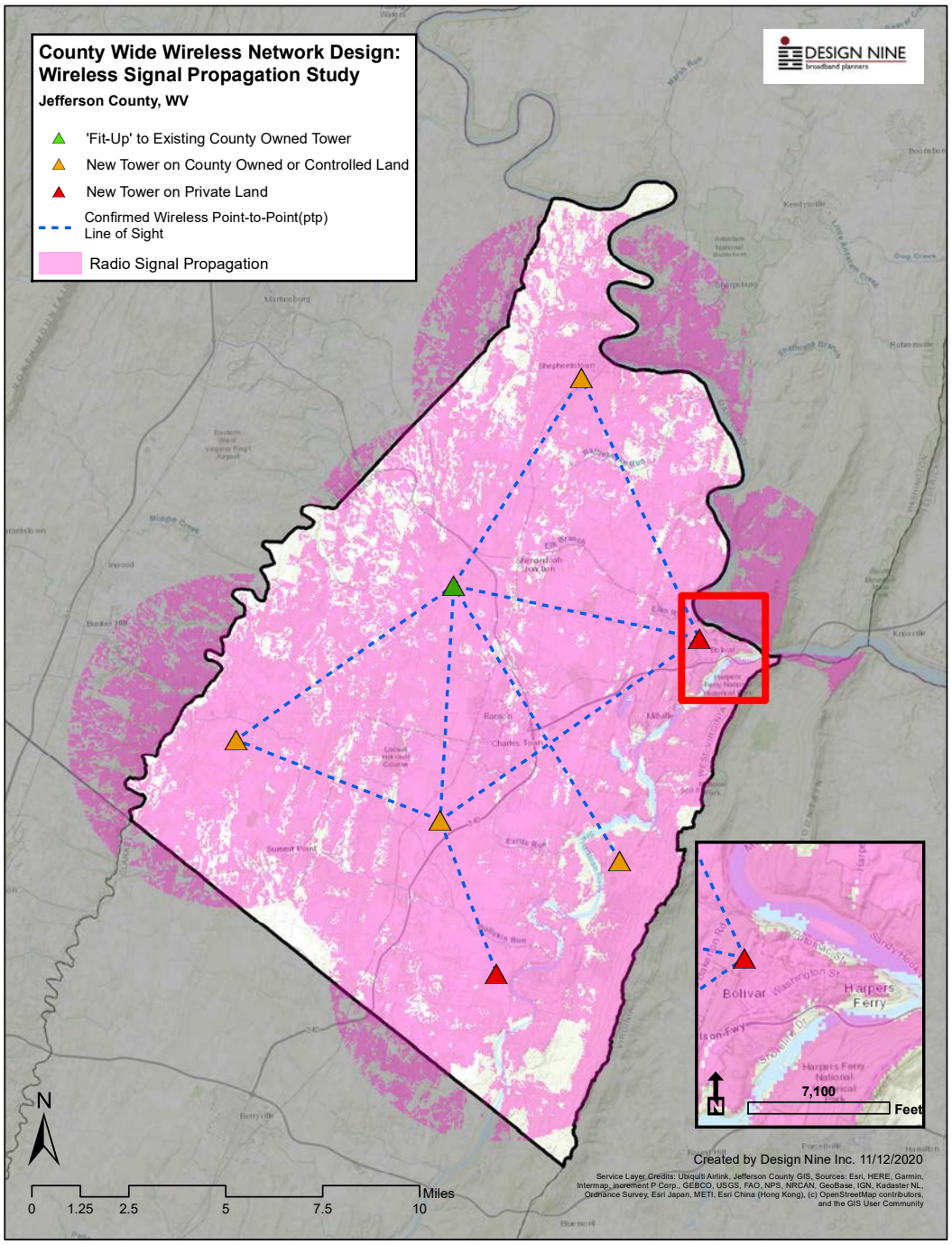
Consultation with interested service providers is essential and their input should be solicited and evaluated to determine where they can connect to one or more planned towers as the build out proceeds.

7.1 WIRELESS NETWORK TOWER DESIGN

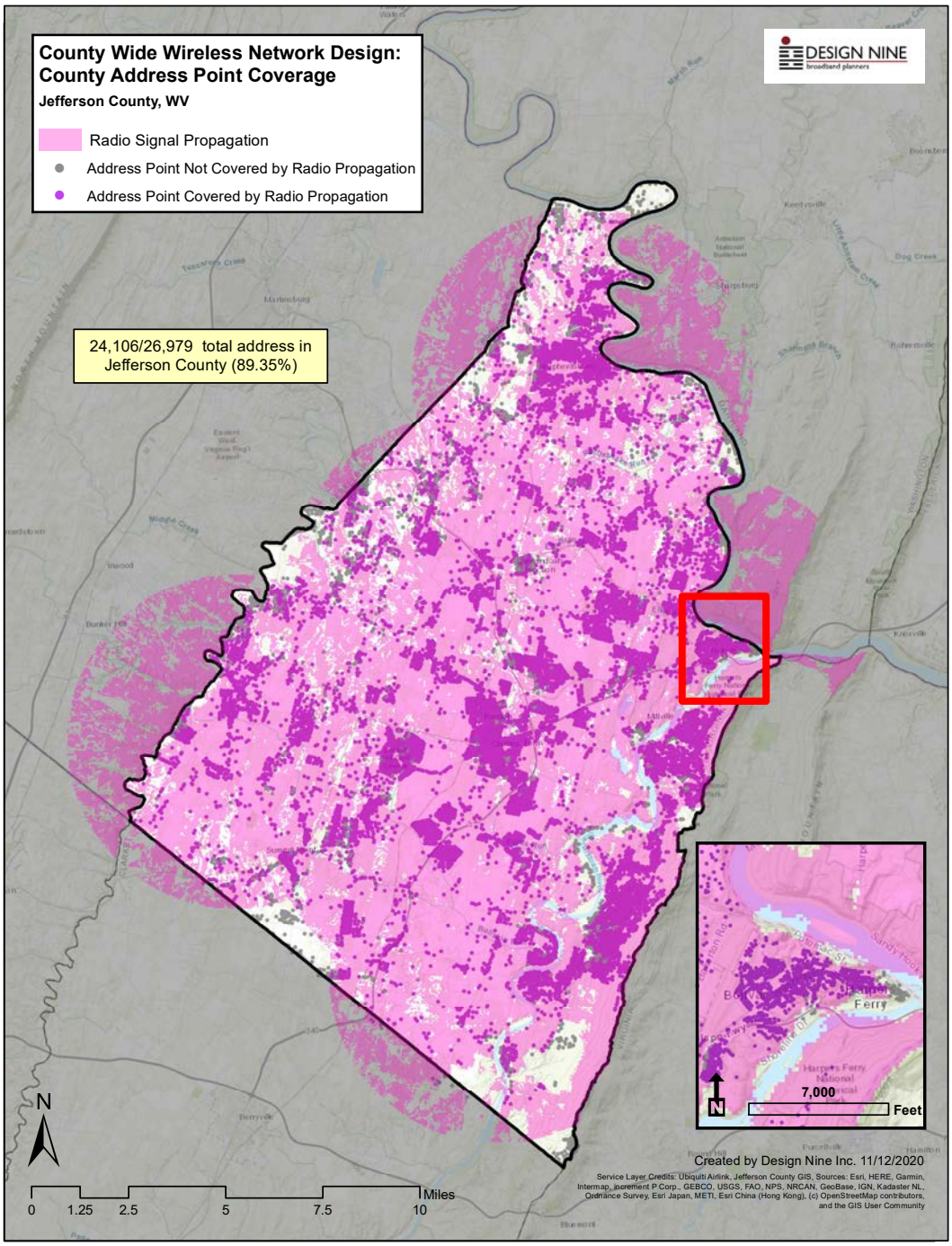
The wireless network design consists of six new towers and uses one existing county-owned tower. The dotted lines indicate point to point connections between each tower, which creates a single county-wide broadband network. The point to point connections (the dotted lines) have all been calculated to have adequate line of sight between towers and poles. A WISP could connect to the county-wide network at any one of the towers.



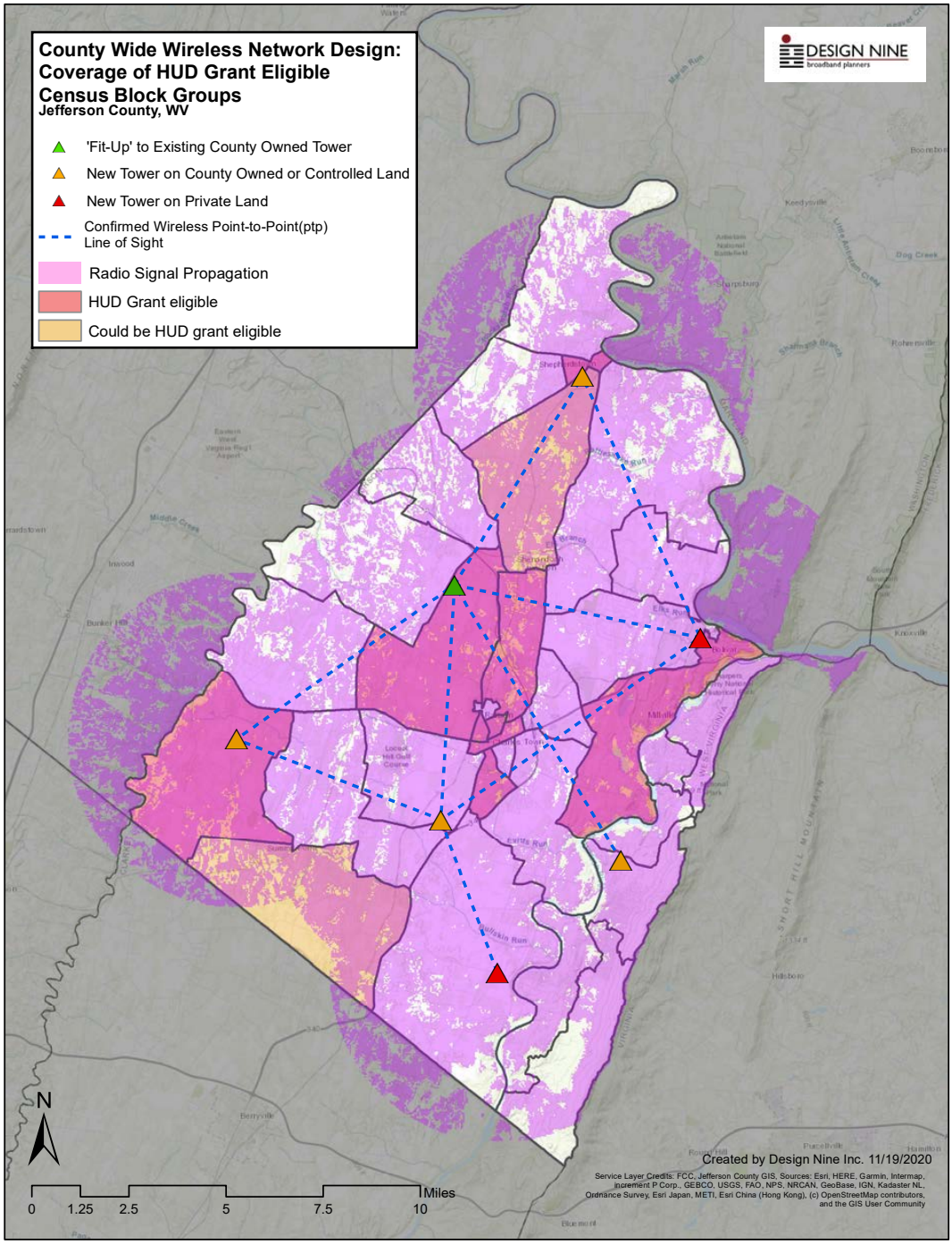
The map below shows the estimated radio signal propagation for the wireless project. Colored triangles indicate the type of tower site being developed.



This map shows the estimated signal coverage (approximately 89%) and includes the address points (households) that can potentially receive service within those shaded propagation areas. It is important to note that the propagation software does make an estimate of foliage and terrain when calculating signal propagation, trees, buildings, and other obstacles near a residence or business could degrade or limit coverage. In many cases, a wooden utility pole placed near the premises may improve line of sight to a tower and enable improved service.



This map shows the estimated propagation of the county-wide wireless network, overlaid on areas of the county that are eligible for HUD grants. At least three towers are in or are very close to HUD-eligible census tracts—the tower locations can often be moved slightly without affecting the overall radio signal propagation.



7.2 COUNTY-WIDE WIRELESS COST ESTIMATE

In this design, there is one tower location that may require placement on private land. In most cases, the proposed tower locations can often be shifted from one parcel to another without affecting line of sight to other towers, but once an exact parcel has been identified, it will be important to validate that the proposed line of sight to other towers has not been affected. It is also possible that negotiating a site lease agreement with a land owner could take longer than the 3-5 months needed to prepare the site and erect the tower.

JEFFERSON COUNTY WIRELESS

SITE	DESCRIPTION	TOTAL COST
Blue Ridge Mountain VFD Tower	New tower on county owned or controlled land, service provider to furnish/install access equipment, one point to point link	$194,069
Jefferson County Health Department Tower - Bardane	Fit-up' to existing county owned tower, service provider to furnish/install access equipment, 5 point to point links	$83,156
Washington High School Tower	New tower on county owned or controlled land, service provider to furnish/install access equipment, four point to point links	$222,138
Middleway Fire Company 6 Tower	New tower on county owned or controlled land service provider to furnish/install access equipment, two point to point links	$203,425
Shepherdstown Middle School Tower	New tower on county owned or controlled land, service provider to furnish/install access equipment, two point to point links	$203,425
Harpers Ferry Tower	New tower on private land that is bought or leased, service provider to furnish/install access equipment, three point to point links	$230,781
Mayerstown Tower	New tower on private land that is bought or leased, service provider to furnish/install access equipment, one point to point link	$212,069
		$1,349,063

7.3 TOWER AND WIRELESS NETWORK DEVELOPMENT ACTIVITIES

This section identifies the key tasks and timelines associated with identifying ISP partner(s) and tower sites.

Tower Site and Tower Development Process

ACTIVITY	DESCRIPTION	DISCUSSION	TASKS
Issue Jefferson County partnership RFP	For many of the grant opportunities, a private sector ISP will be needed.	The RFP should be short and should not require large amounts of work from respondents. For best response, allow at least 45-60 days for ISPs to submit a response.	• Start RFP development by obtaining sample RFPs from other localities. • Develop draft RFP and have it reviewed. • Issue RFP. • Review responses and conduct interviews as needed. • Select best candidate.
Assess and inventory prospective tower sites in Jefferson County	Jefferson applications for wireless towers require specific locations for towers.	Use report data to identify where towers are needed.	• Appoint someone to lead tower site effort. • Assemble a list of locations from report data. • Begin meeting with property owners to determine willingness to provide space for tower and availability of road access and electric service. • Collect site agreements.

Tower Site and Tower Activities

TASKS	MONTHS											
	1	2	3	4	5	6	7	8	9	10	11	12
Obtain sample ISP partner RFPs												
ISP RFP development and review												
Issue RFP for ISP partner(s)												
Review responses and conduct interviews												
Select ISP partner(s)												
Appoint site identification team												
Collect prospective sites												
Meet with property owners												
Collect site agreements												

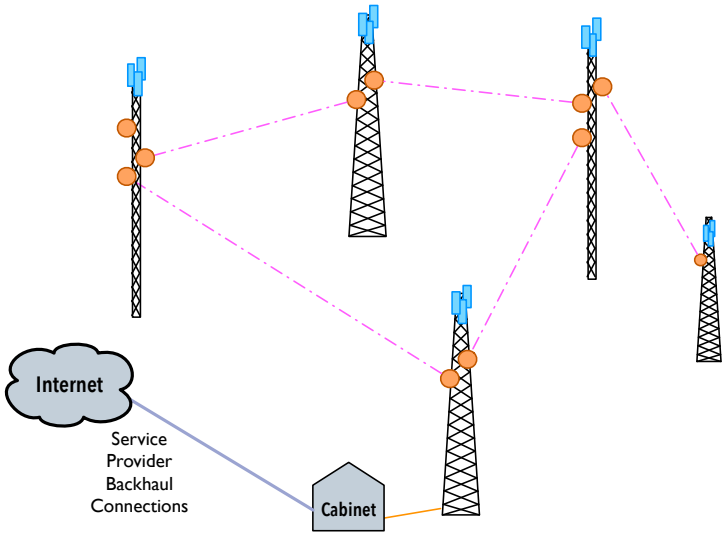
7.4 TOWER COST DETAIL

About Wireless Tower Cost Estimates

The line items for each named tower include the cost of the tower, site preparation, estimated cost of electric service, generator cost and placement, cost of the tower, and labor to assemble and erect the tower, and backbone equipment.

This section of the report provides an estimate of the cost of using existing towers to provide improved Internet access. The diagram below shows the logical design of a five-tower network. Four of the five towers have adequate line of sight between the towers to build a fully redundant ring between the towers, which will provide much more reliable service, because a single tower or equipment failure will not affect service.

Any placement of new towers should be preceded by a careful viewshed analysis of how much area/users are likely to be able to receive service. Site acquisition and site preparation costs can affect the overall cost of such a project. Existing county properties (e.g. fire/rescue stations, county parks, dump transfer sites, etc.) may be candidates for towers. Note that existing towers may require an engineering study to confirm that additional antennas can be added without exceeding the tower load limits.



Existing Tower Improvements

For existing towers owned by the state, the county, or other stakeholders that might be candidates for project use, modest upgrades to equipment at the base of the tower would be needed to make them broadband-ready.

Upgrades to existing towers typically may include adding or upgrading generators, additional cabinet or shelter space for service provider equipment, and sometime fencing and physical access changes.

Note that this estimate represents a worst-case scenario. If the site already has a generator that can be used by a new WISP co-locating on the tower, that could reduce the cost by as much as $7,500. If no road improvements are needed and existing electric service does not require a new H-frame and meter, another savings of up to about $3,000 is possible. If the tower has a current certification (i.e. had a formal engineering inspection), additional savings are possible, bringing the best-case cost to about $11,000 to $12,000.

Existing Tower Development and Improvements (Fit-up)

ITEM/PROJECT	UNITS	UNIT COST (LOW)	UNIT COST (HIGH)	COST (AVG)
Tower Study / Survey	1	$4,500	$7,000	$5,750
Site Development (Clearing, Road Improvements, etc.)	1	$0	$1,500	$750
Small Telecom Cabinet AmProd AM47P-2636-24RU or Equivalent	1	$6,000	$7,500	$6,750
10kW Liquid Propane Generator	1	$4,000	$6,000	$5,000
Cabinet Foundation and Installation	1	$2,500	$4,000	$3,250
New Power Service / Installation (assumes power available on-site)	1	$1,500	$2,500	$2,000
Power System Installation Labor	1	$300	$500	$400
Generator Installation Labor	1	$1,250	$1,700	$1,475
Propane Service Installation - tank and install by local gas company	1	$750	$1,250	$1,000
Poject management				$10,000
Total:				$36,375

New Tower

New towers have a range of configurations and cost options. This estimate is for a new 180 ft bare tower with no radio equipment. If located on existing county properties, the time needed to plan for construction can be shortened. If site acquisition or a site lease of private property is required, purchase or lease negotiations can add several months to the process. Note that a full permitting process may be required even if a new tower is placed on existing county-owned property. The permit process can add 60 to 120 days to the time needed to put a new tower in service.

New Tower Costs (180' Guyed)

ITEM/PROJECT	UNITS	UNIT COST (LOW)	UNIT COST (HIGH)	COST (AVG)
Labor and Contracting: $82,640				
Site Development (Clearing, Road Improvements, etc.)	1	$15,000	$15,000	$15,000
New Power Service / Installation	1	$1,250	$3,450	$2,350
180' Guyed Tower Construction Labor & Contracting	1	$50,000	$74,750	$62,375
Cabinet Installation Labor	1	$600	$1,150	$875
Power System Installation Labor	1	$300	$575	$438
Generator Installation Labor	1	$1,250	$1,955	$1,603
Materials: $35,735				
180' Guyed Tower Construction Materials	1	$17,500	$27,500	$22,500
Small Telecom Cabinet	1	$4,000	$6,000	$5,000
Cabinet Foundation and Installation Materials	1	$1,000	$1,500	$1,250
10kW Liquid Propane Generator	1	$4,000	$6,000	$5,000
Spare Fuses	1	$10	$20	$15
Power System Installation Materials	1	$20	$40	$30
Samlex 1000W Inverter	1	$350	$450	$400
Samlex SEC1230-UL Battery Charger	1	$200	$300	$250
100ah 12v Non Spillable Backup Battery	4	$250	$350	$1,200
DC Voltage Monitoring Device	1	$40	$60	$50
Unmanaged Rack Mount PDU (6O)	1	$35	$45	$40
Total:				$118,375
Project Management, Network Design				$37,500
Site Engineering, Surveying, Viewshed Analysis, Etc.				$9,500
Misc Fees, Technical Services				$7,500
Contingency				$11,838
TOTAL:				$184,713

New Community Pole

A single wooden utility pole or inexpensive steel lattice tower with a line-of-site wireless connection to a 180 ft tower and local access radios could provide access to any residence with line of sight within a half mile or more. This would spread the cost of pole construction and equipment costs across several households or businesses. There are many areas in the county where there is a cluster of homes along a relatively short stretch of road. All of those homes could share the use of a single local utility pole access site.

If there were twenty homes that could receive service and the cost of the pole and equipment was $12,000, each household connected would have a one-time cost of $600. There could be a matching grant program where each county could provide 50% of the cost of putting the pole and equipment in place, and the balance would have to be developed from other sources. Some localities are using this concept to offer WISPs exclusive access to the pole in return for a portion of the construction costs.

Pole costs vary depending upon what equipment is installed. Point-to-point link radio costs vary with distance from a nearby tower. More information is contained in Chapter Six - Small Cell Broadband Poles.

Neighborhood Pole Costs

ITEM/PROJECT	UNITS	COST (LOW)	COST (HIGH)	COST (AVG)
Site Development (Clearing, Road Improvements, etc.)	1	$0	$2,000	$1,000
3x3 NEMA Box	1	$300	$600	$450
New Power Service / Installation	1	$500	$1,250	$875
60' Wooden Utility Pole Construction Materials	1	$2,500	$3,500	$3,000
Unmanaged Rack Mount PDU (6O)	1	$35	$45	$40
60' Wooden Utility Pole Construction Labor & Contracting	1	$2,000	$3,000	$2,500
Neighborhood Pole Coordination and Project Management				$5,000
Total:				$12,865

Point-to-Point Links

The table below show the cost of a backhaul radio installation, with one licensed radio set (AirFiber 11FX). The licensed radios are less susceptible to interference and have higher bandwidth. A regional backhaul network between towers has several desirable characteristics:

- It reduces the cost to providers of being able to affordably offer service on all the towers.
- It increases the reliability and robustness of the WISP services because of the ring design (on at least four of the towers).
- County government data and/or public safety services could also be carried on the backhaul network to provide improved access to some remote facilities.
- K12 schools may be interested in having a redundant network to improve reliability of their existing fiber connections. This can be especially important during periods when online standardized testing is taking place.

A tower in a larger network may have one, two, or several backhaul radios included, and number of radios depends on the tower's location in the network and how many other towers it is connected to using point to point link pairs.

Licensed PTP Radio - Single Side - AirFiber 11FX

ITEM/PROJECT	UNITS	UNIT COST	COST
AF11X Radio	1	$799	$799
AF11-CA Adapter Kit	1	$49	$49
AF11FX Duplexer	2	$199	$398
AF11 X Antenna 11GHz, 35dBi	1	$379	$379
FCC Licensing	0.5	$2,000	$1,000
Shipping @ 5%	1		$131
Point to Point Link Assembly, Installation, Alignment, and Testing	1	$3,600	$3,600
Project Management, NIIT	0.5		$3,000
TOTAL			$9,356

7.5 PUBLIC WIFI COST ESTIMATE

The following section describes the features and costs of a small public Wi-Fi Hotspot deployment, with a backhaul connection to a cellular network. Wireless access points intended for outdoor public use could be placed in small groups in downtown areas of Charles Town, Harpers Ferry, Shepherdstown, or in more rural areas where people are likely to gather.

There is also a recent trend of community and government groups placing hot-spots in easily accessible areas where citizens and school aged kids especially can utilize the hotspots to download schoolwork and access remote learning or remote work content. In a downtown area or park, Jefferson County could install a group of four access points to spread out the coverage area. The estimate shows the cost of four access points.

This cost estimate is for the public WiFi network that would be available for visitors and residents as they travel in the downtown area or in a rural location intended primarily for K12 student use.

Limits would be enforced on both bandwidth and time used. This is not intended or designed to be a free alternative to a subscriber-based Internet service. Bandwidth available to a user will support casual uses (e.g. email, Web access, social media uploads, etc.) but would not support video streaming, heavy use of two way video (e.g. Skype) and other bandwidth intensive services.

Where a smaller coverage footprint is required a single access point can be utilized. The estimate table shown includes equipment for a cellular backhaul service. If other Internet connections are available where the access point will be installed the County can forego the cost of the cellular modem and service and use a similarly priced cable modem, fiber modem, or network switch to supply connectivity to the hotspot.

Each access point is intended to serve individuals near the device. Coverage will depend on the end users device (laptop, phone, etc.) but in general can be expected to reach about 250 feet or cover a small parking lot. The coverage should not be expected to reach into homes or businesses unless they are very near the hotspot (e.g. 50-75 feet).

When utilizing a cellular service for backhaul we would expect that 15-25 devices could be supported before users might notice congestion as long as uses include light use of multimedia. (e.g. this is not intended to support streaming of entertainment video (e.g. Netflix, Hulu, Amazon Prime, Disney, etc.).

The speed of cellular data services varies, so performance of the access point will depend on the performance of the individual cellular connections.

In locations where the County could arrange for the hot-spot to be connected to a faster business Internet connection, then congestion and data use could be less of an issue. Remote management and administration of the hotspot is a standard feature now and the Ubiquiti equipment described on the next page can be configured to include custom splash pages and other advanced features.

Wi-Fi Hotspot Estimate, Cellular Backhaul

Item	Units	Unit Cost	Total
Ubiquiti UAP PRO AC	4	$124.54	$498.16
NETGEAR 4G LTE Broadband Modem OR EQUIVALENT	4	$129.99	$519.96
NETGEAR 6000450 MIMO Antenna OR EQUIVALENT	4	$41.08	$164.32
Tycon Systems UPSPro, 12V 120W, 50aH Batt, Steel Encl	4	$599.00	$2396.00
SAMLEX 450W 12V DC to AC Power Inverter, *or* DC to DC Power Conversion as compatible with load equipment	4	$40.59	$162.36
Commscope 2-3/8" OD Galvanized Pipe - Plain End 12.5'	4	$125.00	$500.00
Misc. Hardware, and Cabling	4	$120.00	$480.00
Assembly and Installation	32	$60.00	$1920.00
Administration, procurement, warehousing			$1660.20
Access Points:	**4**	**Estimated Cost**	**$8301.00**

7.6 ESTIMATED TIMELINES FOR COMPLETION

Each kind of project will have its own timeline, and will vary widely depending on the type of funding. Grant-funded projects may need six months to one year to plan and apply for funding, depending on where in the grant cycle the network owner commits to applying for a grant and the length of time that the grant agency takes to review and approve grants.

Tower improvements and construction times can be dependent on weather (more weather related delays are likely in late fall through early spring) and on procurement. Most grant-funded projects require careful attention to a public procurement process, which can add 90 to 180 days to the timeline.

Broadband Construction Timetable

Project Type	Project Execution Planning	Project Procurement	Project Engineering and Construction	Total Estimated Timeline
Improvements to existing towers	2-3 months	3-4 months	2 months	7-9 months
New towers of 180 ft	4-6 months	4-5 months	4-8 months	12-19 months
Small cell community broadband poles	3 months	2 months	2 months	7 months
Public WiFi Hotspot	3 months	1 month	1 month	5 months
Point to point tower backhaul links	2-3 months	3-5 months	1-2 months	6-10 months
Fiber to the home/ business projects	4-6 months	4-6 months	6-12 months	14-24 months

7.7 FIBER PILOT DESIGN AND COST ESTIMATES

In Jefferson, three pilot fiber cost studies were created to demonstrate the potential cost of different types of fiber projects. The architecture of the fiber pilot is a dark-fiber meet-me box design, where ISPs bear the cost of equipment and the operational burdens of a lit fiber network. Service providers would lease dark fiber strands, install their own network electronics, and provide all day to day network management required. The County would only have to maintain an emergency break-fix contract with a qualified private sector fiber repair company and a contract to locate underground lines when required by 811 (Miss Utility). The designs are specified as underground construction, which means that fiber breaks would be very rare.

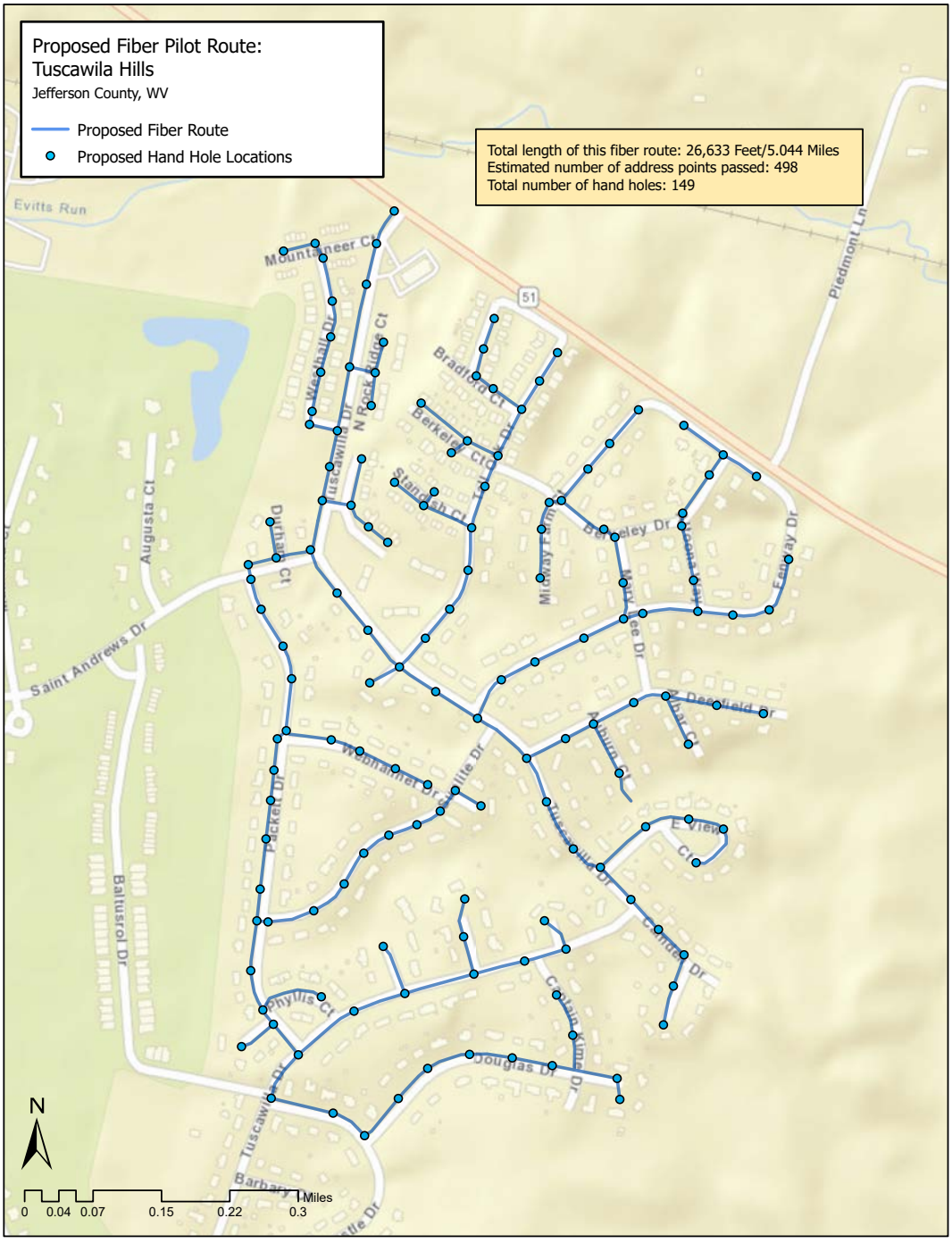
Tuscawila Hills – A residential/business fiber to the home network that could be served by a nearby wireless tower. This is a lit fiber cost estimate (network equipment included in the estimate).

Knott Road to Potomac River – A residential/business fiber to the home network that could be served by a nearby wireless tower. This is a dark fiber project (network electronics would be provisioned by the service provider).

Shenandoah Junction – A relatively long fiber run extending about eight miles that connects the Hopewell fiber to the home pilot to the Saxton community. This is a dark fiber project (network electronics would be provisioned by the service provider).

Tuscawila Hills Fiber Pilot

This study is in a mixed residential neighborhood with some single family homes, some duplex homes, and some apartments, adjacent to the golf course. This is a "lit" network cost estimate, with the network equipment included.



Tuscawila Hills Cost Summary

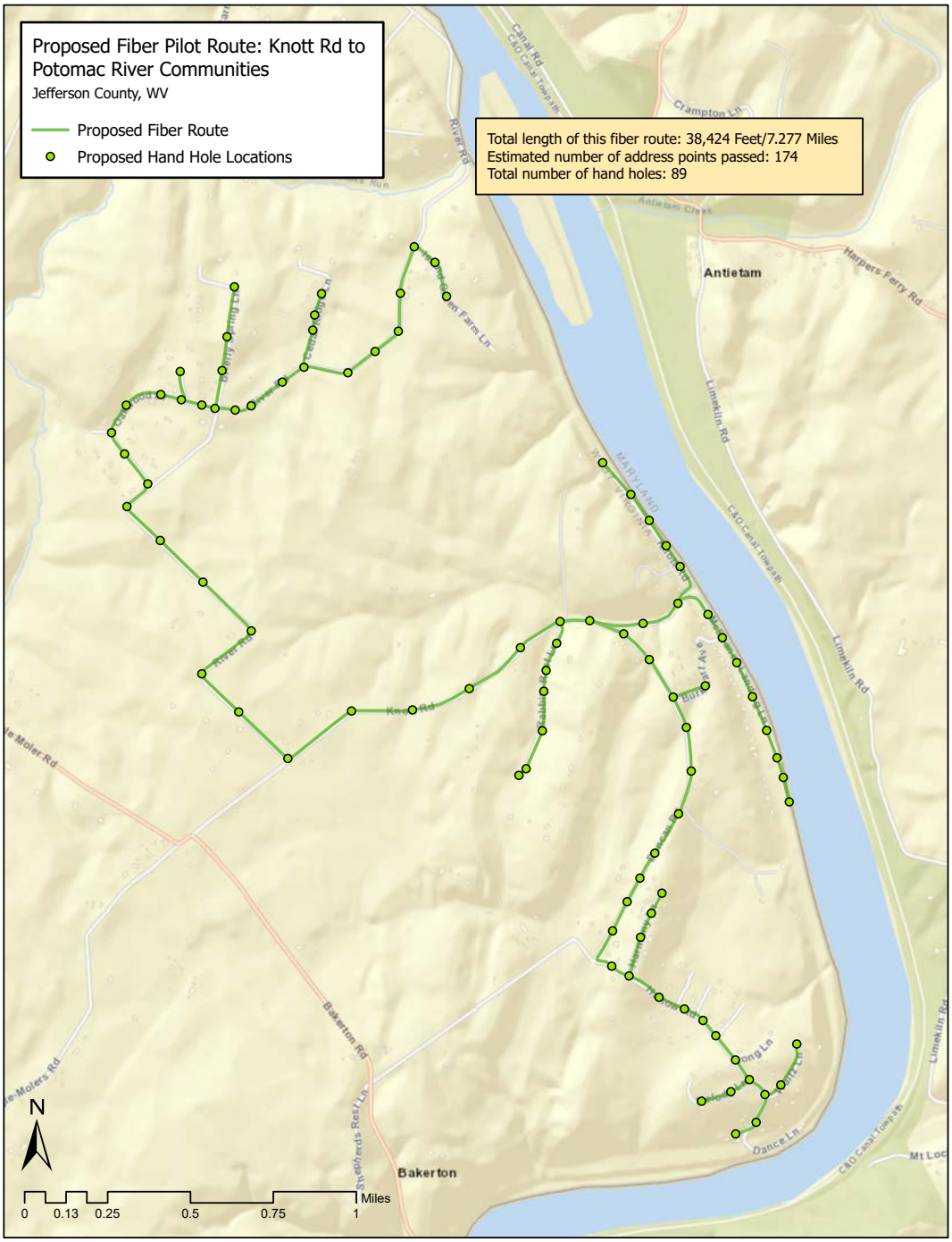
0	ITEM/PROJECT	ESTIMATED
1	Tuscawila Hills Construction Materials	$143,592
2	Tuscawila Hills Distribution Labor	$369,936
3	Tuscawila Hills Structures, Cabinets, and Equipment	$80,823
4	Tuscawila Hills Drop Construction	$229,125
5	Network Construction Subtotal	**$823,475**
6	Project Management, Network Engineering, Integration, and Testing	$98,817
7	Misc Fees, Advertising, Technical Services	$5,000
8	Bookkeeping and Administration	$2,500
9	Engineering, Permitting	$30,300
10	Legal Costs	$2,500
11	Network Management Software and Services	$4,500
12	Other Costs Subtotal	$143,617
13	Project Total	**$967,092**
14	Contingency at 5%	$48,355
15	Project Total (with contingency)	**$1,015,447**

Tuscawila Hills Cost Summary

0	ITEM/PROJECT	ESTIMATED
1	Tuscawila Hills Construction Materials	$143,592
2	Tuscawila Hills Distribution Labor	$369,936
3	Tuscawila Hills Structures, Cabinets, and Equipment	$80,823
4	Tuscawila Hills Drop Construction	$229,125
5	Network Construction Subtotal	**$823,475**
6	Project Management, Network Engineering, Integration, and Testing	$98,817
7	Misc Fees, Advertising, Technical Services	$5,000
8	Bookkeeping and Administration	$2,500
9	Engineering, Permitting	$30,300
10	Legal Costs	$2,500
11	Network Management Software and Services	$4,500
12	Other Costs Subtotal	$143,617
13	Project Total	**$967,092**
14	Contingency at 5%	$48,355
15	Project Total (with contingency)	**$1,015,447**

Knott Road to Potomac River Fiber Pilot

This study is of a more rural area with longer distances between many of the homes. For this pilot we have structured the cost estimate with a 50% take rate. This is a dark fiber cost estimate, where the service provider leasing the infrastructure would provide their own network equipment. The dark fiber approach significantly reduces the County day to day management activities (e.g. very little day to day responsibility).



Knott Road to Potomac River FTTH Pilot Route Overview

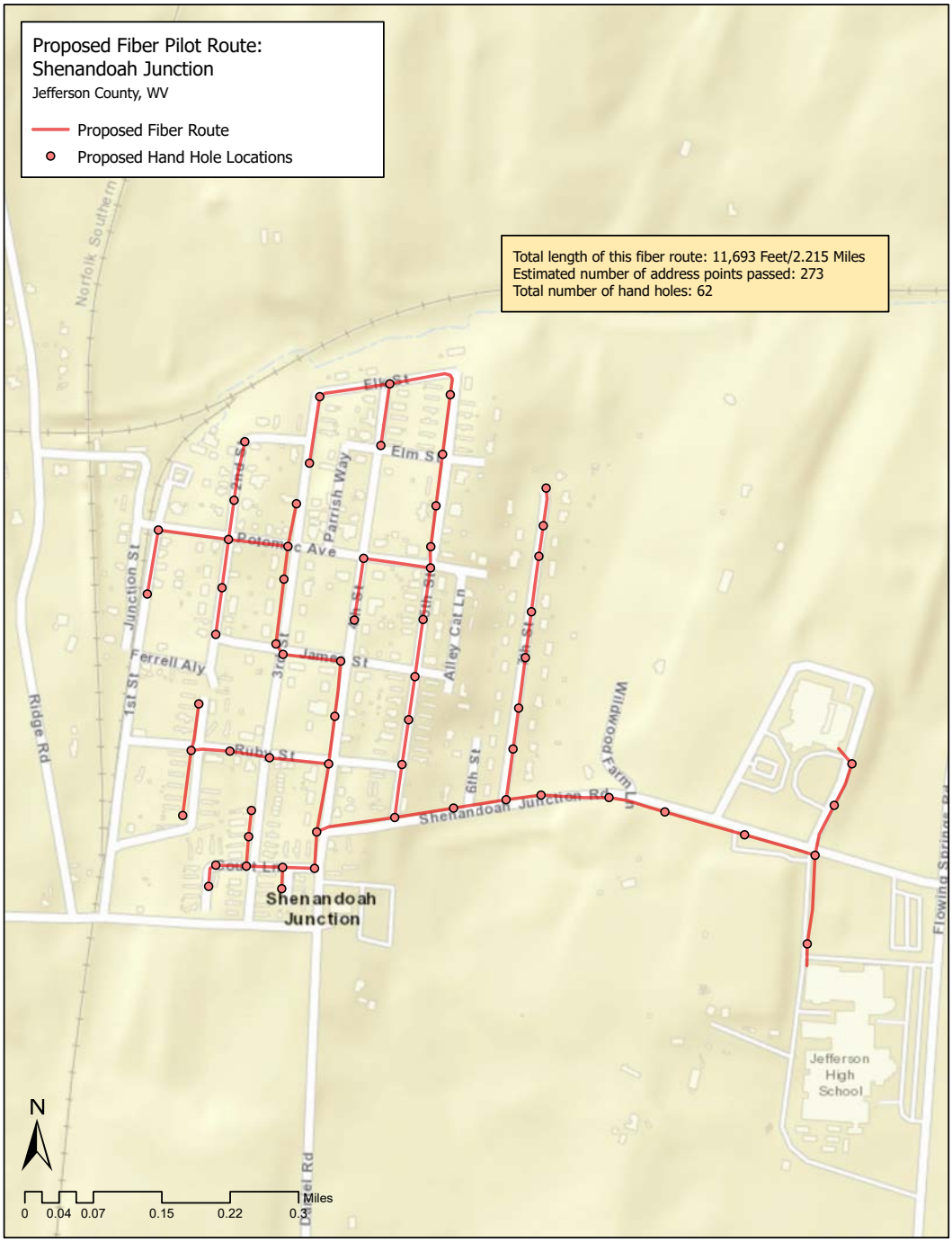
0	ITEM/PROJECT	VALUE
1	Miles of Fiber / Conduit Installed	7.28
2	Number of Handholes Installed	89
3	Splice Closures Installed	43.5
4	Cabinets Installed	1
5	Number of Buildings Connected	87
6	Take Rate - Percentage of the Buildings Passed who are connected	50%
7	Aerial - Percentage of construction expected to be installed on utility poles.	1%
8	Trenching - Percentage of construction installed by trenching	9%
9	Boring - Percentage of construction installed by horizontal drilling.	35%
10	Slot Cutting - Conduit installed in street by special methods.	0%
11	Rock Saw - Required where rock prevents the use of other methods.	0%
12	Direct Bury - Conduit installed by direct bury methods (plow, vibratory plow)	55%
13	Aerial Info	1% Aerial is estimated to account for water body crossings and other obstacles to construction.
14	Other Notes	Estimated labor rates are based upon common rates seen for recent medium sized rural projects.

Knott Road to Potomac River FTTH Pilot Cost Summary

0	ITEM/PROJECT	ESTIMATED
1	Knott Road to Potomac River FTTH Pilot Construction Materials	$129,918
2	Knott Road to Potomac River FTTH Pilot Distribution Labor	$410,733
3	Knott Road to Potomac River FTTH Pilot Structures, Cabinets, and Equipment	$28,455
4	Knott Road to Potomac River FTTH Pilot Drop Construction	$88,775
5	Network Construction Subtotal	**$657,881**
6	Project Management, Network Engineering, Integration, and Testing	$78,946
7	Misc Fees, Advertising, Technical Services	$5,000
8	Bookkeeping and Administration	$2,500
9	Engineering, Permitting	$43,680
10	Legal Costs	$2,500
11	Network Management Software and Services	$4,500
12	Other Costs Subtotal	$137,126
13	Project Total	**$795,007**
14	Contingency at 5%	$39,750
15	Project Total (with contingency)	**$834,757**

Shenandoah Junction Fiber Project

This project provides fiber in residential neighborhood with a mix of modest homes. The fiber also connects to the Jefferson High School and the Wildwood Middle School. The opportunity to sell Internet to the two schools would be of high interest to a service provider. This is a dark fiber cost estimate (network equipment provided by the service provider).



Shenandoah Junction FTTH Pilot Route Overview

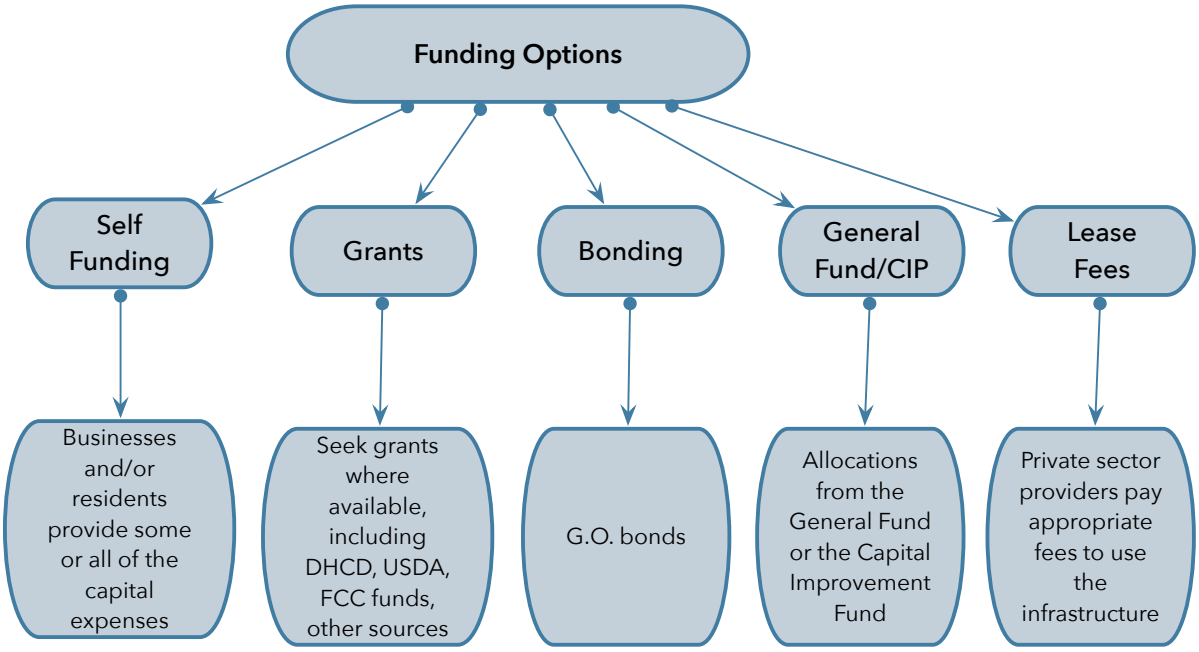
0	ITEM/PROJECT	VALUE
1	Miles of Fiber / Conduit Installed	2.22
2	Number of Handholes Installed	62
3	Splice Closures Installed	68.25
4	Cabinets Installed	1
5	Number of Buildings Connected	137
6	Take Rate - Percentage of the Buildings Passed who are connected	50%
7	Aerial - Percentage of construction expected to be installed on utility poles.	1%
8	Trenching - Percentage of construction installed by trenching	9%
9	Boring - Percentage of construction installed by horizontal drilling.	35%
10	Slot Cutting - Conduit installed in street by special methods.	0%
11	Rock Saw - Required where rock prevents the use of other methods.	0%
12	Direct Bury - Conduit installed by direct bury methods (plow, vibratory plow)	55%
13	Aerial Info	1% Aerial is estimated to account for water body crossings and other obstacles to construction.
14	Other Notes	Estimated labor rates are based upon common rates seen for recent medium sized rural projects.

Shenandoah Junction FTTH Pilot Cost Summary

0	ITEM/PROJECT	ESTIMATED
1	Shenandoah Junction FTTH Pilot Construction Materials	$64,802
2	Shenandoah Junction FTTH Pilot Distribution Labor	$173,592
3	Shenandoah Junction FTTH Pilot Structures, Cabinets, and Equipment	$28,455
4	Shenandoah Junction FTTH Pilot Drop Construction	$125,925
5	Network Construction Subtotal	**$392,774**
6	Project Management, Network Engineering, Integration, and Testing	$47,133
7	Misc Fees, Advertising, Technical Services	$5,000
8	Bookkeeping and Administration	$2,500
9	Engineering, Permitting	$13,320
10	Legal Costs	$2,500
11	Network Management Software and Services	$4,500
12	Other Costs Subtotal	$74,953
13	Project Total	**$467,726**
14	Contingency at 5%	$23,386
15	Project Total (with contingency)	**$491,113**

8 INFRASTRUCTURE FUNDING AND GRANT OPPORTUNITIES

It is important to note that any investment by county government in broadband infrastructure should be focused on passive infrastructure. These assets will have a conservative life span of thirty years or more (e.g. wireless towers, conduit, fiber cable). These types of infrastructure investments create hard assets that have tangible value and can then be leveraged for additional borrowing. The demand for services and the associated fees paid for those services will provide the revenue that will pay back loans over time. There is ample time to recoup not only the initial capital investment, but also to receive regular income from the infrastructure.



The financing of local government and/or community-owned telecommunications infrastructure faces several challenges with respect to funding.

- Not all local governments are willing to commit to making loan guarantees from other funding sources like property taxes, because the idea of community-owned telecom infrastructure has a limited track record and therefore a higher perceived risk.
- Similarly, citizens are not always willing to commit to the possibility of broadband fees or higher taxes that may be needed to support a telecom infrastructure initiative, for many of the same reasons that local governments are still reluctant to make such commitments: perceived risk and a lack of history for such projects.
- Finally, banks and investors are also more skeptical of community telecom projects because of the relative newness of the phenomenon. By comparison, there are decades of data on the financial performance of water and sewer systems, so the perceived risk is lower.

Somewhat paradoxically, the cost of such a community digital road system is lower when there is a day one commitment to build to any residence or business that requests service. This maximizes the potential marketplace of buyers and attracts more sellers to offer services because of the larger potential market. This is so because:

- Service providers are reluctant to make a commitment to offer services on a network without knowing the total size of the market. A larger market, even if it takes several years to develop, is more attractive.
- Funding agencies and investors that may provide loans and grants to a community network project want to know how the funds will be repaid and/or that grants will contribute to a financially sustainable project. Knowing that the size of the customer base is the maximum possible for a service area helps reduce the perceived risk for providing loans and grants.

8.1 WEST VIRGINIA LEGISLATIVE ACTIVITIES

The West Virginia legislature has been evaluating legislation to improve broadband access in the state. The bills are designed to make it easier and less expensive to build broadband infrastructure in underserved parts of the state.

- Published in 2020, the West Virginia Broadband Plan provides a broad overview of broadband activities in the state. The report provides detail on current broadband speed availability across the state, Federal grant opportunities, long term goals of the West Virginia Broadband Enhancement Council, and county level results of the WV Speed Test site.
- Passed in 2019, Senate Bill 3 creates the "Wireless Technology Business Property Valuation Act," which would make it less expensive for telecommunications and broadband internet companies to build more towers, particularly in rural parts of the state. The tax treatment of the towers would be changed to reduce property taxes on the towers, making it less expensive to build and maintain those towers.
- Senate Bill 800 is a "Make-Ready Pole Access" provision. This portion of the law would require electric utilities companies to evaluate using their utility poles to expand broadband access.
- Passed in 2019, Senate Bill 3 also creates the "West Virginia Small Wireless Facilities Deployment Act," which would make it easier for ISPs and cellular providers to use the state's existing rights of way and utility poles to place the next generation of wireless and broadband technologies. 5G services could be deployed more quickly in West Virginia if this is included in the final bill.

8.2 HUD COMMUNITY DEVELOPMENT BLOCK GRANTS

The U.S. Housing and Urban Development CDBG State Program allows the West Virginia state government to award grants to smaller units of general local government (e.g. counties, towns) that develop and preserve decent affordable housing, to provide services to the most vulnerable in our communities, and to create and retain jobs. In recent years, CDBG funds have been successfully used for broadband infrastructure development where the local government applicant can show the improvements meet the general guidelines of the program—so grant funds have to spent in low and moderate income areas.

Over a 1, 2, or 3-year period, as selected by the grantee, not less than 70 percent of CDBG funds must be used for activities that benefit low- and moderate-income persons. In addition, each activity must meet one of the following national objectives for the program: benefit low- and moderate-income persons, prevention or elimination of slums or blight, or address community development needs having a particular urgency because existing conditions pose a serious and immediate threat to the health or welfare of the community for which other funding is not available. More information is available here (https://www.hud.gov/program_offices/comm_planning/communitydevelopment/programs).

8.3 USDA RECONNECT PROGRAM

The ReConnect program is a new funding program managed by the USDA Rural Development Office. This program is sometimes called the USDA e-Connectivity pilot program. Grant applications can be a combination of 100% grant, 50% grant/50% loan, or 100% loan. $600 million has been allocated to the program, and a wide variety of entities can apply, including non-profits, coops, and state and local governments. Successful applications will require a very credible business plan that shows the project can be financially sustainable. Up to $25 million is available for a 100% grant application. Applications are due in the spring of 2021. More information is available here: (reconnect.usda.gov). A mapping tool is available on the Web site to show areas that are eligible. To qualify as an eligible area, households must have less than a minimum of 10 Megabit down/1 Megabit up broadband service.

8.4 911 FEES

Improved broadband access in the county can improve household access to 911 services by using broadband Internet to carry 911 voice calls, using one or more strategies to include:

WiFi calling – now a commonly available feature on new cell phones. WiFi calling switches voice telephone call from the cellular network to a nearby WiFi Internet network seamlessly. The reduces the need for additional large cell towers in low density areas of the county.

Nano-cell Devices – Nano-cells are a small box attached to a home wireless router. The nano-cell, which is typically obtained from the cellular provider, enables a cellphone to operate inside the home or business even if there is no cell tower near by.

A modest increase in the 911 fee to improve 911 access in rural areas of the county could generate funds to support additional broadband towers and community poles, but this approach would require legislative changes at the state level–which has been a topic of discussion in Charleston. See the tables above in the Special Assessment section of this chapter.

8.5 OPPORTUNITY ZONES

An Opportunity Zone is an economically-distressed community where new investments, under certain conditions, may be eligible for preferential tax treatment. Localities qualify as Opportunity Zones if they have been nominated for that designation by the state and that has been approved by the Internal Revenue Service. Opportunity Zones are designed to create tax incentives for private investors to make investments that can encourage economic development and job creation in distressed communities. Opportunity Zones would be of most use for Internet Service

Providers who could use the tax benefits to make a business case to improve Internet access in a qualifying area (zone).

Opportunity Zones are defined by census tract, and the Census Bureau's Geocoder online tool can provide census tract ID numbers. A link to the list of currently qualified census tracts can be found on this page (https://www.cdfifund.gov/Pages/Opportunity-Zones.aspx). Large parts of Jefferson County have designated Opportunity Zones.

8.6 BONDING

Revenue bonds are repaid based on the expectation of receiving revenue from the network, and do not obligate the local government or taxpayers if financial targets are not met. In that respect, they are different from general obligation bonds. Many kinds of regional projects (water, sewer, solid waste, etc.) are routinely financed with revenue bonds. We believe many community projects will eventually finance a significant portion of the effort with revenue bonds, but at the present time, the limited financing history of most community-owned broadband networks has limited using revenue bonds.

Selling revenue bonds for a start up municipal network can be more challenging because there is no financial or management history for the venture. Bond investors typically prefer to see two or three years of revenue and expenses and a track record of management success. It would be advisable for the county to have an early conversation with qualified municipal bond counsel to assess the viability of this approach.

Obtaining funding using revenue bonds requires an excellent municipal credit rating and an investment quality financial plan for the operation and management of the network. Revenue bonds must be used carefully, and a well-designed financial model is required to show investors that sufficient cash flow exists to pay back the loans.

General obligation bonds are routinely used by local governments to finance municipal projects of all kinds. G.O. bonds are guaranteed by the good faith and credit of the local government, and are not tied to revenue generated by the project being funded (i.e. revenue bonds). G.O. bonds obligate the issuing government and the taxpayers directly, and in some cases could lead to increased local taxes to cover the interest and principal payments. Some bond underwriters have indicated a willingness to include telecom funds as part of a larger bond initiative for other kinds of government infrastructure (e.g. adding $1 million in telecom funds to a $10 million bond initiative for other improvements).

In discussions with bond underwriters, it has been suggested that it would be easier to obtain bond funds for telecom if the telecom bonding amount was rolled into a larger water or sewer bond, or some other type of bond request that are more familiar to the bond market.

8.7 CAF 2 FUNDS

The second round of the FCC Connect America Fund (CAF2) continues to provide funds to incumbent and competitive service providers. The funds must be used in unserved or underserved areas as defined by Federal census blocks. To be eligible, a census block could not have been served with voice and broadband of at least 10/1 Mbps (based on Form 477 data) by an unsubsidized competitor or price cap carrier.

The FCC published the final eligible census blocks for the auction on February 6, 2018. The final areas were based on FCC Form 477 data as of December 31, 2016 (the most recent publicly available FCC Form 477 data at the time). So there is a time lag between the determination of a qualifying census block or blocks and the schedule for submitting a bid to serve those areas.

Because many CAF2 qualifying areas are only served by low performance DSL (e.g. less than 10/1 Mbps service), incumbent carriers use the awards to upgrade DSL switches, which is not a long term solution. More recently, competitive carriers are applying for CAF2 funds to provide higher performance broadband wireless and in some cases fiber to the home. Because the use of CAF2 funds are so restricted, it has not had as much impact as many hoped.

8.8 LEASE FEES

Initiatives like tower access and access to local government-owned conduit and fiber can create long term revenue streams from lease fees paid by service providers using that infrastructure. The City of Danville, Virginia has recovered their entire initial capital investment from lease fees paid by providers on the nDanville fiber network.

8.9 COMMUNITY REINVESTMENT ACT

The Community Reinvestment Act (CRA) was developed forty years ago to encourage banks and savings institutions to help meet the credit needs of their local communities, with a focus on low and moderate income areas of those communities. The Federal agencies that oversee private banks assign a CRA rating to each institution. Banks are often looking for well-planned community efforts that need loans. Such loans can improve a bank's CRA rating.

The CRA was revised in 2016 to encourage banks to support community broadband efforts. A community broadband project may be able to get some loan financing from a local bank that wants to get credit for their CRA work.

8.10 COOP MEMBERSHIP FEES

Coop members pay a one time membership fee to join the coop. For fiber and wireless improvements, this fee could be set at a level that pays for part or all of the cost of building the fiber to the business or residential premises and/or placing the towers and equipment to deliver wireless service. It may also be possible to work with local banks to provide a financing option (e.g. the membership fee could be paid monthly over a period of several years to reduce the financial burden on a household or business).

The coop membership fee offers the area a way to self-finance a substantial portion of the initial network, as well as providing a long term framework for expansion.

8.11 CONNECTION FEES

Tap fees, pass by fees, and connection fees are already commonly used by local governments for utilities like water and sewer. The revenue share model can be strengthened from additional sources of revenue, including one time pass by fees, connection fees and sweat equity contributions. It is important to note that the Coop Membership Fee can be treated as a connection fee in whole or in part.

Pass By Fees – Pass by fees could be assessed once the fiber passes by the property, just as some communities assess a pass by fee when municipal water or sewer is placed in the road or street– and the fee is assessed whether or not the premise is connected, on the basis that the value of the property has been increased when municipal water or sewer service passes by. At least one study has indicated that properties with fiber connections have a higher value by $5,000 to $7,000 that similar properties without fiber access.

One Time Connection Fees – A one time connection fee can be assessed to property owners (e.g. residents and businesses) when the fiber drop from the street to the premise is installed. This is similar to the kinds of connection fees that are typically charged when a property is connected to a municipal water or sewer system. The fee is used to offset the cost of the fiber drop and the Customer Premise Equipment (CPE) needed to provide the operational access to the network. The connection fee can be modest (e.g. $100) or it can be a larger percentage of the actual cost of the connection. Fiber CPE may range from $250 to $350 and a fiber drop may cost from $200 for a premise very close to the distribution fiber passing along the property to $1,000 or more if the premise is hundreds of feet from the road. One variant would be to charge a minimum connection fee for up to some distance from the road (e.g. $100 for up to 75' and $2 for each additional foot).

There is already some data that indicates that residential property values increase by as much as $5,000 to $7,000 if fiber broadband services are available, so pass by fees can be justified on the basis of increased property values accruing to the property owner. Given the novelty of this approach, pass by fees may need more time to become an accepted finance approach, but tap fees (for installing the fiber cable from the street or pedestal to the side of the home or business) may be easier to use, especially for businesses that may need improved broadband access. Tap fees have the potential of reducing the take rate in the early phases of deployment, but as the value of the network becomes established, it is likely that there will be much less resistance to paying a connection fee.

8.12 GRANTS

Grant funding is limited and should be viewed as part of a larger basket of funding. Federal funds from sources like the USDA and the FCC are highly competitive and often come with substantial limitations on who can qualify and how the funds can be used. CDBG funds can support telecom infrastructure construction but must be tied to job creation and/or job retention.

8.13 NEW MARKETS TAX CREDIT

New markets tax credits are a form of private sector financing supported by tax credits supplied by the Federal government. The New Markets Tax Credit (NMTC) Program permits taxpayers to receive a credit against Federal income taxes for making qualified equity investments in designated Community Development Entities (CDEs). The CDEs apply to the Federal government for an allotment of tax credits, which can then be used by private investors who supply funds for qualifying community projects. Substantially all of the qualified equity investment must in turn be used by the CDE to provide investments in low-income communities.

The credit provided to the investor totals 39 percent of the cost of the investment and is claimed over a seven-year credit allowance period. In each of the first three years, the investor receives a

credit equal to five percent of the total amount paid for the stock or capital interest at the time of purchase. For the final four years, the value of the credit is six percent annually. Investors may not redeem their investments in CDEs prior to the conclusion of the seven-year period.

Throughout the life of the NMTC Program, the Fund is authorized to allocate to CDEs the authority to issue to their investors up to the aggregate amount of $19.5 billion in equity as to which NMTCs can be claimed.

These tax credits can be quite useful, and there may be some areas that qualify. However, it can take up to a year or more to apply and then finally receive NMTC-related cash. This can be a useful long term source of funds.

8.14 SPECIAL ASSESSMENT/SERVICE DISTRICT

Communities like Bozeman, Montana and Leverett, Massachusetts have been funding broadband infrastructure improvements with special assessments (in Leverett, $600/year for five years), and in Bozeman, TIF (Tax Increment Funding) is being used in some areas to add telecom conduit, handholes, and dark fiber. In some localities, it is possible to levy a special assessment in a service district designated for a particular utility (like broadband) or other kind of public service.

Charlemont, Massachusetts intends to add an $11/month assessment to every household to build a town-owned Gigabit fiber network that will pass every household in the community. A town-wide vote supported this funding approach. Put in perspective, the average cost of a large, single topping pizza in the U.S. is currently $9 to $12.

Two small cities in Utah are currently evaluating the potential of a $10-12 utility tax levied on every household and business to finance a full fiber to the premises build out, including a modest "free" Internet service that would be adequate for email and light Web use. Most households will probably choose to select a higher performance Internet package from a private provider on the network. A $10/month special assessment (the cost of one large pizza) on every household in Jefferson could raise as much as $47 Million for broadband over twenty years—enough to take Gigabit fiber to nearly every home and business.

The tables below shows the kind of funds that could be generated over several time periods. If ten dollars per month were collected from each household for thirty years, it would easily finance the immediate build out of Gigabit fiber that would pass nearly all homes and businesses in each county.

Individual Service District Examples				
Monthly Assessment Amount	Fifty Homes Five Year Assessment	Fifty Homes Ten Year Assessment	100 Homes Five Year Assessment	100 Homes Ten Year Assessment
$5	$15,000	$30,000	$30,000	$60,000
$10	$30,000	$60,000	$60,000	$120,000
$25	$75,000	$150,000	$150,000	$300,000

Individual Service District Examples				
Monthly Assessment Amount	Fifty Homes Five Year Assessment	Fifty Homes Ten Year Assessment	100 Homes Five Year Assessment	100 Homes Ten Year Assessment
$50	$150,000	$300,000	$300,000	$600,000

A lesser amount (e.g. $2/month over twenty years) would easily finance the immediate build out of a comprehensive wide area wireless tower network in each, as well as some fiber infrastructure.

Jefferson County Special Assessment Examples		
Monthly Assessment Amount	Twenty Year Assessment	Thirty Year Assessment
Number of Households	19,931	
$1	$4,783,440	$7,175,160
$2	$9,566,880	$14,350,320
$5	$23,917,200	$35,875,800
$10	$47,834,400	$71,751,600

8.15 PROPERTY TAX INCREASE

While raising taxes can be politically very difficult, a very small incremental increase in property taxes, with the increase clearly earmarked specifically designated for broadband development (.e.g. one-quarter cent) might be possible to sell to citizens and businesses. The table below is adjusted to reflect the cost of borrowing over the listed periods of time.

The table below illustrates a hypothetical example of what funds might be raised for broadband improvements with a sample county-wide assessed property value.

	Sample Assessed property value	Broadband increment	Annual Broadband Fund	Ten Year Aggregate	Twenty Year Aggregate	Thirty Year Aggregate
1/4 of one cent	$900,000,000	$0.0025	$20,250	$202,500	$405,000	$607,500
1/2 of one cent	$900,000,000	$0.0050	$40,500	$405,000	$810,000	$1,215,000
1 cent	$900,000,000	$0.0100	$81,000	$810,000	$1,620,000	$2,430,000

8.16 GRANT APPLICATION ACTIVITIES

Activity	Description	Discussion	Tasks
Develop a grant application	The grant application process, from start to award announcement, can be nine to twelve months.	Broadband grant application requirements have become more stringent over time, with more grant agency oversight and review. Careful planning is essential to develop a successful application.	• Once a grant opportunity has been identified, review grant requirements to determine if the project can qualify. For example, some grants require two years of financial history. • Identify regional agency that will assist (e.g. Region 8 PDC). • Begin contacting potential ISP partners. • If the project qualifies, identify at least two people to take the lead to prepare application. • Prepare a task list of all grant materials requirements and identify data needed. • Develop a timeline for developing sections of the grant. • Identify requirements for letters of support and matching funds and develop timeline to solicit and collect commitments. • Complete all sections of grant application with assistance from public and private partners. • Submit grant application.

Typical Timeline	Months											
Tasks	1	2	3	4	5	6	7	8	9	10	11	12
Determine grant qualifications												
Identify regional council partner												
Identify ISP or WISP partner if needed												
Appoint grant team												
Create grant task list												
Prepare timeline and assign tasks to partners												
Identify matching fund requirements and letters of support to solicit and collect as needed												
Complete all sections of the grant application												
Submit grant												
Grant agency review												
Awards announcement												

9 NETWORK OPERATIONS OPTIONS

Throughout the U.S., many WISPs are aggressively pursuing public-private partnerships (PPPs) with county governments. These partnerships may include a variety of strategies: collaboration on a grant opportunity, shared costs of developing a new tower site, revenue sharing, fee waivers, and other sorts of cost and revenue sharing. The advantage of this kind of PPP is that the WISP typically is responsible for most of the day-to-day management of the network assets. County and local government investments are typically limited to passive assets like towers and site maintenance that requires no day to day responsibility and only occasional site and tower maintenance.

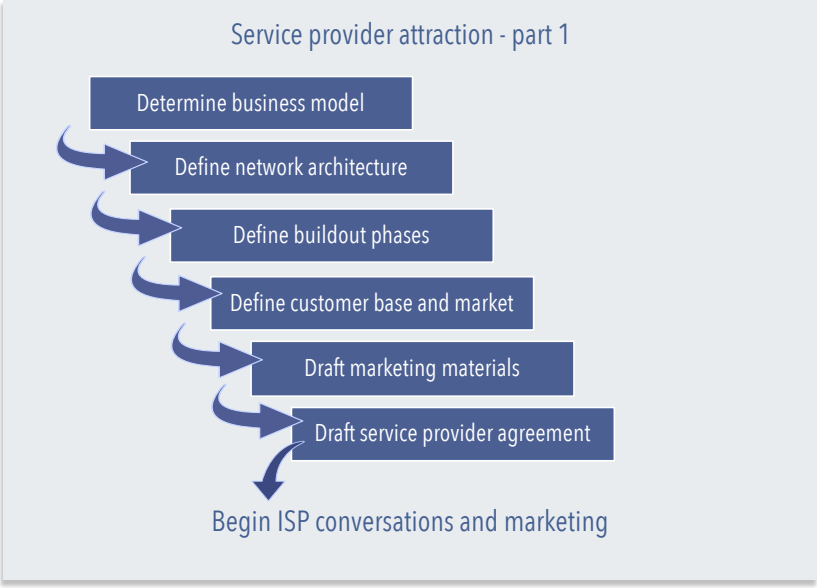
9.1 PUBLIC SAFETY PARTNERSHIPS

The availability of public-safety towers and/or new towers can enable new services and applications for police, fire, and rescue in Jefferson County. Secure WiFi hotspots can be set up around and near the towers, so that reports can be filed from the field using the WiFi Internet connection. Other communities that have done this have found that it saves time and keeps patrol cars out in the field longer.

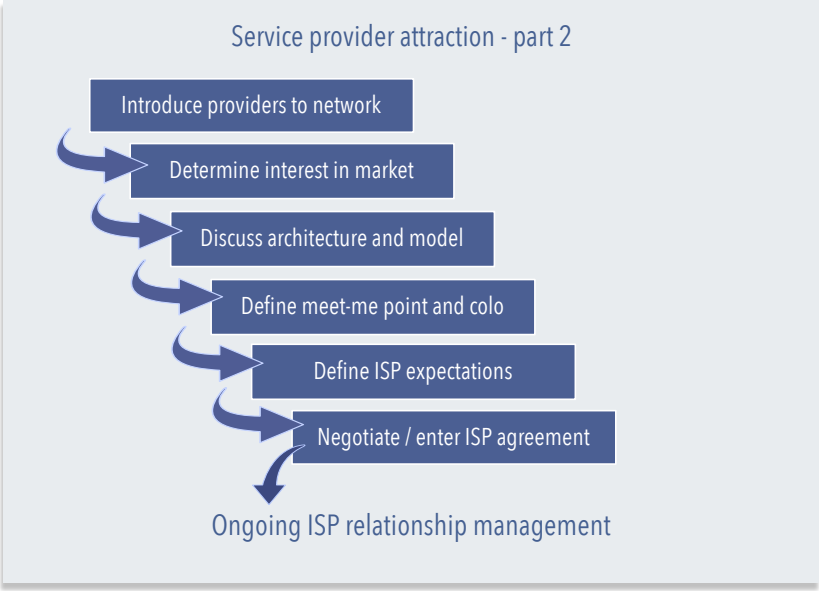
There are often grants available for public-safety voice and data communications improvements, like new towers and upgrades to existing tower facilities, that could also support the broadband initiative. Any public-safety tower or communications expenditure should be analyzed to determine if the expenditure can also support expanded broadband access in the county.

9.2 ATTRACTING PROVIDERS TO THE NETWORK

The WISP business is challenging. Setting the high cost of towers aside, a WISP placing equipment on a newly available tower must engage in a significant marketing and sales effort to identify customers who want service. Because most broadband wireless frequencies, including the new LTE frequencies, require or work best with line of sight between the customer and the tower, the WISP, even after identifying a potential customer, must often send a technician to the prospective customer location to determine if line of sight or near line of sight is available. It is common that a low hill, a building, trees, or other vegetation will degrade or block the signal.



If line of sight or near line of sight is available at the customer location, a second visit to install the customer antenna may be required before the customer can receive service. At this point, the WISP may have spent several hundred dollars on the acquisition of a single customer, and it can take many months of service before the WISP will even break even.



The cost of tower access be one of the most expensive parts of offering wireless Internet service. If a WISP has capital funds, it must choose where to place towers and smaller poles very carefully, and few WISPs have the capital to build enough towers to cover an entire county.

Just as government builds roads to enable commerce and services offered by the private sector, local government can also build towers to enable Internet services. Space on those towers is offered to WISPs for modest fees with the goal of expanding and improving Internet access.

Historically, tower space lease fees have been high, because early lessees were cellular companies offering high-margin cellphone and data services. Vertical space on a county-owned tower or water tank often range between $1200 and $2500 per month. But the business margins on fixed point wireless Internet are much lower, and tower lease fees should be set at levels that allow WISPs to make a business case to spend the additional capital for radios and related equipment on a new tower.

Activity	Description	Tasks
Attract Internet Service Providers (ISPs, WISPs)	One or more service providers will be needed to lease poles, and/or manage the network, and to partner for grant funds.	• Once owners/stakeholders have approved the plan, contact local and regional ISPs to assess partnership interest. • Schedule individual meetings with the ISPs to present project goals and objectives. • Assess interest of the companies in public-private partnership. • If interest is positive, reach agreement on which grant opportunities to pursue jointly and in what area. • Develop an MOU (Memo of Understanding) that identifies what tasks the WISP will perform for grant application and what project will perform.

Typical Timeline	Months											
Tasks	May '20	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Contact ISPs and WISPs												
Schedule individual meetings												
Assess interest in partnerships												
Schedule meetings to discuss grant opportunities												
Develop MOUs as needed for grants that will be pursued jointly												

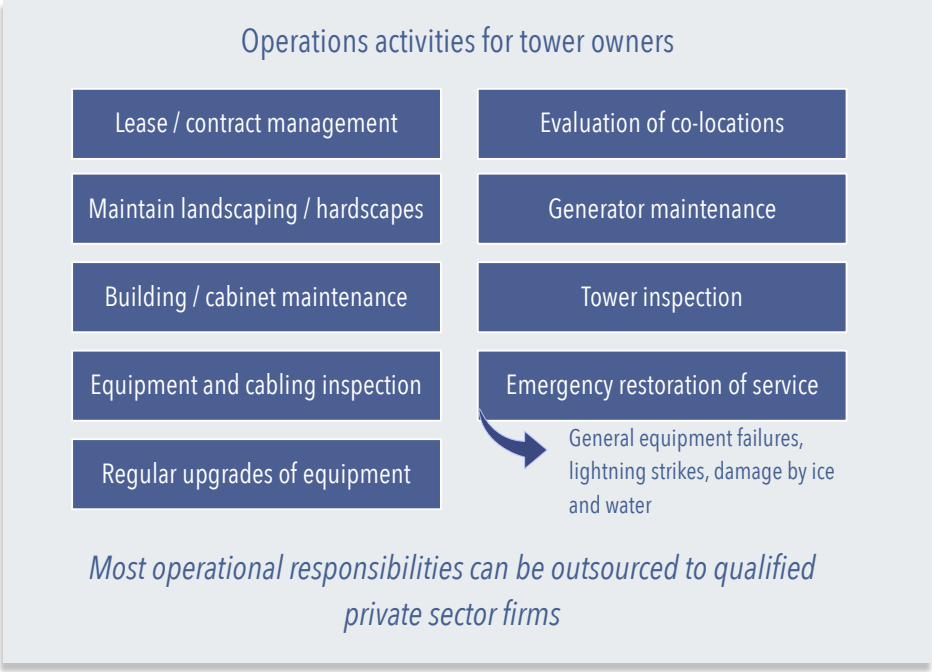
9.3 TOWER MANAGEMENT

A modest application fee, for example $200, for tower access should be nominal for WISPs; high application fees discourage WISPs from evaluating new tower opportunities.

Revenue sharing arrangements, where WISPs pay as they acquire customers, instead of a fixed lease fee are more difficult to manage. While the argument for revenue sharing seems to make sense, in practice, it requires the tower owner to have access to the accounting and financial records of the business, which can be challenging to enforce. It is also a financial disincentive for the WISP, as the fees that they have to pay for tower access continue to increase without end. The following is suggested:

- Use a single public fee schedule for all providers.
- Use a single tower space agreement for all providers.
- Tower access should be made available in ten foot vertical segments or on a per attachment basis, as high as possible on the tower without interfering with other uses, such as public safety antennas. Note that it is unlikely that any tower will have more than two providers on it.
- If a WISP is applying for space on an existing tower, no certified engineering plans should be required, but if a structural analysis is needed to determine wind and tower loading will not exceed tower specifications, the tower owner may have the WISP bear some or all of the cost of that study. Note that there appears to be high variability in the cost of these studies, and the tower owner should be careful to keep the structural analysis costs as low as possible.
- For a typical tower, identify two 10 ft spaces (where space is available) on existing towers and designate/reserve those for WISP use. The spaces should be as high as possible on each tower without interfering with other local government and public safety use. The lease cost of the lower space should be at least 20% less than the higher space. Tell WISPs exactly what space is available at each tower and at what heights; this makes it easier for WISPs to evaluate the potential market that could be served from each tower.

- If an existing shelter is available at the base of a tower and rack space for WISP equipment is available within that shelter, electric power should simply be provided as part of a very modest lease fee for rack space. If there is no space available in the shelter (e.g. lack of space or dedicated for public safety use), then the WISP should install an H-frame and have their own electric meter installed in an area designated at the base of the tower.



- Leases should be a minimum of two years and should auto-renew if the ISP is meeting performance requirements.
- It may be more effective to have a single lease agreement with access to all towers, and the contract should require the ISP to put equipment on all towers within a certain period of time (e.g. nine to twelve months). This limits ISPs from cherry picking towers with more potential customers and ignoring towers in parts of the service area with lower population density.
- Monthly tower lease fees should be on the order of $200 to $250 per tower or an equivalent per-attachment fee (e.g. $50-$75 per attachment). Higher fees make it difficult for providers to make a business case for the cost of equipment and the extensive marketing required to develop a customer base around a tower.
- Consider offering an initial grace period on fees of three to six months, and/or offer a one-year sliding scale of fees. An example sliding scale would waive the fee for the first 3 months, charge 25% of the fee for the next 3 months, up until 12 have passed and the full fee is assessed. There are many ways to structure the initial fee period, but it is important to recognize that the WISPs incur substantial early costs to develop revenue and customers for a new tower.

- All tower leases should expire on the same date even if started at different times. This allows the tower owner to potentially make a smoother transition to a new provider if there are issues, and will give them more leverage and control over the service.
- In contracts, fee reductions should be worded as discounts that can be revoked if performance requirements are not adequately being met.
- Describe what is available for ground space, such as space for WISP cabinets, shelters, and H-frames for electric service, shared generators that may be provided. Also indicate what the WISP has to provide at the base of the tower. If new shelters will be allowed, set minimum standards for new shelters.

9.4 WORKING WITH INFRASTRUCTURE LEASES

Once dark fiber cable and/ existing or new towers have space available to lease to WISPs, there are policy and contract decisions that must be evaluated.

Tower Lease Considerations

- There should be a single public fee schedule for all providers that want to lease space on the tower.
- There should be a single tower space agreement that is used for all providers.
- Tower access should be made available in ten foot vertical segments, as high as possible on the tower without interfering with other uses (e.g. public safety antennas). Note that it is unlikely that any tower will have more than two providers on it.
- Leases should be a minimum of two years and should auto-renew if the ISP is meeting performance requirements.
- It may be more effective to have a single lease agreement with access to all towers, and the contract should require the ISP to put equipment on all towers within a certain period of time (e.g. nine to twelve months). This limits ISPs from "cherry picking" towers with more potential customers and ignoring towers in parts of the county with lower population density.
- Monthly tower lease fees should be on the order of $200 to $250 per tower. Higher fees make it difficult for providers to make a business case for the cost of equipment and the extensive marketing required to develop a customer base around a tower.
- For a typical tower, identify two (2) ten foot spaces (where space is available) on existing towers and designate/reserve those for WISP use. The spaces should be as high as possible on each tower without interfering with other local government and public safety use. The lease cost of the lower space should be at least 20% less than the higher space. Tell WISPs exactly what space is available at each tower and at what heights; this makes it easier for WISPs to evaluate the potential market that could be served from each tower.
- An initial grace period of three to six month should be offered on fees, and/or offer a one year sliding scale of fees (e.g. first three months, fee waived; months four to six, 25% of normal fee; months seven to nine, 50% of normal fee; months ten to twelve, 75% of normal fee). There are many ways to structure the initial fee period, but it is important to recognize

that the WISPs incur substantial early costs to develop revenue and customers for a new tower.

- All tower leases should expire on the same date even if started at different times. This allows the enterprise to potentially make a smoother transition to a new provider if there are performance issues, and will give the project entity (e.g. County government, Jefferson County Development Association) more leverage and control over the WISPs.
- Leases should be a minimum of two years and should auto-renew if the ISP is meeting performance requirements.
- In contracts, fee reductions should be worded as discounts that can be revoked if performance requirements are not adequately being met.
- There are considerations for ground-space (e.g. WISP cabinets, shelters, H-frames for electric service) that will have to be evaluated at each tower site. If new shelters will be allowed, the ownership entity should set minimum standards for new shelters.

Dark Fiber Lease Considerations

Passive fiber infrastructure (i.e. no electronics) can include conduit, fiber cable, splice closures, and cabinets. Because all powered network equipment would be provided by the lessee (i.e. the ISP), there is no day to day management responsibilities and only occasional routine maintenance. Emergency break-fix for situations like a cable broken by a construction firm working in the right of way can be outsourced to a qualified private sector provider. Local governments routinely manage much more complex water and sewer systems. Some guidelines for leasing dark fiber include:

- There should be a single public price list for the cost of leasing fiber strands.
- A standard master agreement should be used for leases. This agreement will typically require an SLA (Service Level Agreement) that specifies repair times for emergency break-fix (i.e. the fiber cable has been damaged and a qualified break-fix repair firm must be on call to make repairs).
- It will also be important to have IRU pricing (Indefeasible Right of Use). Fiber strand leases are typically for periods of ten years or less. IRUs are long term leases and are typically twenty to thirty years in length. IRU fees have two parts: a single upfront payment that usually reflects some portion of the construction cost for the fiber route. As an example, if a lease will include twelve strands of fiber on a ten mile route of 144 strand fiber that cost $100,000 to construct, the one time fee might be 12/144 * $100,000 = $8,333. Most IRUs also have a modest annual maintenance fee that reflects the cost of maintenance and repairs; this would also be pro-rated to reflect the number of fibers assigned to the IRU agreement.
- Splice points and who is allowed to open handholes to perform splicing must be identified in the master agreement.

9.5 PREPARING FOR TOWER EXPANSION

Activities Preparing for Tower Expansion

ACTIVITY	DESCRIPTION	DISCUSSION	TASKS
Draft tower site lease agreement	Tower site lease agreements between the property owner and the broadband entity will be needed.	The county attorney may be able to provide most or all of the legal agreements needed.	• **Establish a basic tower lease agreement that will be used with all providers.** • **Identify legal counsel who will provide a draft agreement.** • **Circulate draft agreement for comments.** • **Approve lease agreement for use.**
Identify prospective tower sites	New towers will be needed in the county. The broadband plan identifies the general area where towers will be needed and most effective, but specific tower locations will have to be identified with the assistance of residents in the area and property owners. This will be an ongoing activity for at least the first year.	Height above the surrounding terrain, proximity to roads, and proximity to electric service are factors that have to be evaluated.	• **Review broadband plan and prepare a list of sites to survey.** • **Determine road access and electric service. Closer is better.** • **Meet with property owner to discuss a potential lease.** • **If site owner is agreeable, add site to list of grant-ready tower sites.**
Identify prospective community pole sites	Many community poles will be needed to provide the maximum amount of wireless broadband availability.	Community poles should only be placed where there is a cluster of nearby residents who are prepared to purchase Internet service from the provider on the pole.	• **For each area in a build out phase, identify clusters of typically 12-25 homes.** • **Identify a local champion willing to talk to neighbors and assess demand.** • **If demand meets target, add to list for next grant application with community poles.**

Timeline Preparing for Tower Expansion

TASKS	2020								2021			
	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Obtain agreement on using a standard lease for all towers												
Identify legal counsel to draft agreement												
Circulate draft agreement for comment												
Obtain approval for site lease agreement												
Develop list of potential tower sites												
Assess road, electric service access												
Meet with property owners												
Add agreeable owners to prospective tower list												
Identify clusters of residents for community poles												
Identify a local champion to assess demand												
Add clusters that meet demand to prospect list for community poles												

APPENDIX A: GLOSSARY

Active network: Typically a fiber network that has electronics (fiber switches and CPE) installed at each end of a fiber cable to provide "lit" service to a customer.

Asymmetric connection: The upload and download bandwidth (speed) are not equal. Cable Internet and satellite Internet services are highly asymmetric, with upload speeds typically 1/10 of download speeds. Asymmetric services are problematic for home-based businesses and workers, as it is very difficult to use common business services like two way videoconferencing or to transfer large files to other locations.

Backhaul: Typically refers to a high capacity Internet path out of a service area or locality that provides connectivity to the worldwide Internet.

Colo facility: Colo is short for Colocation. Usually refers to a prefab concrete shelter or data center where network infrastructure converges. A colo or data center can also refer to a location where several service provider networks meet to exchange data and Internet traffic.

CPE: Customer Premises Equipment, or the box usually found in a home or business that provides the Internet connection. DSL modems and cable modems are examples of CPE, and in a fiber network, there is a similarly-sized fiber modem device.

Dark fiber: Dark fiber is fiber cable that does not have any electronics at the ends of the fiber cable, so no laser light is being transmitted down the cable.

Fiber switch: Network electronic equipment usually found in a cabinet or shelter

Fiber Optic Splice Closure: See **FOSC**.

FOSC: Fiber Optic Splice Closure. Typically a water and air tight cylindrical container where fiber cable is split open to allow splicing (connecting together) of fiber strands for a drop to a premises.

FTTH/FTTP/FTTx: Fiber to the Home (FTTH), Fiber to the Premises (FTTP), and Fiber to the X (FTTx) all refer to Internet and other broadband services delivered over fiber cable to the home or business rather than the copper cables traditionally used by the telephone and cable companies.

Handhole: Handholes are open bottom boxes with removable lids that are installed in the ground with the lids at ground level. The handholes provide access to fiber cable and splice closures that are placed in the handhole. Handholes are also called **pull boxes**.

IP video: Video in various forms, including traditional packages of TV programming, delivered over the Internet rather than by cable TV or satellite systems.

Latency: The time required for information to travel across the network from one point to another. Satellite Internet suffers from very high latency because the signals must travel a round trip to the satellite in stationary orbit (22,500 miles each way). High latency makes it very difficult to use services like videoconferencing.

Lit network: A "lit"network (or lit fiber) is the same as an active network. "Lit" refers to the fact that the fiber equipment at each end use small lasers transmitting very high frequency light to send the two way data traffic over the fiber.

MST: Multiport Service Terminals are widely used in fiber to the home deployments to connect individual home drop cables to larger distribution cables on poles or in handholes. Pre-connectorized drop cables snap into the MST ports and do not require any splicing.

Passive network: Refers to infrastructure that does not have any powered equipment associated with it. Examples include wireless towers, conduit (plastic duct), handholes, and dark fiber.

Pull boxes: Pull boxes (also called handholes) are used to provide access to fiber cable and splice closures. They are called pull boxes because they are also used during the fiber cable construction process to pull the fiber cable through conduit between two pull boxes.

Splice closures: Splice closures come in a variety of sizes and shapes and are used to provide access to fiber cable that has been cut open to give installers access to individual fiber strands. Splice closures are designed to be waterproof (to keep moisture out of the fiber cable) and can be mounted on aerial fiber cable or placed underground in handholes. Also called **FOSC**s.

Splicing: The process of providing a transparent joint (connection) between two individual fiber strands so that laser light passes through. A common use of splicing is to connect a small "drop" cable of one or two fiber strands to a much larger (e.g. 144 fiber strand) cable to provide fiber services to a single home or business.

SCADA: Supervisory Control and Data Acquisition. Used by the electric utility industry and some other utilities (e.g. water/sewer) to manage their systems.

Symmetric connection: The upload and download bandwidth (speed) is equal. This is important for businesses and for work from home/job from home opportunities.

Virtual Private Network: A VPN creates a private, controlled access link between a user's computer and a corporate or education network in a different location. VPNs are often encrypted to protect company and personal data. VPNs usually require a symmetric connection (equal upload and download speeds) to work properly.