Broadband GAP and Feasibility Report

Cottonwood County, Minnesota

September 19, 2022

Finley Engineering
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EXECUTIVE SUMMARY

Finley Engineering and CCG Consulting submit this Broadband Plan Feasibility Report for Cottonwood County, Minnesota. We've written this report to be an actionable plan for seeking better broadband for the rural residents that don't have good broadband today and who are not on anybody's radar to build faster broadband networks.

This report has been undertaken with the goal of providing the facts that ISPs need to decide to pursue a rural broadband solution. First, Finley Engineering has quantified the cost of building the needed fiber networks – an effort that ISPs will welcome. The report also discusses the amount of grant funding that is needed at various levels of anticipated customer penetration.

This report documents how we undertook the investigation of broadband. There are hundreds of facts included in the report that document our findings, and the accumulation of these facts led us to reach the following conclusions about the state of broadband in the county:

- This is a county with broadband haves and have-nots. The broadband speeds are good in and around Mountain Lake provided by Mediacom. There has been some fiber built by Windomnet, Woodstock Communications, and Southwest Broadband. But there are still 2,135 homes and businesses that suffer from extremely slow broadband that are not slated by any ISP to be upgraded to faster broadband.
- Our financial analysis shows there is a need for significant grant funding to build the networks needed to bring broadband to the rural areas. The amount of needed grant funding looks to be in the range of 75% of the cost of the broadband assets that are needed to bring fiber to everybody. That means it's going to be a challenge for any ISP that wants to build to the unserved and underserved areas of the county.
- The good news is that there is a large amount of federal broadband funding on the way in the $42.5 billion BEAD grants that could be used to fund the needed fiber solution.
- Our analysis focused on building fiber because any broadband solution needs to be built for the future and not just for the needs of today. The requirements for broadband have been growing at a steady rate since the 1980s. OpenVault recently showed that the average broadband usage for a U.S. home has grown from 215 gigabytes per month in the first quarter of 2018 to 536 gigabits at the end of 2021. That growth rate is slightly higher than historical averages due to the pandemic – but not by much. Any broadband network built must be capable of providing the bandwidth needed today and also for the decades to come.

Our first phase of the investigation was market research to understand the availability of broadband in the county today. We interviewed the existing ISPs. We looked at publicly available data that documents prices and broadband availability in the county. Our engineers drove extensively through the county to identify the infrastructure used to provide existing broadband.

We also looked at the county from a wider perspective. For example, the FCC defines broadband as a customer connection that provides speeds of at least 25 Mbps download and 3 Mbps upload. We found that some ISPs have misrepresented the broadband speeds they are providing in the county – the FCC believes that everybody in the county has access to 25/3 Mbps broadband, which we know is not true.

After our investigation, we decided to adopt the broadband map created by the State of Minnesota as an accurate depiction of broadband availability. That map shows that practically all rural residents don't have access to adequate broadband.

The report dives deeper into identifying the broadband gaps in the county. The most obvious gap is the broadband availability gap described above. We also heard from residents who can't afford broadband, meaning the county also has a broadband affordability gap.

The next phase of the assessment quantified the cost of bringing better broadband to the county. Finley Engineering studied all parts of the county that we classify as unserved or underserved, meaning that today's broadband speeds are less than 100/20 Mbps. Finley recommends building a fiber network that can accommodate both passive and active electronics. We expect an ISP building a new network will choose XGS-PON technology that is capable of delivering 10-gigabit symmetrical broadband – but there are other options. We quantified the cost of the needed investments for a fiber network to be around $27.7 million.

Our next step was to create financial forecasts from the perspective of ISPs that might bring better broadband to the rural areas. The purpose of the studies was two-fold. We first wanted to quantify the amount of grant funding needed by an ISP to be successful building a fiber network. We also wanted to kick the tires on the key variables of funding this kind of venture such as the customer penetration rate, the interest rate on debt, and broadband prices. Our goal was to demonstrate to ISPs that there are ways to be successful while building fiber broadband.

We knew before we started that any fiber built in the rural areas would require grant funding. We still don't fully know the rules for the large upcoming BEAD federal grants, but we know the grant program will provide up to 75% of the funding for grant-eligible assets. That happens to be in the same range as what we've calculated will be needed to be successful as an ISP.

Immediately following a summary of the report findings are two sections discussing what the County needs to consider doing next after getting this report. The first section is labeled Strategic Considerations, where we discuss the big issues the County must tackle in deciding to find a broadband solution. As an example, you'll need to consider if you are willing to commit ARPA funding to help lure an ISP partner or partners to build the needed fiber networks. We think the County can play a big role in choosing the ISP partner or partners that you want to serve the rural areas.

We also provide a list of concrete next steps you should consider after digesting this report. That includes identifying the staffing needed this year to pursue a broadband solution, finding and partnering with ISPs to pursue grants, educating elected officials and the public on broadband issues, reviewing local policies that might be a barrier to constructing a broadband network, and tackling the other broadband issues like digital literacy.

FINDINGS

The following are our primary findings:

Existing ISPs. The county has a wide array of ISPs today. CenturyLink, Frontier, Arvig, and Nuvera are the incumbent telephone companies. Mediacom is the only incumbent cable company. There are a few fiber overbuilders in the county, including Windomnet, Southwest Broadband, and Woodstock Communications. There are numerous fixed wireless providers, including MVTV, Lismore Wireless, Rise Broadband, Federated Broadband, and LTD Broadband. Some rural customers are using broadband provided by cellular companies with cellular hotspots or the more recent fixed cellular products. Most rural homes and businesses can buy satellite broadband from Viasat, HughesNet, or Starlink.

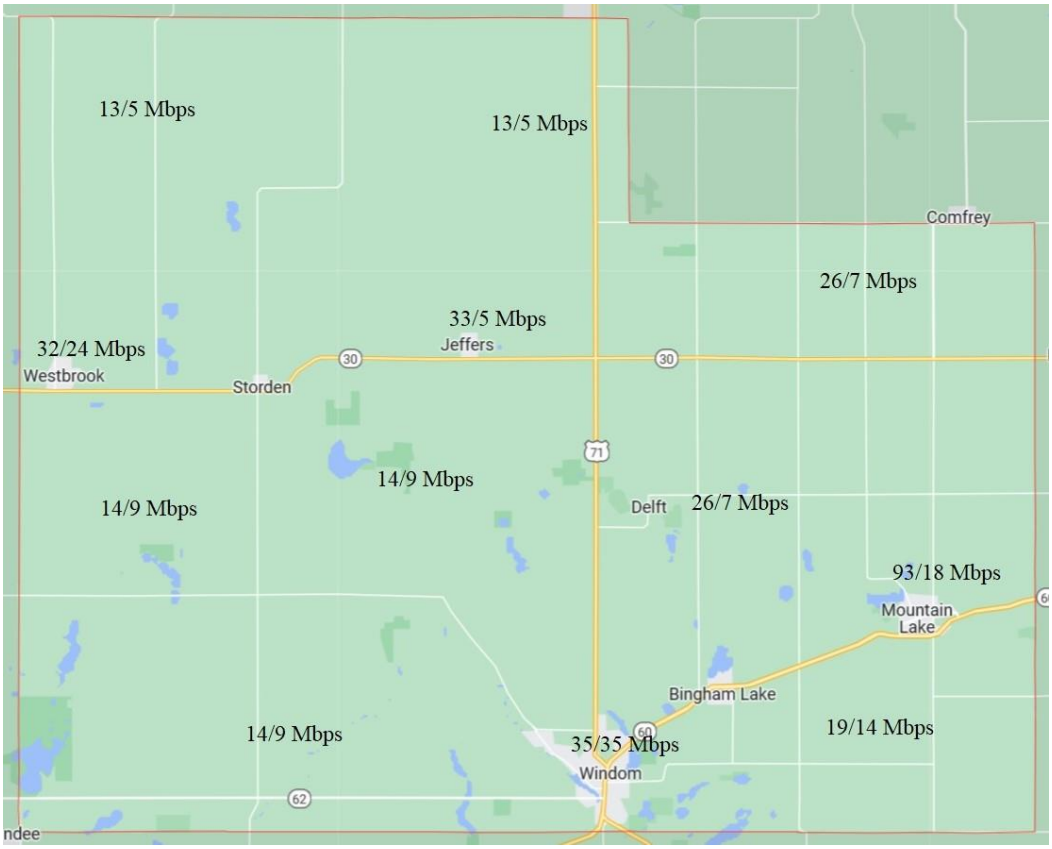
Existing Broadband Prices. As might be expected with so many different ISPs, broadband prices vary widely. Following is a summary of the prices charged by the most commonly used residential ISPs. Note that prices are not always directly comparable since ISPs differ on charges for things like modems. ISPs often offer promotional prices for new customers and sometimes bundle products together. As will be discussed throughout the studies, many of the existing ISPs don't come close to achieving the advertised speeds.

- CenturyLink offers lower rates to new customers that eventually reach prices that start at $47 for 7 Mbps and $72 for 40 Mbps. The fee for the modem varies from $1.95 to $6.95.
- Frontier charges $44.95 for 6/1 Mbps, $54.95 for 12/1 Mbps, and $59.95 for 18/1.5 Mbps. For all products, a modem is $10.
- Arvig prices start at $47 for 5/1 Mbps and climb to $80 for 100/20 Mbps.
- Nuvera Communication's prices start at $50 for up to 30 Mbps and go to $90 for up to 100 Mbps.
- Mediacom offers a 60 Mbps broadband product with data caps – it's $49.99 with a 200 GB cap or $69.99 with a 400 GB cap. Most new customers are offered the standard starting product of $79.99 for 100/10 Mbps and a 1-terabyte data cap. The modem is $10.
- Windomnet prices range from $52 for a symmetrical 12 Mbps connection to $87 for a symmetrical 60 Mbps connection.
- Southwest Broadband charges range from $64.95 for 100/100 Mbps to $109.95 for 1 Gbps on its fiber network. The router is $10.
- Woodstock Communication charges prices for fiber, starting at $39.95 for 25 Mbps to $99.95 for 250 Mbps. Prices for fixed wireless start at $49.95 for 10 Mbps to $79.95 for up to 50 Mbps.
- MVTV Wireless has speeds between 6 Mbps and 50 Mbps and charges $39.95 to $79.95, respectively.
- Lismore Wireless charges $47.95 for 10/2.5 Mbps and $77.95 for 50/10 Mbps for its fixed wireless broadband.
- Rise Broadband charges $42 for 5 Mbps up to $57 for up to 50 Mbps speeds on its fixed wireless networks. Every Rise Broadband plan comes with a 250-gigabyte data cap and charges an additional $5 per 10 gigabytes of data.
- Federated Broadband rates for fixed wireless start at $50 for 6/2 Mbps to $90 for 40/3 Mbps.
- LTD Broadband charges $50 for 6 Mbps up to $110 for 35 Mbps on its fixed wireless network.
- T-Mobile's new fixed cellular plan costs $60 per month for customers that use autopay. Speeds are whatever is delivered, and usage is unlimited. Prices are higher for the 4G hotpots.

- Verizon's new fixed cellular plan costs $55 per month for customers that buy Verizon cellular plans, and $75 for non-subscribers. Speeds are whatever is delivered, and usage is unlimited. Prices are higher for the 4G hotpots.

The Study Areas. The study looks at the cost of bringing to all of the areas of the county that are classified by federal grants and the State of Minnesota as either unserved (speeds below 25/3 Mbps) or underserved (speeds between 25/3 and 100/20 Mbps). This represents 2,138 households and businesses in the rural parts of the county.

Speed Tests. One of the easiest ways to understand broadband speed shortfalls is by using speed tests where customers test the speed of their broadband connection. The following map is a summary of the average results of speed tests taken in different parts of the county collected by Ookla, the most popular speed test site (speetest.net).



Broadband Gaps. Cottonwood County has a significant broadband availability gap, and the county is a story of broadband haves and have-nots. Mountain Lake is served by Mediacom, and a few other places in the county have fiber broadband. But when viewed by geographic area, the vast majority of the county has broadband speeds that are considered unserved or underserved.

Like most places, there are also other broadband gaps, such as an affordability gap, a computer gap, and a computer training gap. The report discusses ways that the County might want to tackle these issues as you also tackle the more important availability gap.

Engineering Analysis. The telecom industry uses the term passing to mean any home or business that is near enough to a network to be considered a potential customer. In the assessment, Finley Engineering counted the following passings that are eligible for broadband grants.

	Speeds	Passings
Unserved	Less than 25/3 Mbps	1,556
Underserved	From 25/3 Mbps to 100/20 Mbps	579
Total		2,135

Fiber Design. Finley Engineering investigated the technology options for bringing broadband and selected a design that can accommodate active or passing fiber technologies. We expect that any ISP build a new network will choose XGS-PON fiber technology which can deliver 10-gigabit broadband speeds to residents and businesses. The network was designed using the following primary assumptions:

- The network was designed to pass every home and business in each scenario.
- After examining the poles in the county, Finley determined that the most cost-effective solution is to bury all fiber construction.
- The network is designed to accommodate future growth.
- We sized the fiber to fit the needs of each route using industry-standard fiber sizes of 12, 24, 48, 72, 144, and 288 fibers.

Asset Costs. Below is a summary of the cost of the needed assets to construct fiber to all unserved and underserved locations. These costs represent connecting 60% of the households and businesses in the study area, and the investments would be higher if more customers were added to the network.

	Study Area
Fiber	$22,733,802
Drops	$ 2,298,079
Electronics	$ 1,308,926
Huts	$ 470,700
Operational Assets	$ 130,273
Total	$26,761,370
Passings	2,135
Cost per Passing	$12,535

We knew when we saw this high cost per passing that any ISP that brings broadband will need grant funding to make a viable business plan. Generally, grants are needed for costs above approximately $3,000 per passing. The need for grant funding is not unusual and rural areas generally require significant grant funding due to the low household density.

Our Approach to the Financial Analysis. Our next task was to create financial projections showing how an ISP might fare if they financed and built the fiber solutions. The purpose of this analysis was twofold. First, we wanted to quantify the amount of grant funding that is needed. Next, we wanted to show that an ISP could be reasonably profitable if it can attract the needed grant funding. We used the following approach in estimating the revenues and costs for operating a new fiber network for each of the three scenarios:

- The financial projections were made on an incremental basis, meaning we only considered new network costs, new operating expenses, and new revenues.
- A base model was created for each operating model. The models assume that a commercial ISP would offer broadband over a new network.
- We arbitrarily chose a market penetration rate of 60% for residents and businesses in the study area. We don't know how many customers a new fiber business might attract, and we picked this penetration rate as a conservative but typical of what we see in other markets.
- The base models assumed financing with loans with a 20-year term.
- We included the engineering cost estimates provided by Finley Engineering, which we believe to be conservatively high.
- All studies include an estimate of future asset costs that are needed to maintain and upgrade the network over time. We've assumed that electronics wear out and need to be replaced periodically during the studied time frame.
- Broadband was priced at a modest discount from the existing market prices. The base fiber price was set at $60. The expectation is that the Internet speeds offered on the fiber network will be significantly faster than what is available on other technologies today.
- The estimates of operating expenses represent our best estimate of the actual cost of operating the fiber business and are not conservative. Most operating expenses are adjusted for inflation at 2.5% per year.

Key Financial Results. The assumptions used in creating the various financial forecasts are included in Section III.B of the report. The results of the financial analysis are included in Section III.C of the report. A summary of the financial results is included in Exhibit II. Following are the key financial findings of our analysis.

All Scenarios Require Substantial Grant Funding. We expected when we started the assessment that grant funding would be required to help fund fiber to rural parts of the county. Our analysis allowed us to quantify the amount of grant needed. It turns out that the amount of grants required varies depending upon the expected customer penetration rate. The following tables represent the breakeven grant scenarios for a commercial ISP. Breakeven means an ISP would need to get the grants shown in order for the business to always be cash-positive. ISPs are not interested in operating a market that never generates any profit, so the actual amounts or grants needed by an ISP would be higher than these breakeven amounts - with the difference determined by the profitability goals of a given ISP.

	Penetration Rate	Assets Needed	Grant Needed	Grant Percent of Assets
Full Study Area	50%	$26.3 M	$22.8 M	87%
	55%	$26.6 M	$21.8 M	82%
	60%	$26.9 M	$21.0 M	78%
	65%	$27.2 M	$20.1 M	74%
	70%	$27.5 M	$19.2 M	70%

We make the following observations about the financial analysis:

- Our primary finding is that the amount of needed grant funding is high and is going to create a challenge for ISPs. There are federal grants that might be able to fund up to 75% of the assets in rural areas. These tables show that the needed grants are higher than 75% unless the network

achieves at least a 65% penetration rate. ISPs are probably going to want additional grant funding from the state or the county.

There are provisions in the upcoming BEAD grants where ISPs can win grants greater than 75%, but there are penalties for asking for more than a 75% grant that is probably going to make it challenging to get the higher grant funding.

- The fiber business is sensitive to other key variables. While customer penetration rate seems to be the most important variable, all scenarios are sensitive to other key variables like interest rates, loan terms, and prices. The report quantifies and describes these impacts.
- Other operating models don't look easily feasible. We looked at both open-access and public-private partnerships. These scenarios don't look to be able to generate enough cash to satisfy both the needs of the County and also an ISP.

Funding Options. As mentioned above, any broadband expansion into rural areas will require substantial grant funding. The most likely grant funding is going to come from various federal broadband grants. There are several substantial grant programs already underway, with a few more opportunities coming later this year. The biggest upcoming grant is the BEAD grant program that will distribute $42.5 billion through states to build broadband infrastructure. There are numerous smaller grant programs that support a wide range of stakeholders like schools, libraries, electric companies, and others.

One of the more interesting upcoming grants will provide $2.5 billion in grants to tackle digital literacy and to get more computers into households.

Finding an ISP Partner. Section IV.A. of the report discusses the process for identifying and creating partnerships with ISPs to bring better broadband.

Community Engagement Plan. Section IV.B discusses how other communities have engaged the public in working towards finding broadband solutions.

STRATEGIC CONSIDERATIONS

The creation of the $42.5 billion BEAD grant program has changed the opportunity of finding grant funding to build broadband for much of rural America. Before the big federal grants, the big challenge for most counties was where to find the money needed to bring broadband. We don't know if the BEAD grant program is large enough to solve the broadband problems in all of rural America, but it's going to solve a significant percentage of the problem.

The focus for communities has shifted the focus from wondering where to find the needed funding to bring broadband to instead positioning the community to be a key player in making sure their area gets broadband funding.

The biggest challenge the County faces is in finding one or more ISP partners willing to pursue the grant funding needed to bring broadband. There are still 2,138 residences and businesses that don't have good broadband, and which are not on any ISP's radar to bring faster broadband. Our hope is that the work we've done in this study gives the County a starting place to make sure that all of these areas get better broadband.

The County can't just sit back and assume that somebody is going to solve your broadband gaps by pursuing grants to build fiber in all of these areas because it's also possible that nobody asks for the funding in some or all of your rural areas. Most of the other counties around you have the same kind of broadband shortfalls, and there may be more opportunities than the local ISPs can reasonably pursue.

There is going to be a lot of interest in the $42.5 billion in grants, and it's likely that the largest telephone companies, large wireless providers, or new ISPs created by venture capitalists to pursue the grants might seek the funding. A lot of counties are leery about the grants going to the big telephone companies. The big telephone companies carry a lot of the blame for the poor condition of broadband in your area. The companies started to abandon rural America starting in the 1980s. They closed local customer service offices. They cut back on technician staff to the point where it is nearly impossible to get a problem fixed. They stopped making any investments in rural areas, so technology came to a standstill at a time when technology everywhere else was being modernized – including rural areas operated by smaller telephone companies and cooperatives.

Communities are also leery about somebody using grant funding to improve broadband. The county already has a plethora of wireless ISPs, and in a few places, there are as many as six different wireless carriers covering the same homes.

Finally, communities are nervous about newly formed ISP pursuing the grant funding. There is no way to know if new ISPs are going to be responsible or reliable. One of the concerns with a new ISP is that it might have a business plan of flipping the business to somebody else in 7-10 years.

By contrast, the smaller telcos in the county are upgrading to fiber. The question that communities are wrestling with is if they should trust big ISPs again. What's to stop the big companies from taking federal grants, building just enough to meet the letter of the law, and then underfunding maintenance going forward and starting the cycle over again? If a new fiber network is not properly maintained, it will begin to show problems in a decade and could become a paperweight in two decades.

The purpose of this discussion is to point out that the County can play a significant role in influencing which ISPs will win the grants to serve the remaining rural areas. For example, if the County partners with an ISP and pledges some ARPA or other money as matching funds, that ISP will be viewed favorably by those making the big federal grant awards. Grant programs encourage and reward local collaboration and local skin in the game.

This is not to say that an ISP partner chosen by the County will be an automatic grant winner. If some large, well-financed ISP promises to serve a seven-county area that includes the county, that big ISP may still win instead of the County and your chosen partner. But we think it's likely that the County and a strong ISP partner will have a strong case for winning grant funding.

We think your biggest strategic decision to make is if you should take an active role in trying to make sure that all rural areas get better broadband. If the County does nothing, it's possible that an ISP you don't want or a technology you don't want could get funded. Even worse, it's possible that nobody will win grant funding for the county - especially if none were endorsed by the County with a local financial pledge. There are many who think the $42.5 billion is not enough to solve all of the rural broadband needs in the country. If the County doesn't find a broadband solution in the upcoming grants, there might not be another chance for a long time.

The bottom line of this discussion is that the County should strongly consider partnering with one or more ISP partners to pursue grant funding. In recommending this, we aren't precluding partnering with a large telephone or cable company – we're just cautioning to go into such a partnership with your eyes wide open. If you don't take an active role, you could end up with an ISP you don't trust, a technology that is not future-proof, or even with no broadband solution. The County's biggest strategic decision might be deciding who to partner with to pursue grants.

The report includes specific recommendations about the best way to create such partnerships. But there are a few other strategic decisions to make before moving forward to find ISP partner(s).

Is the County Willing to Help Fund a Solution?

As the discussion above highlighted, we believe that communities that put skin in the game will have a higher chance of attracting grant funding than those that don't. This boils down to being willing to invest in a broadband solution.

Our analysis shows that bankers are likely to require significant equity from any ISP seeking the BEAD grants. Those awards are capped at 75%, and the ISPs will have to pay a minimum of 25% of the cost of any grant project, probably more. That's still a large investment to make in a rural market, and we're seeing ISPs favor projects where the local governments help to offset some of that cost.

One role that the County can play is to bring some matching funds to make it easier for an ISP to be successful. There are a lot of other demands on ARPA funding, but we think you should consider setting aside some of that funding to help find a broadband solution you like. Funding doesn't only have to come from ARPA monies. Around the country, we are seeing rural counties that are willing to float small bond issues or use tax revenues as matching funds to attract a broadband solution.

What Are You Willing to Tackle?

There are a lot of different ways for the County to get involved. Not only is there an opportunity to build rural broadband infrastructure, but there is an opportunity to find grant funding for digital inclusion that might include such efforts as getting computers into homes, making sure residents take advantage of broadband subsidies, funding training classes in digital literacy, or workforce development by establishing programs to train fiber technicians.

This is all a lot to tackle, and one of the earliest strategic discussions is to have a frank discussion of what the County and other local stakeholders are realistically willing and able to tackle. The County's role might be as simple as finding a local non-profit willing to tackle the effort and working with them to secure the grant funding to pay for it.

RECOMMENDED NEXT STEPS

The section above discussed the big strategic decisions that must be made - the County needs to decide how you want to move forward. Once you've made that decision, this section discusses specific steps that we think you'll want to consider. You might want to undertake some of these steps concurrently with wrestling with the strategic issues.

Who Will Tackle the Next Steps?

One of the first things to consider after getting this public is to determine who specifically needs to get involved in the next steps. We've seen many efforts to get better broadband that fizzled when nobody was dedicated to taking the needed steps. We've seen the following ways that communities have identified the needed resources.

- Dedicate Staff. The communities that have done this the best have dedicated at least one staff person to concentrate on community engagement. The biggest challenge in doing this is usually finding the funding. A lot of communities are funding this effort this year through the ARPA funding. The staff could come from many different places, from existing county staff, from economic development staff, or a new hire.

  The person undertaking this task needs to be a big believer and advocate of broadband for it to be successful. This is not a permanent position, but rather somebody dedicated to this effort for some fixed time. This is also not a 9 to 5 job with a lot of demands placed on evenings and weekends.

  We worked with a county in Minnesota that found a broadband solution because the mayor of one of the smallest towns in the county told his economic development director that getting broadband was his top priority. This one person met with everybody imaginable in the county, including city governments, county governments, state representatives, and every civic and social group imaginable. After two years of tireless effort, the county found a broadband solution. This would never have happened without this one dedicated staff position.
- Volunteers. Volunteers are also an important part of this effort. It might be possible to recruit volunteers to help this year. There are typically people living in areas with no broadband who are willing to volunteer to help find a solution. In the example given above of the Minnesota county, the staffer assembled a group of active volunteers who helped with the effort to engage the public. These folks created email lists, went canvassing house-to-house talking about the need for broadband, and showed up at every government meeting to stress that they wanted a broadband solution. It's important that any volunteer effort have some structure and working with a staff person can make sure such a group stays focused. The County needs to be prepared to fund efforts that the volunteers think are needed. In the case of the Minnesota county, the volunteers engaged in several rounds of postcard mailings asking homeowners to pledge support for broadband.
- ISPs. Any ISP partners will do most of the technical and grant preparation work, but they are going to be of little help for the community side of the effort.

Reach out to Potential ISP Partners

One of the primary purposes of this study was to gather the facts needed by ISPs to tackle rural broadband. This report does several things for any potential ISP partner:

- The study quantifies the cost of building a new fiber network. The engineering was also done in such a way that Finley Engineering can supply an ISP with a subset of the costs if an ISP only wants to tackle bringing broadband to a portion of the county.
- We've demonstrated the financial viability of an ISP being able to make a viable business case in several ways. For example, this study estimates broadband revenues. It wouldn't be hard for an ISP that has different rates than the ones assumed in our analysis to update our estimate for their purposes. We've also quantified the amount of grant funding that we think is needed to make this work. An ISP can now look at the potential grant funding and decide if that creates a viable business plan.
- We've made some high-level estimates of customer penetration rates based on our experience working in other similar rural areas.

We think one of your first steps should be to reach out to potential ISP partners. That begins by sharing the results of this report with local ISPs. We warn that you must be careful in interpreting the reactions of ISPs. Most ISPs will say they are interested in looking at grants. What some of them won't tell you is that they are only interested if they can find almost all of the needed funds through grants. Your challenge will be to find out if any local ISPs are really interested. As mentioned elsewhere in the report, the biggest barrier for most ISPs is the ability to raise the needed matching funds.

If there are no local ISPs interested, you should widen the search. This is discussed in more detail in Section IV.A. of the report. This is also the time to start seriously thinking of alternate plans, such as the County funding the network and partnering with an ISP to operate it.

You also might find that no single ISP is willing to tackle the entire rural areas of the county. There might be different ISPs interested in different geographic areas. You'll have to be flexible because that might mean working to support multiple grant applications.

Educate the Public

The surveys and interviews indicate a lot of interest from the general public in getting better broadband. You should determine the best way to inform the public of the results of this report and begin gathering support for moving towards a broadband solution. One important aspect of community engagement is to provide useful information to the public to help them better understand broadband issues. It also means providing basic information that explains broadband in ways the public can understand. We've seen communities tackle public education in some of the following ways.

- Publish This Feasibility Report. While not a lot of people will wade the whole way through a report of this size, it has been written for the layperson.
- Hold Public Meetings. Meetings can be held to explain the results of this report, or meetings could be more generic and be aimed at explaining the broadband issues. It's worthwhile to have elected officials at public meetings to directly hear the kinds of issues that households have due to the lack of broadband. It's vital to advertise heavily to drive attendance at meetings – even if they are virtual.
- Broadband Website.[1] Many communities that are looking for broadband solutions create a broadband web page. Such a page can be used to educate as well as inform. For example, a

[1] Here is a good example of a community broadband website. https://falmouthnet.org/

common educational feature is to have a lengthy section with responses to "Frequently Asked Questions." It's important that if you create a broadband website that it is kept current. You want the public to think of this site as a resource.

- Gather a List of Broadband Proponents. One valuable tool is to create a database of local broadband proponents – citizens who say they support fiber. Having a list of emails, home addresses, and phone numbers can be useful when you want to ask for public support for specific tasks or want to notify people of upcoming meetings.
- Broadband Newsletter. Cities often create a newsletter dedicated to broadband. These newsletters are aimed at educating the public on topics related to broadband and also keeping the public informed on the progress of the effort to get better broadband.
- Outreach Meetings. One of the most successful ways to reach the public is what CCG calls outreach. This means sending a spokesperson to meetings of local organizations to talk about better broadband. This can be any sort of group – PTAs, church groups, service organizations, youth groups, etc. Most organizations will allow time for a short presentation. It's vital to have a prepared presentation to get across whatever message you want the public to know. These outreach meetings are best done by those who are strong broadband proponents – this could be one of the tasks assigned to a Broadband Task Force or given to willing volunteers.

Review Local Policies Related to Fiber Construction

One factor that always worries ISPs is that there will be local rules, ordinances, and processes that will slow down the construction process and add cost to the fiber construction process. The County should coordinate a review of the following kinds of policies to see if there are ways to be friendlier to ISPs. Changing these processes might require new ordinances or new internal procedures. Local governments need to remember that any changes made to accommodate a new ISP should also apply to the incumbent ISPs operating in the county. Some of the areas that should be investigated include:

- Granting rights-of-ways to construct a network.
- Issuing permits to construct a network.
- Locating existing underground utilities where fiber is to be buried.
- Inspecting and approving that construction is following the permits.
- Requiring things like traffic control during the construction process.
- Requiring other kinds of agreements like franchise agreements or rights-of-way agreements.
- Requiring records of what's been constructed.

It's possible that the rules are the same everywhere, but they also might differ around the county. The goal would be to eliminate rules that would hinder fiber construction.

Tackle the Other Broadband Gaps

Section I.C. of the report discusses ways to tackle the other broadband gaps, such as the homework gap, the computer ownership gap, and the digital literacy gap.

I. MARKET ANALYSIS

A. Providers, Products, and Price Research

CenturyLink, Frontier, Nuvera Communications, and Arvig are the incumbent telephone companies in the county. The companies are primarily providing DSL broadband over copper wires, although Nuvera Communications has begun converting to fiber. Mediacom is the incumbent cable television provider. There are three fiber overbuilder in the county - Windomnet, Woodstock Telephone Company, and Southwest Minnesota Broadband. Several fixed wireless providers claim coverage in the county, including Federated Broadband, Lismore Wireless, LTD Broadband, Arvig, Rise Broadband, and Woodstock Communications. Some rural customers use broadband provided by cellular companies with cellular hotspots or the newer fixed cellular products. Most rural homes and businesses can buy satellite broadband from Viasat, HughesNet, or Starlink.

Following is an analysis of the prices being charged in Cottonwood County today. We know from experience that prices vary widely by customer for many ISPs. Some ISPs include products in bundles that can be unique by customer. Many ISPs have special rates for new customers or customer rates for customers willing to negotiate rates. Some customers are grandfathered into old rates and old products that don't change for as long as they keep the original product. The wide variance in rates charged in the community means there is no longer anything that can be considered a "standard" price in the market. Nevertheless, it's important before considering the viability of a new ISP to understand the base prices in the market today.

Incumbent Telephone Companies

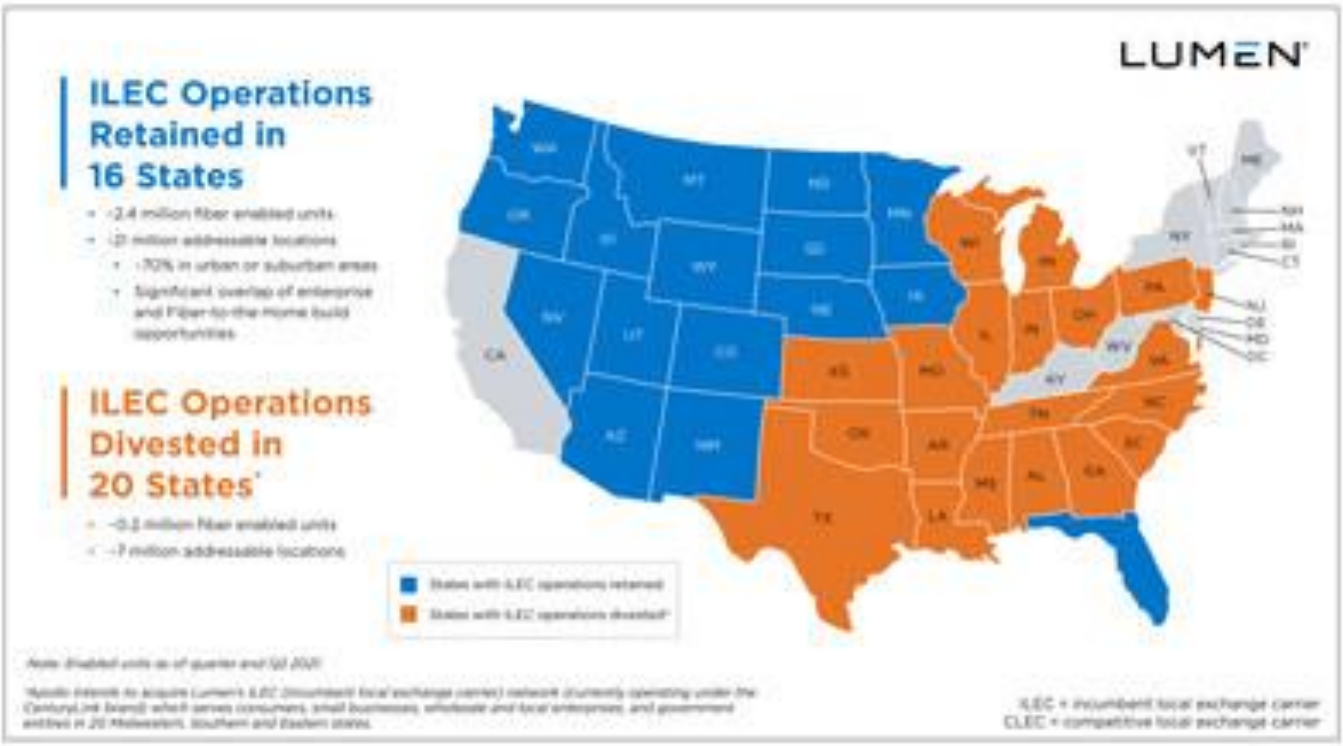
CenturyLink[2] is the third-largest telephone company in the country with headquarters in Monroe, Louisiana. The company became large after purchasing Qwest, which was formerly Mountain Bell and US West, and was part of the Bell Telephone system. At the end of the second quarter of 2022, the company had 4,377,000 broadband customers. The company bundles with DirecTV for cable service.

As the incumbent provider, CenturyLink is considered the "provider of last resort" in its service areas. This means that CenturyLink is required to offer service to all residential and business customers.

In recent years CenturyLink invested significant capital in improving broadband speeds in metropolitan areas. For example, in 2016, the company constructed fiber to pass 900,000 homes in major markets like Seattle, Phoenix, Denver, and Minneapolis. Since then, the company merged with Level 3 Communications, and the new CEO announced that the company would not be making any future investment in assets with "infrastructure returns," meaning it's not going to build new fiber to residential customers and is probably not going to invest any more money in its copper networks. However, since that time, the company is again building small amounts of fiber each year, predominantly to reach businesses and large apartments. The company announced plans to build fiber in 2021 and 2022 to pass 400,000 homes and businesses.

[2] https://www.centurylink.com/

The big news for CenturyLink is that it sold its copper business in twenty states to Apollo Global Management, a private equity firm. The sale is for $7.5 billion for what is described as seven million passings. All but 200,000 fiber passings are served by telephone copper. While the Minnesota property is not being sold, this is likely to have a significant impact on CenturyLink.



CenturyLink DSL

CenturyLink sells high-speed broadband using DSL technology. They sell both a bundled DSL product, meaning that you purchase it along with a telephone line, and also a "Pure" product, meaning a customer can buy just DSL (most of the industry refers to this as naked DSL). As discussed above, CenturyLink offers a lot of specials, with special rates available on their website for new customers. But as typical with most big ISPs, a subscriber's broadband pricing reverts to the list price at the end of the promotion period. Following are the base list prices for residential DSL. Note that the quoted speeds offered by CenturyLink DSL are best-effort speeds, meaning they are not guaranteed. Rural customers typically get speeds significantly slower than the advertised speeds.

Residential DSL

Pure DSL is CenturyLink's name for a DSL line that can be purchased without a mandatory bundle with a telephone line or DirecTV. There is a low price for the first year, a higher price for the second year, and starting the third year, the customer pays the list price:

	1st Year	2nd Year	List
1.5 Mbps download, 896 Kbps upload	$30.00	$40.00	$42.00
7 Mbps download, 896 Kbps upload	$35.00	$45.00	$47.00
12 Mbps download, 896 Kbps upload	$40.00	$50.00	$52.00
20 Mbps download, 896 Kbps upload	$50.00	$60.00	$62.00
40 Mbps download, 896 Kbps upload	$60.00	$70.00	$72.00

Pure DSL also requires a DSL modem. The charge for this seems to be negotiated and ranges from $1.95 to $6.95.

CenturyLink Business DSL

CenturyLink no longer publishes business DSL prices. There are no prices on the website and no prices listed in any of their sales literature or tariffs. CenturyLink will negotiate a price with a business customer based on both how many other products they purchase as well as how long they are willing to sign a contract.

When CenturyLink last published rates, their slowest business DSL ranged from $40.00 per month for a 3-year contract up to $62.50 for a month-to-month product and no contract commitment. But today, each customer will negotiate with a salesperson, and rates charged in the market are all over the board for the same product.

Telephone Rates

CenturyLink's telephone rates were as follows when last tariffed. This does not mean that these are the rates any longer, and with a de-tariffed rate, CenturyLink can charge whatever it wants, within reason.

	Monthly
Flat Rate Residential Phone Line	$18 - $22
Flat Rate Business Telephone Line	$42 - $45
Business PBX Trunk Lines	$45 - $51

These rates do not include the Subscriber Line Charge, which is currently $6.50 for both a business and a residential line and would be added to the above rates. The rates also do not include the Access Recovery Fee (ARC), which is an FCC fee that is currently capped at $1 per month, and CenturyLink could be charging any amount up to and including the $1 rate.

CenturyLink telephone line prices don't include any features. These features are either sold individually or are sold in bundles and packages. Some of the most commonly purchased features are call waiting, 3-way calling, voice mail, and caller ID. CenturyLink offers dozens of residential features, which range in price from $2.95 to $8.50 per feature. These products are also now de-tariffed, and CenturyLink can charge whatever it likes for these products.

Frontier Communications[3] is the fifth largest telephone company in the U.S. The company changed its name from Citizens Communications Company in 2008. Frontier Communications has grown through acquisitions. For instance, in 2015, it agreed to buy 2.2 million customers from Verizon in Florida, Texas, and California. The company spent $8.5 billion to buy a huge pile of customers from Verizon in 2009, and in 2013 bought the Connecticut operations of Verizon. As of the end of the second quarter of 2022, the company had 2.8 million broadband customers.

Frontier has struggled financially in recent years and emerged from bankruptcy protection a year ago. The company announced it reached 1 million fiber passings in the first quarter of 2022 and said it plans to continue to aggressively build fiber to reach 10 million passings by 2025. In 2020 the company sold its properties in Washington, Oregon, Idaho, and Montana to WaveDivision Capital for $1.35 billion.

Frontier is an incumbent telephone provider and is considered a provider of last resort, meaning they must make reasonable efforts to try to provide telephone service to somebody within their defined service area.

Frontier DSL. Frontier offers broadband with DSL served on copper lines.

	Speed	Price
Frontier Internet	Fastest Speed Available	$ 54.99

All products also get assessed a $1.99 Internet Infrastructure Surcharge. This is not a tax and is part of the price of the product.

Frontier Fiber. Frontiers now offers fiber in select markets.

Frontier Fiber Optic	500/500 Mbps	$ 54.99
Frontier Gig	1000/1000 Mbps	$ 79.99
Frontier 2 Gig	2000/2000 Mbps	$154.99

Telephone Rates

Frontier's telephone rates are still tariffed. However, like other telcos in the state, the rates have been deregulated. Frontier offers cable TV in rural areas through bundles with Dish Network.

	Monthly
Basic Calling	$ 15.50
Community Plus	$ 22.00
Frequent Caller	$ 29.00
Call Detail	$ 2.00

Frontier charges by the minute for long-distance. This means that free calling is generally only available to those living close to the serving area, while there is an extra fee to call anywhere else.

[3] https://frontier.com/

For all telephone lines, Frontier charges an additional $6.50 for Subscriber Line Charge and up to $1 for an Access Recovery Charge (ARC). There has been a proposal at the FCC to abolish the Subscriber Line Charge, in which case Frontier's rates would likely drop by $6.50

Frontier offers a dizzying array of other telephone services. This tariff lists all of the deregulated rates and includes long-distance, features, and a wide variety of business telephone services.

Nuvera Communications[4] is an incumbent telephone company that was founded in 1905 and is headquartered in New Ulm, Minnesota. In 1986, Nuvera entered Cottonwood County with the purchase of the Western Telephone Company. Nuvera has recently invested $250 million across the company to upgrade many of its service areas to fiber. In Cottonwood County, Nuvera operates a DSL network in the northeastern part of the county, which will be converted to fiber.

Residential DSL Broadband	
Up to 30 Mbps	$50
Up to 60 Mbps	$70
Router	$ 6.95

Voice	
Basic	$22
Long-Distance	$0.11/per minute

Arvig[5] purchased Redwood County Telephone in 2010 and expanded its service territory into Cottonwood County. Arvig was founded in 1950 and is headquartered in Perham, MN. Arvig has plans to upgrade this area to fiber.

Arvig also provides fixed wireless broadband in the telephone exchange areas and in other parts of the county. Redwood County Telephone reports to the FCC that it provides service everywhere, except in one Census block using its fixed wireless network. The one Census block is served with DSL.

Residential Broadband	
5/1 Mbps	$47
10/1 Mbps	$57
25/3 Mbps	$64
50/10 Mbps	$70
100/20 Mbps	$80
Installation	$99

[4] https://nuvera.net/

[5] https://www.arvig.com/

Cable Companies

Mediacom[6] primarily provides service in Mountain Lake and the surrounding area. The company is a large cable company with corporate headquarters in New York City. They are an interesting company that serves some large markets, like parts of the New York City metropolitan area but mostly serves smaller rural markets. At the end of the second quarter of 2022, the company had 1.46 million broadband customers and 540,000 cable customers.

Residential Broadband		
100/5 Mbps	$ 29.99	200-Gigabyte Data Cap
200/10 Mbps	$ 79.99	1-Terabyte Data Cap
400/30 Mbps	$ 99.99	2-Terabyte Data Cap
1 GB/ 50 Mbps	$129.99	6-Terabyte Data Cap
Modem w/WiFi	$ 13.00	
Installation	$109.99	

Television	
Local TV	$ 40.00
Essential TV	$ 80.00
Variety TV	$100.00
HBO + HBO Max	$ 18.95
Showtime	$ 14.95
Cinemax	$ 12.95
Starz/Encore	$ 12.00
International Channels	$ 9.99 each
Settop Box	$ 10.50
TiVo DVR Box	$ 14.95

Telephone Rates: Mediacom offers a phone line with unlimited long-distance calling and 17 features.

Standalone Telephone	$49.95
Bundled with one other product	$39.95
Bundled with TV and Broadband	$29.95
Voicemail	$ 4.95
Sells Long-Distance Packages at	$0.05 per minute

Hidden Fees

Mediacom has some significant hidden fees in its rates. A hidden fee is something that big ISPs charge to customers but do not advertise. Customers often only find out about hidden fees when getting the first bill for service. Consider the following:

- The broadcast fee is $24.59 per month. This is a fee where Mediacom has accumulated increases in programming costs into this side fee rather than raise the basic price of cable. When Mediacom advertises cable prices, it only lists the basic fees that don't include this hidden fee.

[6] https://mediacomcable.com/

- The regional sports fee is $8.81 per month – the fee varies by market depending upon the local sports networks that Mediacom carriers. Again, the company has shuttled rate increases into this fee to hold down the advertised price of cable TV.
- Mediacom also charges from $10.50 to $14.95 extra for a settop box – a fee that is not included in the advertised price.
- A first-time customer buying the $40 basic cable product from Mediacom could get the first bill for over $85 – a startling difference.

Mediacom also has what most in the industry consider as hidden fees for broadband. The company charges $13 per month for a WiFi modem. The biggest surprise a broadband customer might see is the Mediacom data cap on the 100 Mbps product. The company charges $10 for every extra 50 gigabytes of data used in excess of the 200-gigabyte data cap each month.

Fiber Overbuilders

Windomnet[7] is the brand name for the municipal ISP owned by the City of Windom. Windomnet provides video, voice, and broadband services.

Residential Broadband		
Starter Lite	12 Mbps	$52
Starter	15 Mbps	$67
Starter Plus	20 Mbps	$67
Deluxe	30 Mbps	$77
Premium	60 Mbps	$87

All speeds provided by Windomnet are symmetrical.

Voice	
All In Voice - unlimited long-distance	$30

Video		
Basic Video	20+ Channels	$ 48
Expanded Basic Video	70+ Channels	$ 93
Digital Basic Video	160+ Channels	$108

Woodstock Communications[8] is the brand name for Woodstock Telephone Company. Woodstock Communications serves customers with both fiber and fixed wireless in the county. Woodstock has served rural families in southwest Minnesota for more than 70 years.

Woodstock Communications provides fiber in the city of Westbrook. The company sells fixed wireless in the western part of the county.

[7] https://www.windomnet.com/

[8] https://www.woodstocktel.net/

Residential Fixed Wireless	
10 Mbps	$ 49.95
25 Mbps	$ 59.95
50 Mbps	$ 79.95

Residential Fiber	
25 Mbps	$ 39.95
50 Mbps	$ 49.95
100 Mbps	$ 69.95
250 Mbps	$ 99.95
500 Mbps	$129.95

Voice	
Basic	$ 18.00

Southwest Broadband[9] is the brand name for Southwest Minnesota Broadband Services (SMBS). Southwest Broadband is a fiber provider that is headquartered in Lakefield, MN. The company was formed by several municipalities joining together to get faster broadband.

Southwest Broadband offers internet-based video, voice, and broadband services. In Cottonwood County, Southwest Broadband provides service in the southeastern portion of the county.

Residential Broadband	
100/100 Mbps	$ 64.95
250/250 Mbps	$ 84.95
500/500 Mbps	$ 94.95
1000/1000 Mbps	$109.95
Router	$ 10.00

Voice	
Basic	$14.95
Voicemail	$ 3.50
Caller ID	$ 3.00
Long Distance	$0.10/minute

There are dozens of different add-ons for voice customers.

WISPs (Wireless ISPs)

WISPs provide broadband using radios on towers that beam signals to residents and businesses.

Federated Broadband[10] is a fixed wireless provider headquartered in Jackson, MN. This is a new company formed in January 2022 when Federated Rural Electric Association purchased Back40 Wireless.

[9] https://www.mysmbs.com/

[10] https://www.back40wireless.com/

The company operates a wireless network in Jackson, Cottonwood, Nobles, Martin, Murray, and Brown counties in Minnesota and Osceola, Dickinson, and Emmet counties in Iowa.

In Cottonwood County, Federated Broadband claims to provide service to most of the county.

Residential Fixed Wireless	
6/2 Mbps	$ 50
15/2 Mbps	$ 70
25/3 Mbps	$ 80
40/3 Mbps	$ 90
Installation	$150
Router	$ 10

Lismore Wireless[11] is the fixed wireless brand name of Lismore Cooperative Telephone Company. Lismore Wireless provides fixed wireless broadband outside of Lismore's historical telephone exchanges. Lismore Cooperative Telephone Company was founded in 1907 and is headquartered in Lismore, Minnesota. The company provides broadband and telephone services. Lismore is currently upgrading its historic telephone exchanges to fiber. In Cottonwood County, Lismore Wireless provides service in the southwest corner.

Residential Broadband	
Up to 10/2.5 Mbps	$47.95
Up to 25/5 Mbps	$57.95
Up to 50/10 Mbps	$77.95
Installation	$79.95
Router	$ 5.00
Voice	
Basic	$19.99

LTD Broadband LLC[12] is a fixed wireless provider that was founded in 2011. LTD Broadband covers Iowa, Minnesota, Nebraska, South Dakota, and Wisconsin. Currently, LTD Broadband has 2,100 tower sites covering 50,000 square miles. LTD Broadband is the 4th largest fixed-wireless provider in the U.S. Originally LTD partnered with Advantenon to increase its service territory it appears that LTD Broadband has purchased the Advantenon fixed wireless customers. There has been no public announcement about the acquisition, but that is not uncommon.

Residential Internet		
Faster	6 Mbps	$50.00
Family	10 Mbps	$70.00
Ultra	25 Mbps	$80.00
Home Office	35 Mbps	$110.00
Installation	$99.00	

[11] http://www.lismoretel.com/

[12] https://ltdbroadband.com/

All prices above are for 1-year plans. Customers can subscribe for 1, 3, or 6-month plans at additional costs.

Business Internet
Interested customers must contact LTD Broadband for business prices.

MVTV Wireless[13] is the fixed wireless brand name of Minnesota Valley Television Improvement Corporation. The company is a cooperative founded in 1999. MVTV Wireless operates 25,000 square miles of Southwestern and Central Minnesota and parts of South Dakota and Iowa. In Cottonwood County, MVTV Wireless provides service throughout the county.

Residential Broadband	
Up to 6 Mbps	$ 39.95
Up to 10 Mbps	$ 49.95
Up to 25 Mbps	$ 59.95
Up to 50 Mbps	$ 79.95
Router	$ 10.00
Installation	$114.95

Business Broadband	
Up to 6 Mbps	$ 62.95
Up to 10 Mbps	$ 87.95
Up to 15 Mbps	$112.95
Up to 25 Mbps	$212.95
Up to 35 Mbps	$312.95
Router	$ 10.00
Installation	$164.95

Rise Broadband[14]**.** In 2015, Skybeam, Digis, T6, Prairie Net, and Rhino Communications were rebranded under the Rise Broadband name. Rise Broadband was founded in Englewood, Colorado, in 2005 and provides fixed wireless broadband and VoIP services. The company claims to have coverage throughout the county.

Residential Internet		
Up to 5 Mbps	$42	250-Gigabyte Data Cap
Up to 10 Mbps	$42	250-Gigabyte Data Cap
Up to 15 Mbps	$42	250-Gigabyte Data Cap
Up to 20 Mbps	$47	250-Gigabyte Data Cap
Up to 25 Mbps	$47	250-Gigabyte Data Cap
Up to 50 Mbps	$57	250-Gigabyte Data Cap

Additional data is $5 for 10 Gigabytes.

[13] https://www.mvtvwireless.com/

[14] https://www.risebroadband.com/

Rise Broadband does not charge an installation or modem rental fee.

Telephone
ActivePhone (Broadband phone) $25.00

Cellular Data

Cell Phone Broadband

All three primary cellular companies now advertise unlimited data plans for cell phones. The plans for AT&T and Verizon are not actually unlimited and have monthly data caps in the range of 20 - 25 gigabytes per month of downloaded data. These plans might provide some relief to homes that rely on cell phones for home broadband, although there have been reports of Verizon disconnecting rural customers who use too much data on these plans. These cellphone plans have limits on how much data can be used when tethering from a cell phone to connect to other devices. T-Mobile claims to offer unlimited data but begins throttling customers after 50 GB of data usage in a month.

Most of the country should be seeing cellular coverage over the next few years from Dish Networks. The company's first markets were launched in June 2022.

Hotspots and FWA Broadband.

In recent years, the cellular plan for home broadband have been marketed as hotspots. These plans have data caps similar to traditional cellular plans.

More recently, the cellular companies have introduced fixed cellular plans that use the new spectrum each company is labeling as 5G. These plans are still only available in places where a carrier has upgraded cellular cell sites to use the new spectrum, but also where the new product is available for marketing. It's unlikely today that all of these products are available in the county, but over the next year, these products should be available in some parts of the rural county.

Nationwide, T-Mobile, and Verizon Wireless have been successful with the new FWA product and have gained over 800,000 new broadband customers over the last year.

AT&T has historically offered hotspot plans. More recently, it is offering fixed wireless plans that use the new bands of spectrum labeled as 5G.

4G Hotspots		
15 Gigabytes of data	$35	
100 Gigabytes of data	$55.	
Additional 1 Gigabyte	$10	
5G Fixed Wireless		
25/1 Mbps	$60	350-Gigabyte Data Cap
Additional 50 Gigabytes	$10	

Verizon has historically offered hotspot plans. More recently, it is offering fixed wireless plans that use the new bands of spectrum labeled as 5G.

4G Hotspots	
15 Gigabytes of data	$ 20
50 Gigabytes of data	$ 40
100 Gigabytes of data	$ 90
150 Gigabytes of data	$110

When a customer hits the data cap ceiling, the speeds revert to 3G.

5G Fixed Wireless	
With Verizon cellphone Plan	$55
Standalone	$75
Discount for autopay	$ 5
Unlimited usage	

T-Mobile has historically offered hotspot plans. More recently, it is offering fixed wireless plans that use the new bands of spectrum labeled as 5G. T-Mobile says that it is shooting for 100 Mbps for this product.

4G Hotspots	
5 Gigabytes of data	$20
10 Gigabytes of data	$30
30 Gigabytes of data	$40
50 Gigabytes of data	$50
Discount for autopay	$ 5

Speeds revert to 3G speeds when the cap has been met. The plans include unlimited texting.

5G Fixed Wireless	
Up to 100 Mbps	$65
Discount for autopay	$ 5
Unlimited usage	

Satellite Broadband

There are two geostationary satellite broadband providers available across the county. Both Viasat and HughesNet use satellites parked at a stationary orbit over 22,000 miles above the earth.

There are a few problems that customers consistently report with satellite broadband. Customers complain that satellite costs too much (Viasat claimed in their 2021 financial report that the average residential broadband bill was $93.06). Customers also hate the high latency, which can be 10 to 15 times higher than terrestrial broadband. The latency is due to the time required for the signals to go to and from the satellites parked at over 22,000 miles above earth – that adds time to every round-trip connection to the web. Most real-time web connections, such as using voice-over-IP or connecting to a school or corporate server, prefer latency of less than 100 ms (milliseconds). Satellite broadband has reported latency between 400 ms and 900 ms.

The other customer complaint is about the tiny data caps. As shown in the pricing below, monthly data caps range from 10 gigabytes to 150 gigabytes. To put those data caps into perspective, OpenVault announced recently that the average U.S. home used 514 gigabytes of data per month in the first quarter of 2022. The small data caps on satellite broadband make it impractical to use for a household with school students or for a household that wants to use broadband to work from home.

Viasat (formerly marketed as Exede or Wildblue). Viasat satellite broadband has gotten better over time. The broadband on the ViaSat-1 satellite launched in 2011 was relatively slow, with speeds as fast as 25 Mbps. The company advertises speeds as fast as 100 Mbps download on the ViaSat-2 satellite launched in 2017. The company plans three new ViaSat-3 satellites with even higher capacity, with the first to launch sometime in 2022.

Prices are high compared to other broadband products. The latest pricing from the company is as follows:

	Price	Speed	Data Cap
Unlimited Bronze	$84.99	12 Mbps	40 Gigabytes
Unlimited Silver	$119.99	25 Mbps	60 Gigabytes
Unlimited Gold	$169.99	100 Mbps	100 Gigabytes
Unlimited Platinum	$249.99	100 Mbps	150 Gigabytes
Equipment Fee	$ 12.99		

A customer must sign a 2-year contract to get these prices and pay a fee of $15 per remaining month if a customer breaks the contract. Online reviews say that speeds can be throttled to as slow as 1 Mbps once a customer reaches the monthly data cap.

HughesNet is the oldest satellite provider. They have recently upgraded their satellites and now offer speeds advertised as 25 Mbps download and 3 Mbps upload for all customers. Prices vary according to the size of the monthly data cap. These packages are severely throttled after meeting the data caps. The packages are as follows:

10 Gigabyte Plan	$ 59.99
20 Gigabyte Plan	$ 69.99
30 Gigabyte Plan	$ 99.99
50 Gigabyte Plan	$149.99

Low Orbit Satellite. There has been a lot of recent news concerning the three new low orbit satellite companies that will be offering broadband. Where the older satellite companies park satellites at over 20,000 miles above the earth, these companies are putting satellites between 300 and 600 miles above the earth.

Starlink is owned by Elon Musk. The company is in beta test mode and has been selling broadband across the U.S. for $110 per month, including a $599 one-time fee for the receiver. The company has gotten infamous for having a year-long waiting list of customers that have made a $99 deposit. The company has over 3,000 satellites in orbit but needs 11,000 for the completed first constellation. Starlink download speeds in beta tests have been between 50 Mbps and 150 Mbps.

OneWeb is owned by the British government and various large private investors. The company says it is testing broadband in the far northern hemisphere in early 2022 and plans to cover the world by the end of the year. This might only be made available for governments, cell towers, the military, and large businesses.

Project Kuiper is owned by Jeff Bezos. The company hasn't launched any satellites but has reserved all of the upcoming space launches from several rocket companies starting at the end of 2022 and beyond. The company is being fully funded by Bezos and Amazon and is expected to catch up to the other two providers.

Low-Income Broadband Programs

There are several programs available to subsidize broadband rates for qualified low-income households.

Arvig - Internet Education Assistance Program

Arvig offers a monthly discount of $10 per month for some residential customers. To qualify for the plan, a customer must have a K-12 student, provide proof of participation in the National School Lunch Program, and agree to pay their bill with AutoPay.

Mediacom (Connect 2 Compete)

Mediacom has a low-income program called Connect 2 Compete that provides broadband to qualifying households. The program offers speeds of 25 Mbps and a free modem. Mediacom provides Connect 2 Compete for $9.95 per month.

Qualifying households must have at least one student in grades K-12 living at home and at least one child who qualifies for free or reduced-price school lunch through the National School Lunch Program (NSLP).

MVTV Wireless – Broadband Assistance Program

MVTV Wireless partnered with United Way of West Central Minnesota to offer low-income broadband with speeds up to 10 Mbps with unlimited data for $29.95 per month. There is a one-time cost of $89.95 for installation, setup, and membership.

Qualifying households must have income at or below 135% of the Federal Poverty Guidelines or participate in SNAP, Medicaid, Lifeline programs, or free and reduced-price school lunch programs.

Federal Lifeline Program

Arvig, CenturyLink, Frontier, Lismore Cooperative Telephone Company (Lismore Wireless), Rise Broadband, and Southwest Broadband participate in the FCC Lifeline program that is a part of the Universal Service Fund. With the program, a customer can receive a discount in Minnesota of $9.25 per month off a telephone bill or a broadband bill for qualifying customers. The program works by the telephone companies providing a discount to customers, and the FCC then reimburses the companies for

the discount. This means it costs the telephone companies nothing to offer the discount – the discount is funded by the FCC.

To qualify, a customer must participate in one of the following programs: Medicare, SNAP (formerly Food Stamps), SSI, Federal Section 8 housing, VA Veterans pension, or VA survivor's pension. The FCC has recently established a web portal where participating carriers can check the eligibility monthly of households to meet one of the above tests.

The telephone companies don't tend to aggressively pursue giving this discount to eligible households – but they will enroll anybody that qualifies and who asks for the discount.

Affordable Connectivity Program

This is a new federal program that was created by $14.5 billion in funding from the Infrastructure Investment and Jobs Bill. The program starts in early 2022 and provides a $30 monthly discount on broadband bills for homes that make up to 200% of the federal definition of poverty. To put that into perspective, in 2021, that would equate to a household of three making less than $44,000 per year.

One of the principles in the new plan is that ISPs must allow households to apply the $30 discount to any broadband product at the same price and terms available to other customers. The new rules have a direct rebuke of Verizon and a few other ISPs and prohibit upselling - forcing customers to buy a more expensive plan to get the discount. The ACP rules also prohibit requiring customers to sign long-term contracts to get the discount.

There are a few new rules that ISPs are not going to like. An ISP may not require a household to submit to a credit check to get the discount. It also appears that the new rules stop ISPs from disconnecting customers for non-payment until after 90 days.

There is no set ending for the plan, and if not renewed in the future, the program will expire when the $14.2 billion of funding has been spent. The big $42.5 billion federal BEAD grant requires that any grant winners must join this program or have an equivalent discount plan.

Speed Tests

One of the most important aspects of obtaining broadband grants is that the grants are only available in areas where the existing broadband speeds are below par. Speed tests provide a way to judge the quality of broadband in a way that can satisfy those who award broadband grants.

A given speed test is not 100% reliable and doesn't always deliver a true picture of the broadband being delivered to a given address. However, we've found that when speed tests are administered in mass for a whole community, we can gain a good understanding of the overall quality of broadband. Following are a few of the criticisms that ISPs rightfully make about any individual speed test:

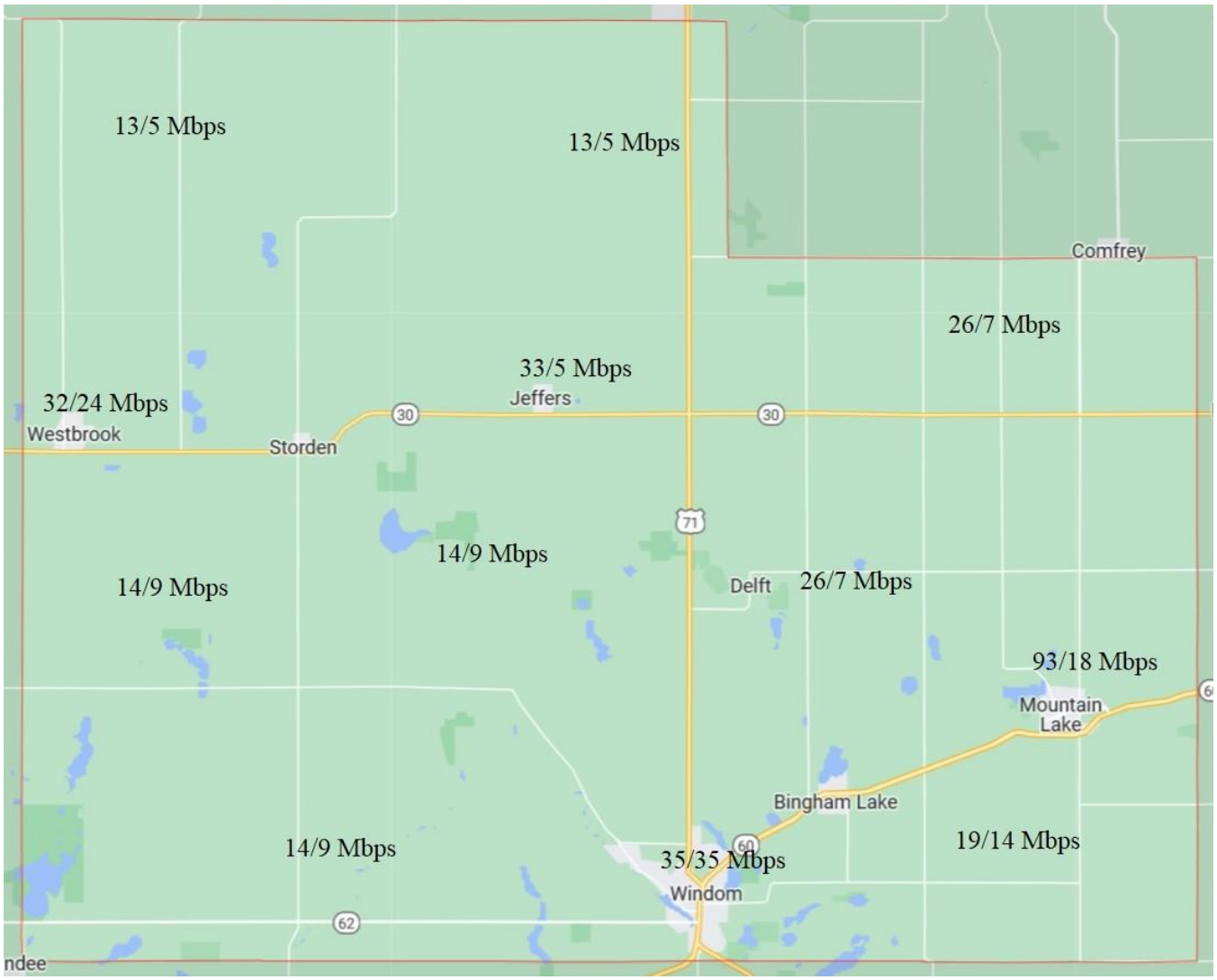
- A speed test only measures the speed of a ping and a short-term connection of less than a minute between a user and the test site router used by the speed test. That doesn't necessarily indicate the speed of every activity on the web, such as downloading files, making a VoIP phone call, or streaming Netflix.

- Every speed test on the market uses a different algorithm to measure speed. As an example, the most common speed tests on the market are from Ookla and M-Labs. The M-Lab test tries to transfer as much data as possible in 10 seconds (both upload and download), using a single connection to an M-Lab server. The Ookla speed test establishes multiple links to the speed test site and averages the results.
- A speed test can be slowed due to network issues within the home, such as problems with a home WiFi router or faulty wire inside a home. A slow speed test doesn't always mean that the ISP was providing a slow connection.
- Broadband speeds vary throughout the day, and anybody that takes multiple speed tests during the same day will see this. Taking only a single speed test might not tell the real story about a given customer.
- Some ISPs use something called "burst" technology. This provides a faster Internet connection for one or two minutes. ISPs know that a large majority of Internet activities are of short duration – things like opening a web page, downloading a file, reading an email, or taking a speed test. The burst technology increases the priority of a customer during the burst window, and the Internet connection then slows down when the temporary burst is over. This raises an interesting question – what's the real Internet speed of a customer that gets 100 Mbps during a 2-minute burst and something slower after the burst – there is no consensus in the industry.

Ookla Speed Tests

One of the best sources of speed test data comes from Ookla, which operates the largest speed test site on the web at speedtest.net. Below are several summaries of speed test results from Ookla. First is a map that distributes the speed tests in different parts of the county. This is followed by tables showing speeds by ISP and speeds by technology.

The following map shows the wide disparity between cities and rural places in the county. The fastest average speeds are in Mountain Lake, with somewhat slower speeds in Windom, Jeffers, and Westbrook. The map shows a drastic drop-off in speeds in the rural parts of the counties, with most download speeds under 20 Mbps and upload speeds of only a few Mbps.



B. The Mapping Story

The easiest way to visualize the current state of broadband in the county is through the mapping of available broadband data. This section of the report will look at publicly available broadband mapping data. As will be discussed below, we know that a lot of the FCC mapping data is inaccurate. CCG Consulting and Finley Engineering have together created maps that we think portray the real current state of broadband in the county.

This section of the report will begin with the broadband data as reported by ISPs to Federal Communications Commission (FCC). In the maps below we will modify the FCC maps to layer on known corrections and updates. Our final map shows the parts of the county that are eligible today for broadband grants.

FCC Definition of Broadband

Any analysis of the availability of broadband begins with broadband data collected by the FCC. The FCC has been tasked by Congress to report every year on the state of broadband in the country. That responsibility has prompted the agency to take two important steps, which will be discussed below. First, the FCC felt compelled to create a definition of broadband to be able to report the number of homes that have or don't have broadband. Second, the FCC began collecting data twice a year from internet service providers (ISPs) that reports on broadband deployment. The FCC requires ISPs to report broadband coverage area and broadband speeds using the Form 477 process. Since the FCC collects broadband statistics by Census blocks, it's relatively easy to translate the FCC database into maps to get a visual understanding of the deployment of broadband.

The following discussion looks at how the FCC gathers broadband data and discusses the specific broadband data for Cottonwood County. We also look at the repercussions for cases where the FCC data is inaccurate.

FCC Definition of Broadband

In 2015, the FCC established the definition of broadband as 25/3 Mbps (that's 25 Mbps download and 3 Mbps upload). Prior to 2015, the definition of broadband was 4/1 Mbps, set a decade earlier. The FCC Chairman Jessica Rosenworcel announced in July 2022 that the agency is going to consider increasing the definition of broadband to 100/20 Mbps.

The FCC defines broadband in order to meet a legal requirement. Congress established a requirement for the FCC in Section 706 of the FCC governing rules that the agency must annually evaluate broadband availability in the country. Further, the FCC must act if broadband is not being deployed in a timely manner. The FCC reports the state of broadband to Congress every year.[15] In these reports, the FCC compiles data about broadband speeds and availability and offers an opinion on the state of broadband in the country. In every report to date, the FCC has acknowledged that there are broadband gaps of various kinds, but the FCC has never determined that the problems are so bad that they need to take extraordinary measures to close any broadband gaps. Most recent FCC reports have acknowledged that there are broadband gaps but claim that the broadband situation is improving due to actions taken by the FCC. As you will see in the following report, the annual reports to Congress are largely fictional and don't describe the state of broadband in places like Cottonwood County.

The FCC didn't use empirical evidence like speed tests in setting the definition of broadband in 2015. It instead conducted what is best described as a thought experiment. The FCC listed the sorts of functions that a "typical" family of four was likely to engage in and then determined that a 25/3 Mbps broadband connection was fast enough to satisfy the typical family.

The FCC asked the question again in 2018 and 2020 if 25/3 Mbps was still an adequate definition of broadband. They took no action and decided that 25/3 Mbps was still a reasonable definition of broadband.

[15] The FCC report to Congress for 2020 can be found at https://docs.fcc.gov/public/attachments/FCC-20-50A1.pdf and https://docs.fcc.gov/public/attachments/FCC-20-50A2.pdf.

There were comments filed by numerous parties in that docket that thought that the definition of broadband should be increased.

The FCC Measures Broadband Speeds

Since the FCC is required by law to state an opinion as to the state of broadband deployment, they collect data from ISPs about broadband that is deployed and sold to customers in the U.S. The FCC collects ISP data using Form 477. The FCC collects data from every landline broadband ISP in the country (they don't require this data from dial-up providers, satellite providers, or cellular companies). The FCC collects the following data twice per year from every ISP (even though we know there are small ISPs that don't participate).

- ISPs report broadband customer counts by Census Block. Those are finite geographic areas defined by the U.S. Census bureau that typically cover between 60 and 120 homes. In a city, a Census Block might be a city block, and in a rural area, it might cover a substantial portion of a county.
- For each Census Block, the ISP reports the fastest speed available to customers.

After the FCC gathers this data from ISPs, they make it available in the form of databases showing the speeds reported by each ISP in every Census Block. The FCC data can be easily mapped by overlaying the data for any ISP or group of ISPs onto a map showing Census blocks. The FCC annual report to Congress has concentrated on the number of homes that can or cannot buy broadband at the 25/3 Mbps definition of broadband.

There is one unfortunate quirk of the FCC data collection process in that the fastest speed available to even one customer in a Census Block is assumed to be available to everybody in the Census block. For example, if an ISP has one customer in the corner of a Census Block who can buy 100 Mbps broadband, then the FCC interprets that result to mean that every customer in that Census Block can get that same 100 Mbps speed.

There are no penalties for ISPs that report fictitious or inaccurate speeds. Many ISPs, particularly rural telcos, have been reporting marketing speeds that are far in excess of actual speeds. As an example, an ISP might advertise DSL as a speed of "up to 30 Mbps" and report the 30 Mbps speed to the FCC. In actual practice, the DSL speeds might be significantly slower than the advertised speed, maybe only a few Mbps. Those two factors – reporting by Census Block and reporting by advertised speeds mean that the FCC's reported broadband speeds are often significantly overstated.

The method of mapping creates some predictable distortions. For example, the availability of broadband is regularly overstated adjacent to towns and cities that have decent broadband speeds. Homes in the areas immediately surrounding a town are often shown as having the same broadband capabilities as the town, even though homes might have no broadband available. This can also happen in rural areas. For example, a big telco might place a DSL cabinet at the opening to a subdivision and provide decent DSL service there. The FCC mapping will show the entire Census Block as having good DSL, even though it is only available inside the subdivision.

The FCC doesn't monitor what is reported and has allowed big reporting errors in the mapping databases. The 2018 Broadband Deployment Report reached the conclusion that the state of rural broadband was improving rapidly. It turns out there was a huge error in the data supporting that FCC report. A new ISP

in New York, Barrier Free, had erroneously reported that it had deployed fiber to 62 million residents in New York. Even after the FCC required the effort to be corrected, the FCC still drew the same conclusion that broadband was getting better, even though the revised report showed millions of fewer homes with good broadband. This raises a question about what defines "reasonable and timely deployment of broadband" if having fiber to 62 million fewer people on broadband doesn't change the answer.

All these factors taken together mean that the FCC broadband databases and maps are generally dismal. Even in towns, the broadband speeds likely represent marketing "up to" speeds instead of actual speeds. Speeds for areas just outside of towns and cities are routinely overstated and often show broadband coverage where there is none. ISPs providing rural DSL or fixed wireless regularly overstate the broadband speeds – these are the two technologies most widely used in rural America and in rural Cottonwood County.

FCC to Revise Maps

Congress passed legislation to require the FCC to fix the maps. In March of 2020, Congress passed S.1822, the Broadband Deployment Accuracy and Technology Availability (DATA) Act. That bill requires the FCC to gather granular service data for wired, fixed wireless, and satellite broadband providers. It requires the FCC to consider using state broadband mapping data where states have tried to create a better picture of broadband. It also requires a crowdsourcing process to allow the public to participate in data collection. The Act provides penalties against ISPs that knowingly or recklessly submit inaccurate mapping data. Finally, the Act requires that all federal agencies begin using the new databases before awarding any major broadband funding.

As often happens in the government, this bill didn't provide any funding to make the needed changes. The FCC started the process of formulating new rules around the Act but didn't take any action to fix the maps due to lack of funding. Congress finally provided $98 million in funding from the American Rescue Plan Act (ARPA) in December 2020, which included $65 million to create better maps. The new updated FCC maps are expected to be issued around November 2022.

The FCC maps have recently taken on extra importance since Congress dictated that the FCC maps would be the basis for deciding what areas are eligible for the $42.5 billion BEAD grant program that will likely launch sometime in 2023.

The new maps are supposed to be more accurate since it requires ISPs to draw polygons around areas that have existing customers or where customers can be connected within ten business days. It's not clear to us that the FCC will fully fix the maps. For example, the FCC is keeping one of the worst features of the old maps, and ISPs can continue to report the fastest advertised broadband speed. This is the primary problem in rural areas today, where the big telcos claim 25/3 Mbps advertised speeds and then deliver a 2 Mbps product.

The revised mapping rules also contain a two-tier challenge process – a challenge by governments or Tribes and a challenge by consumers. The government challenge is complex in that anybody that wants to challenge must draw their own versions of the polygons in an area they are challenging. It will be a huge challenge for governments to gather the huge volume of consumer data needed to make such a challenge. A government might gather a thousand speed tests in a rural city and still be unable to draw an

accurate polygon of the coverage area. We foresee governments undertaking these challenges, but the process looks heavily slanted in favor of ISPs.

The consumer challenges don't have much power. A consumer can challenge that a broadband product is available at their home, and if they win, the carrier simply must redraw the polygon to exclude them. A consumer challenge won't bring better broadband but will clean up the maps. But if a consumer has broadband, they likely can't challenge speeds if the ISPs are justified in reporting advertised speeds instead of actual speeds.

Consequences of Inaccurate FCC Maps

Unfortunately, the speeds reported by the FCC maps have real-life implications. For example, the FCC constantly cites the statistics from the broadband mapping system when developing policies and making decisions that impact rural broadband. The FCC is fully aware of the inadequacies of the mapping data and yet still cites its faulty data as proof that broadband isn't as bad in rural America as critics might suggest.

Probably the biggest impact of poor FCC mapping is that the FCC maps are used to define where federal broadband grants can or cannot be awarded. Areas with overstated speeds in the FCC maps can be excluded from being eligible for federal grant money. In Cottonwood County, we think that some of the speeds claimed by CenturyLink, Frontier, and several of the wireless ISPs are overstated. We also think the FCC maps exaggerate the Southwest Broadband, Windomnet, and Mediacom coverage areas and exclude homes that are close to the cities from being eligible for grant funding.

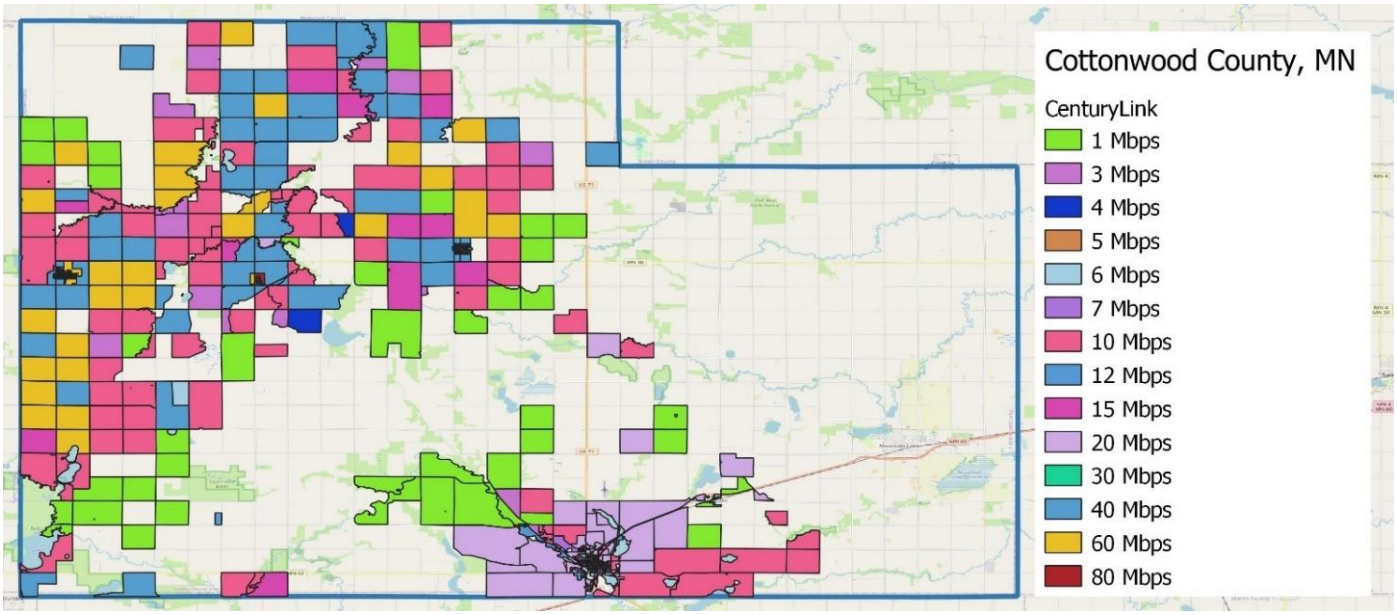
FCC Data for the ISPs in Cottonwood County

Even with the many faults, there is still some good information in the FCC broadband data. If nothing else, the FCC 477 maps are a starting point for trying to define the ISPs that serve any given area and claimed speeds.

CenturyLink. CenturyLink is the incumbent telephone company for most of central and eastern Cottonwood County. The following map is a great example of how telephone companies can report a wide range of speeds for DSL. CenturyLink is reporting 14 different download speeds in different parts of the county, ranging from 1 Mbps to 80 Mbps.

- CenturyLink has two options for providing DSL. Older DSL uses one copper pair and delivers speeds under 25 Mbps download even under ideal conditions. The speed bands showing speeds under 25 Mbps or less are deploying one copper pair DSL. CenturyLink is reporting speeds of 1 Mbps, 3 Mbps, 4 Mbps, 5 Mbps, 6 Mbps, 7 Mbps, 10 Mbps, 12 Mbps, 15 Mbps, and 20 Mbps.
- CenturyLink also deploys DSL using two copper pairs, which effectively doubles the speed. The maximum speed available with this technology is 48 Mbps download.
- CenturyLink shows some speeds faster than 48 Mbps – with Census blocks reported as offering 60 Mbps and 80 Mbps. It's likely that these speeds represent some customers with fiber. Again, due to the rules for reporting speeds to the FCC, CenturyLink might be serving only one business customer with fiber in a Census block, which would show the whole Census block as fiber-capable in the FCC reporting.

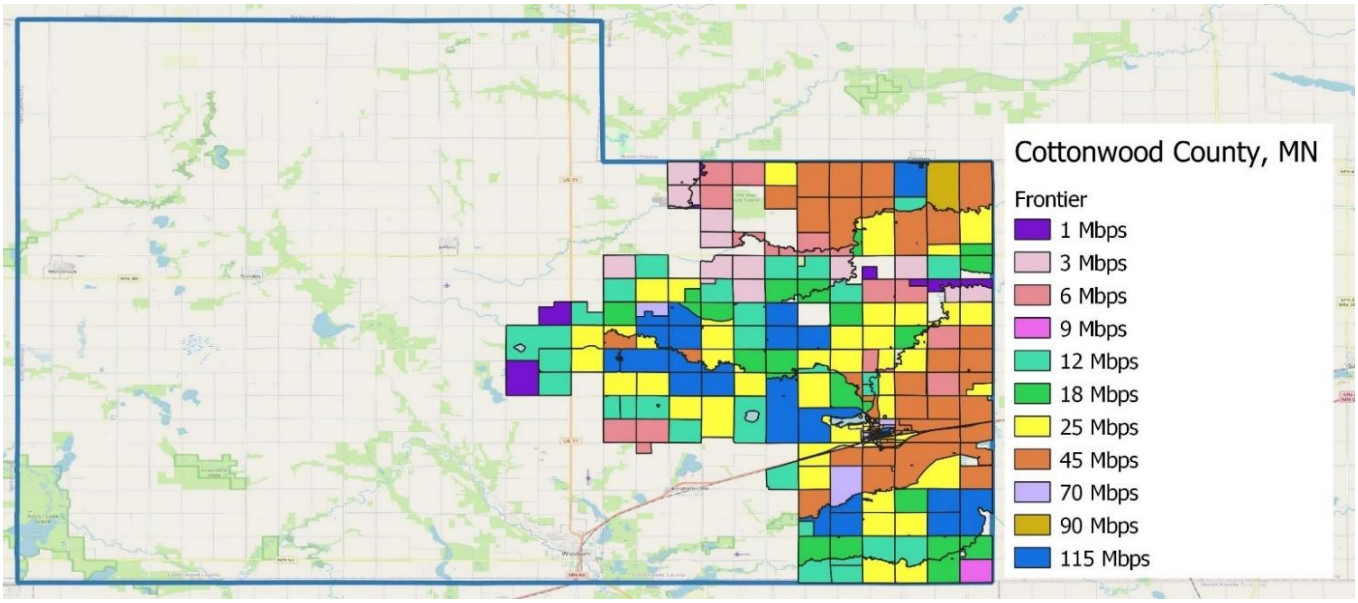
Map 1 - CenturyLink FCC 477 Data



Frontier. Frontier is an incumbent telephone company in Cottonwood County. Frontier claims to provide 11 different speeds in the county. Frontier faces the same DSL limitations with its ability to deliver speeds to customers. The speeds under 25 Mbps are being delivered on a single copper pair, which includes 1 Mbps, 3 Mbps, 6 Mbps, 9 Mbps, 12 Mbps, and 18 Mbps.

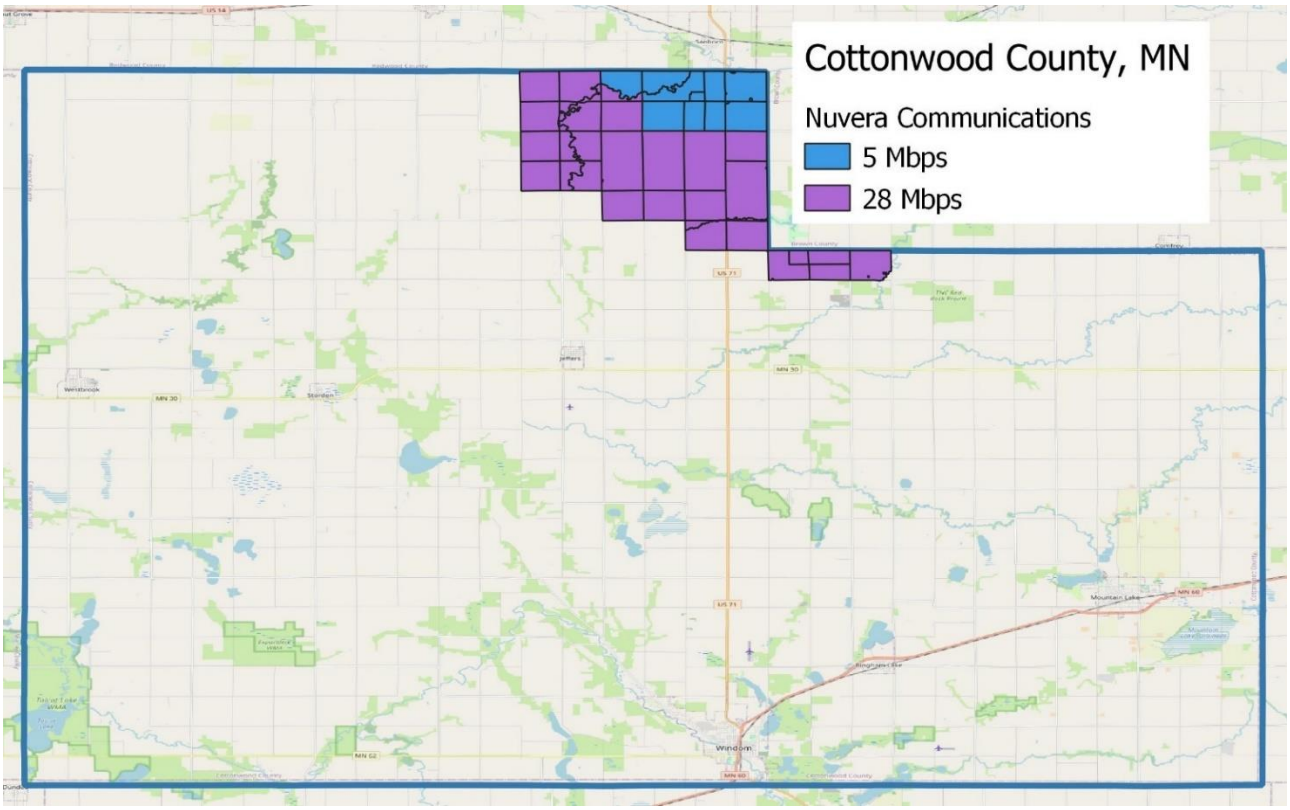
Frontier also claims to provide speeds of 70 Mbps, 90 Mbps, and 115 Mbps which denotes fiber. Frontier might serve a single business with fiber, but due to the FCC reporting rules can claim everybody in that Census block is able to receive those speeds. The reality is that most customer cannot the stated speeds.

Map 2 - Frontier FCC 477 Data



Nuvera Communications. Nuvera Communications is an incumbent telephone company that is still using DSL technology in Cottonwood County. In the most recent FCC 477 reporting, Nuvera Communications claims to provide speeds of 5 Mbps and 28 Mbps.

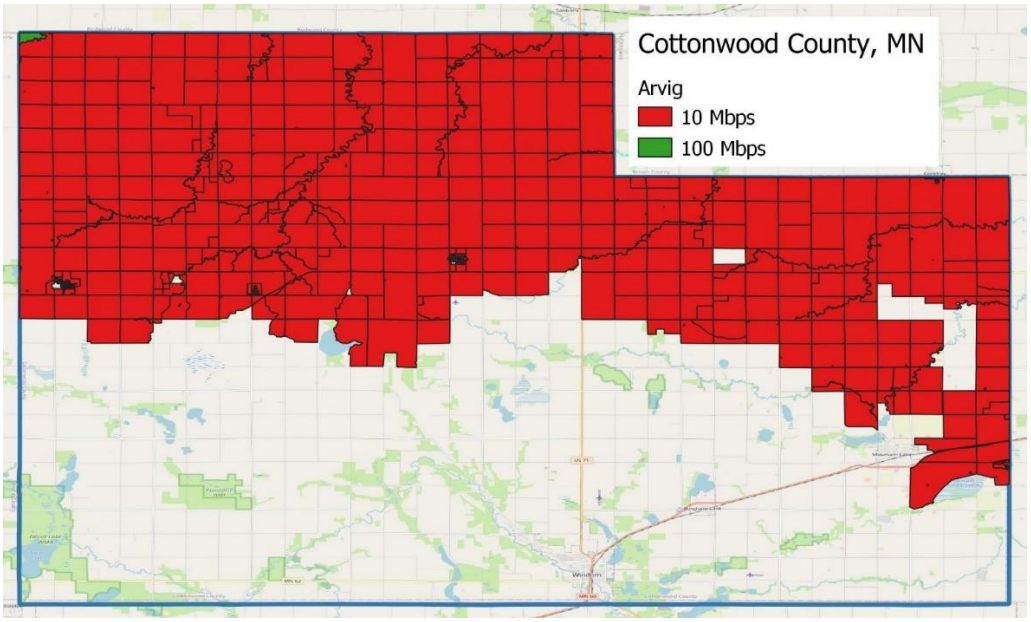
Map 3 – Nuvera Communications FCC 477 Data



Arvig. Arvig is an incumbent telephone company in the northwestern portion of the county, but also provides fixed wireless coverage across the northern half of the county. The FCC reporting shows that Arvig is using fixed wireless coverage even in much of the traditional telephone service area.

In the most recent 477 reporting, Arvig claims to primarily provide 10 Mbps in all of the areas shown in red on the map below. Arvig claims to provide 100 Mbps service to one census block in the northwest corner of the county.

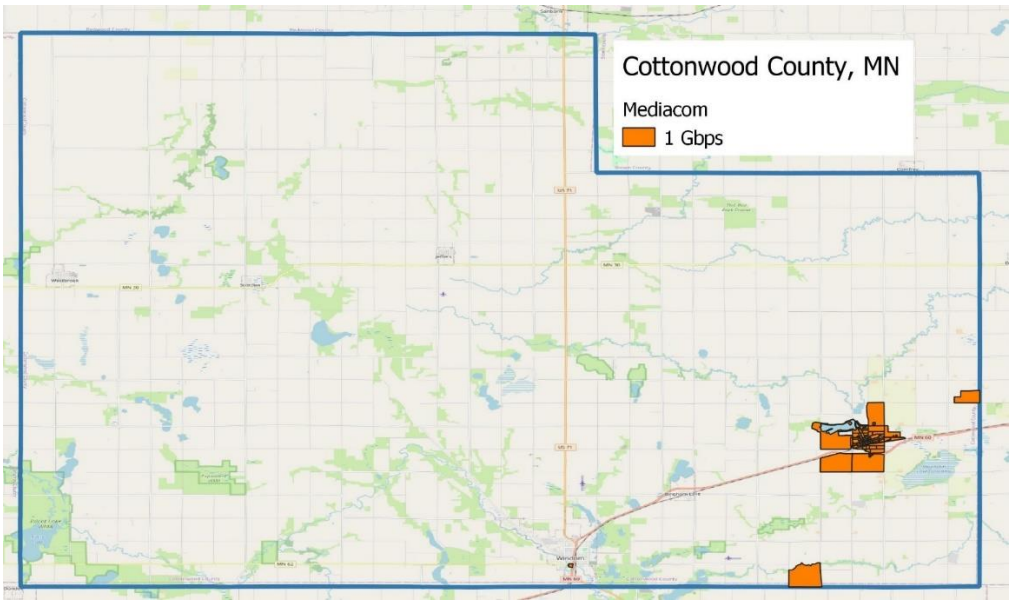
Map 4 – Arvig FCC 477 Data



Mediacom

Mediacom is an incumbent cable provider in Cottonwood County. The FCC data shows that the company provides broadband in the city of Mountain Lake, the surrounding areas, and one census block in southern Cottonwood County. Mediacom claims to provide 1 Gbps download speeds in its service areas, shown in orange on the map below. The coverage area on the map is overstated due to the FCC rule that allows an entire Census block to be considered served even if there is only one customer. It's unlikely that Mediacom reaches as far into the rural areas as shown on the map below.

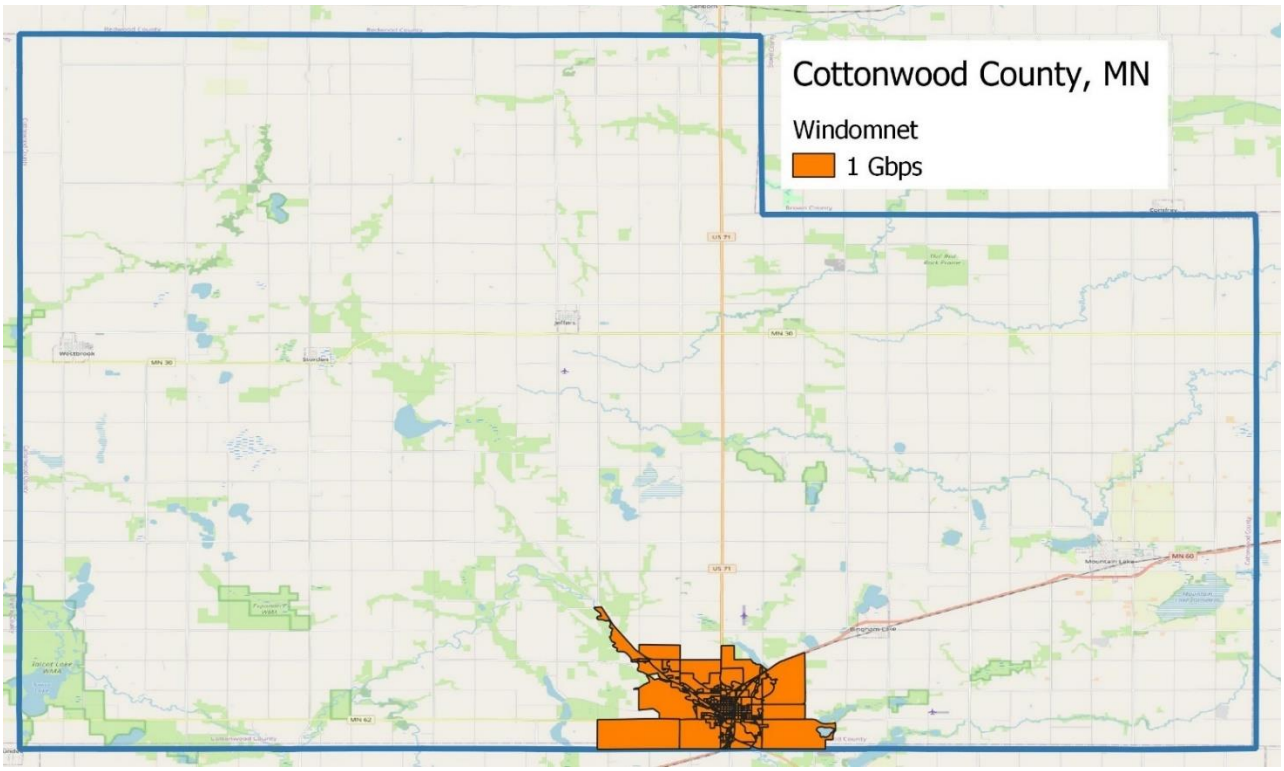
Map 5 – Mediacom FCC 477 Data



Windomnet. Windomnet was traditionally an incumbent municipal cable provider that recently converted the network to fiber in the City of Windom. Windomnet claims to provide 1 Gbps download speeds in its service areas, shown in orange on the map below.

Windomnet reaches out to some customers outside of the city limits, but the coverage area on the map below is overstated due to the FCC mapping protocol that allows an entire Census block to be considered served even if there is only one customer.

Map 6 - Windomnet FCC 477 Data

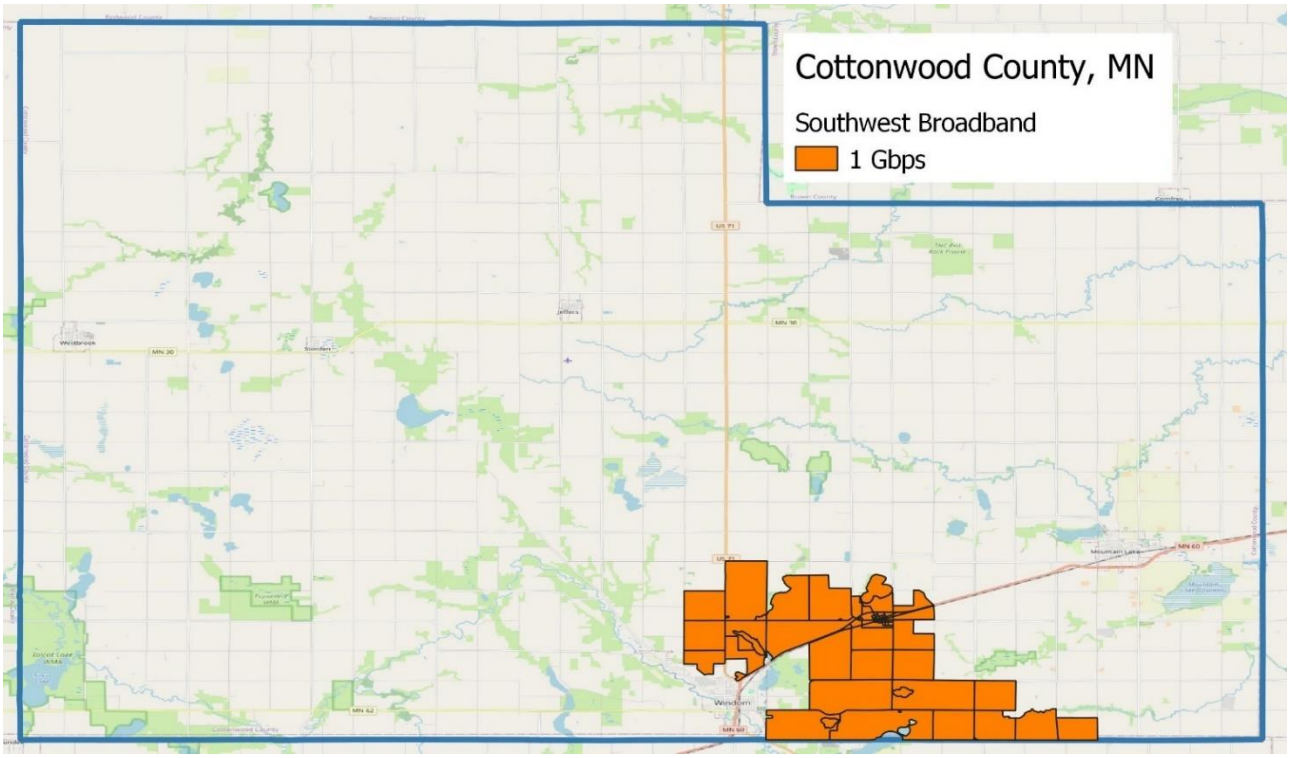


Southwest Broadband

Southwest Broadband is a municipally-owned fiber overbuilder. In Cottonwood County, Southwest Broadband provides service in the city of Bingham Lake and the surrounding areas. In the most recent FCC 477 reporting, Southwest Broadband claims to offer speeds up to 1 Gbps to its entire service territory.

The service area for Southwest Broadband is also likely overstated due to the FCC rule that shows an entire census block as served if at least one customer receives service.

Map 7 – Southwest Broadband



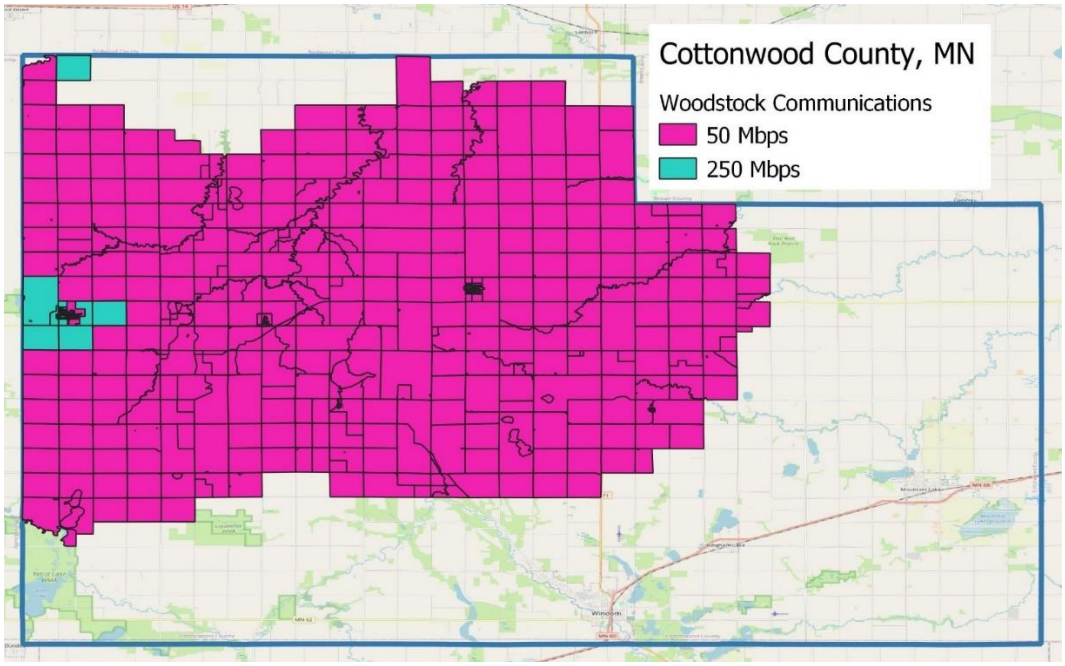
Woodstock Communications. Woodstock Communications is a fiber and fixed wireless provider in Cottonwood County. Woodstock Communications provides fiber service in the city of Westbrook, shown in blue on the map below.

Woodstock Communications provides fixed wireless service throughout the county and claims speeds almost everywhere of 50 Mbps, shown in purple on the map below.

This claimed speed raises an interesting question for Woodstock Communications and every other wireless map shown below. The speeds that can be delivered on a fixed wireless decrease with distance from the transmitter tower. Customers living close a transmitter can get the fastest speeds, while customers further away get slower speeds. The rate at which speeds decrease with distance are different for every WISP due to a number of factors such as the height of the tower, the brand of the radios, the amount of interference, the types of impediments in the radio path like hills or trees, etc.

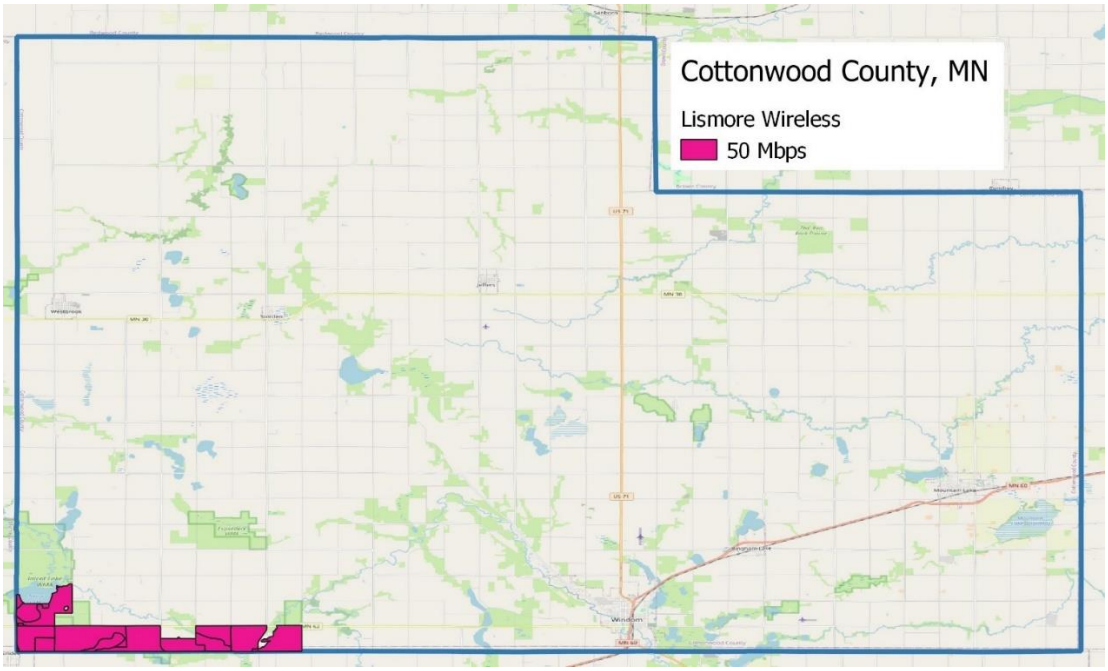
It's not possible for Woodstock Communications to deliver 50 Mbps to every customer located in the colored parts of the maps. Many of those customers will get slower speeds, and some customers probably can’t be reached at all. But there are also likely customers receiving speeds faster than 50 Mbps. The new FCC maps due out later in 2022 are supposed to try to show more accurate wireless coverage areas.

Map 8 – Woodstock Communications FCC 477 Data



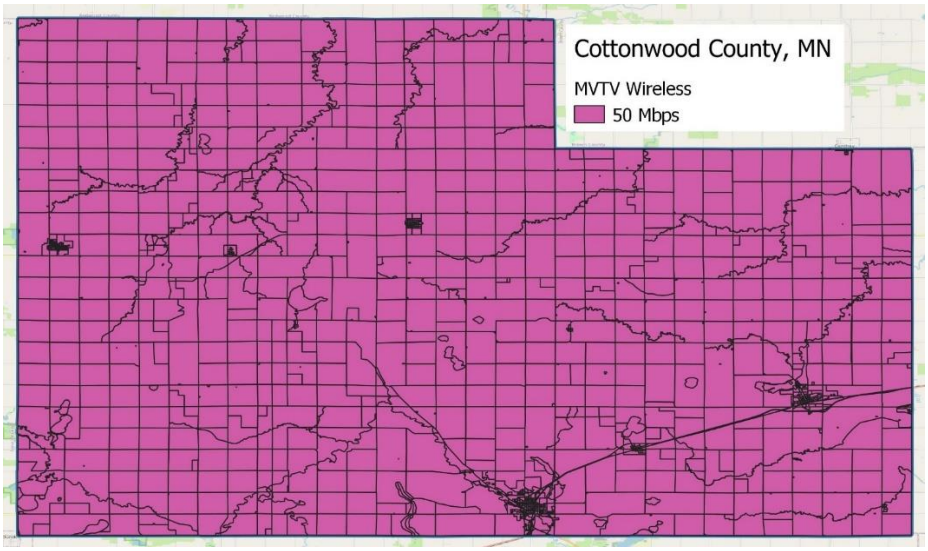
Lismore Wireless. Lismore Wireless is a fixed wireless and fiber provider in Cottonwood County. The company claims to serve the southwest corner. Lismore Wireless claims download broadband speeds of 50 Mbps in the most recent FCC 477 process. It is unlikely that all customers in the service territory can receive speeds of 50 Mbps. Customers living close to the transmitting tower can likely receive speeds that fast, but many customers probably are receiving speeds slower.

Map 9 – Lismore Wireless FCC 477 Data



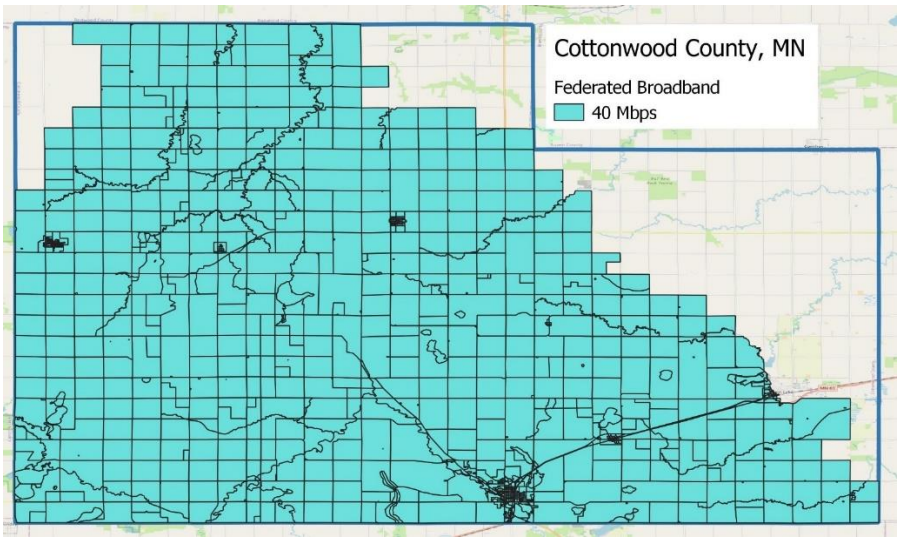
MVTV Wireless. MVTV Wireless is a fixed wireless provider operating in Cottonwood County. MVTV Wireless claims to the FCC that it can provide speeds of 50 Mbps to the entire county. As discussed above, this is not technically possible. Most customers likely can only receive much slower speeds.

Map 10 – MVTV Wireless FCC 477 Data



Federated Broadband. Federated Broadband is a fixed wireless provider. Federated Broadband provides service throughout the county. In the most recent FCC 477 form process, Federated Broadband claims to provide 40 Mbps throughout its service area. Like with the other WISPs, the coverage area is likely not as big as shown, and it's also virtually impossible to deliver the same speeds everywhere.

Map 11 – Federated Broadband FCC 477 Data

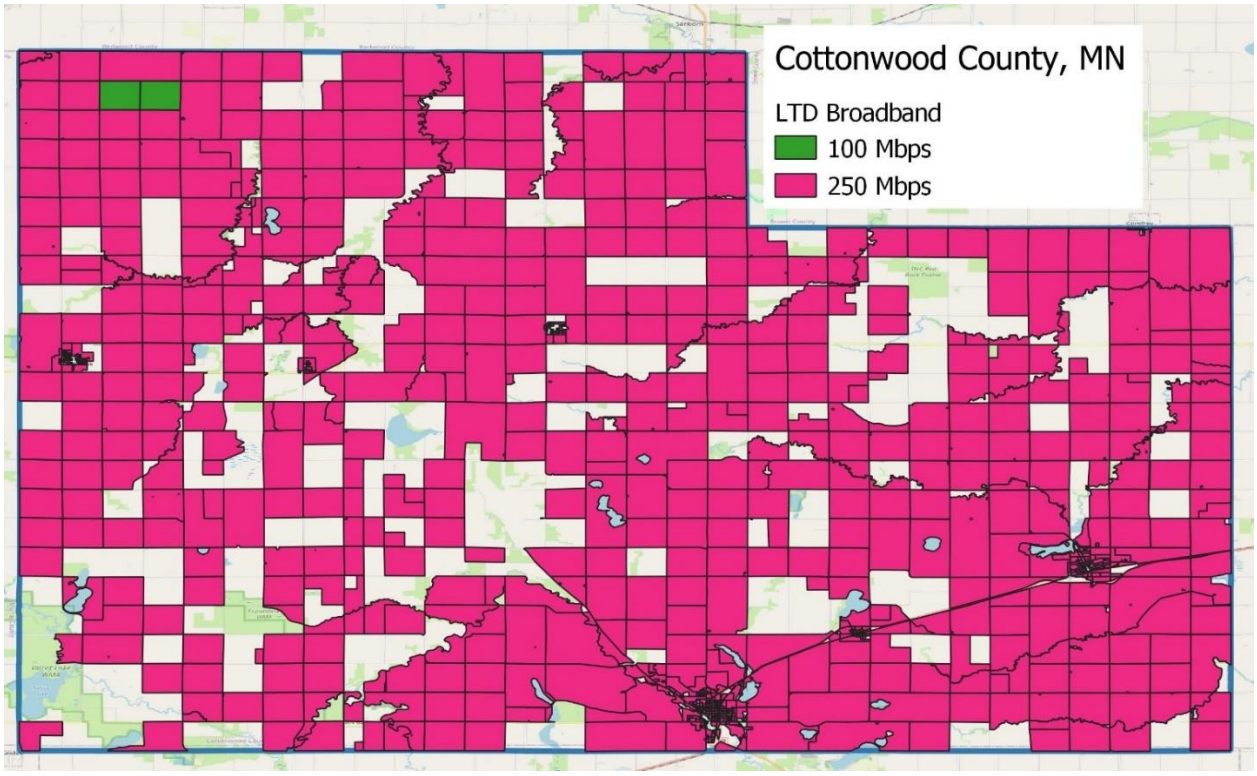


LTD Broadband. LTD Broadband is a fixed wireless provider in Cottonwood County. LTD Broadband claims to provide service throughout the county. According to the most recent FCC 477 process, LTD Broadband claims to provide speeds of 250 Mbps for the majority of its service area. LTD Broadband claims to provide speeds of 100 Mbps to two census blocks in the northwestern part of the county.

We find the claimed coverage to be massively overstated. LTD is using the same technology as the other WISPs in the county that are claiming speeds of 40 Mbps to 50 Mbps. As we stated with the other WISPs, we also don't believe any of them can deliver those speeds across large coverage areas. We view the LTD claimed speeds as a massive over-exaggeration, and it's likely possible that no customers can get speeds faster than 100 Mbps – and most probably get the same range of speeds delivered by the other WISPs.

This is bolstered by the products that LTD offers to customers. The company offers 10 Mbps for $70 and 35 Mbps for $110.

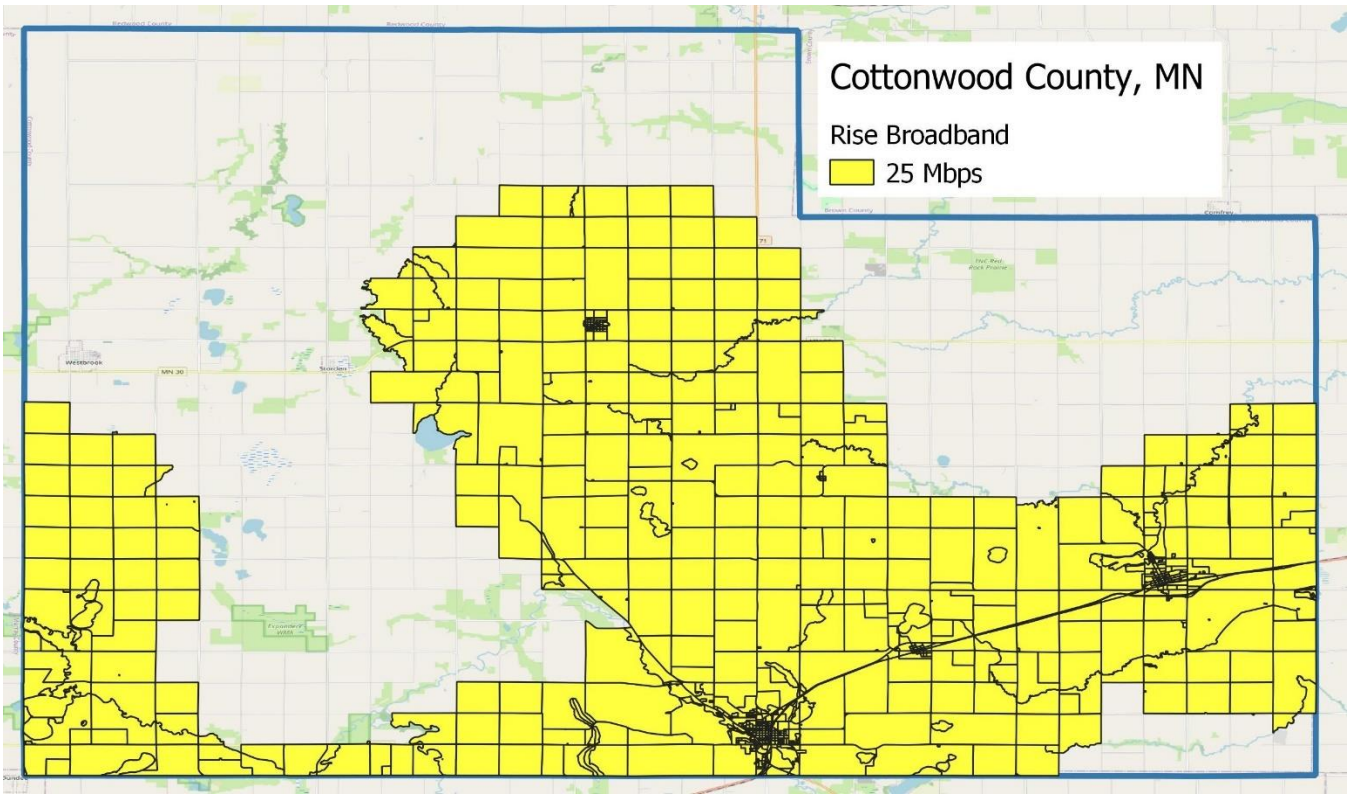
Map 12 – LTD Broadband FCC 477 Data



Rise Broadband

Rise Broadband is a fixed wireless provider in Cottonwood County. Rise Broadband claims to provide service throughout the south and eastern parts of the county. In the most recent FCC 477 reporting, Rise Broadband claims to provide 25 Mbps to its entire service territory. This is a more achievable speed than claimed by the other WISPs, but it's unlikely that Rise Broadband can deliver everywhere shown on the map.

Map 13 – Rise Broadband FCC 477 Data

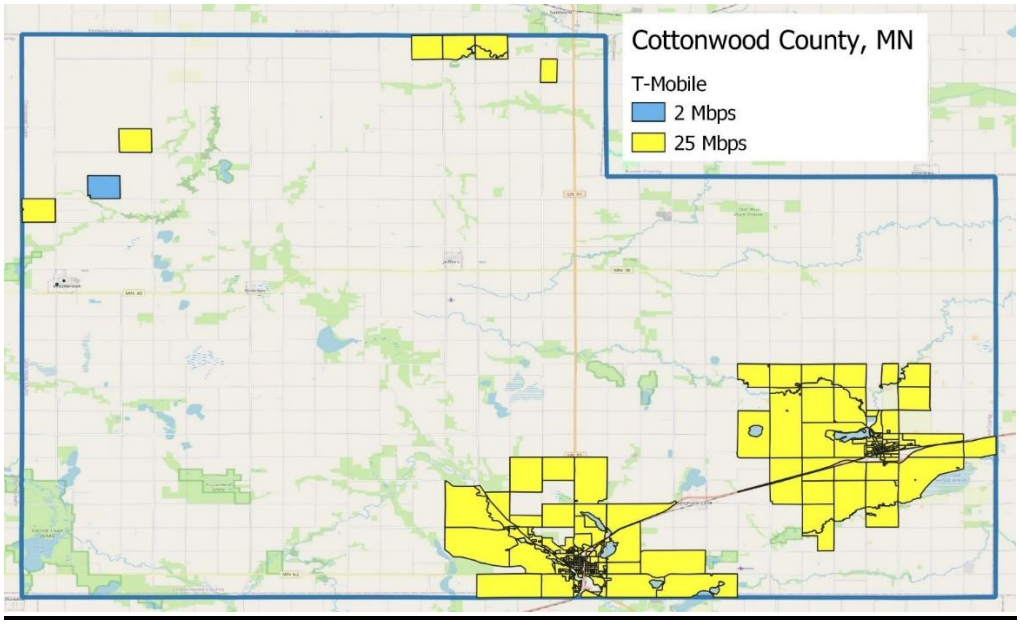


T-Mobile

T-Mobile reports coverage in a few sections of the county with broadband using its cellular spectrum. The speeds claimed on the map below likely represent areas where T-Mobile sells traditional hotspots using 4G LTE spectrum.

Around the country, the company is starting to sell faster broadband using 5G spectrum, but those speeds are likely to be reported at 100 Mbps download – so that product is likely not yet offered in the county, at least at the time of the most recent FCC reporting. The company reports speeds of 2 Mbps (blue) and 25 Mbps (yellow) in the most recent FCC reporting. Cellular broadband suffers from the same characteristic as fixed wireless in that speeds decrease with distance from a tower. However, a cellular broadband signal doesn't carry as far from a tower as a fixed wireless signal.

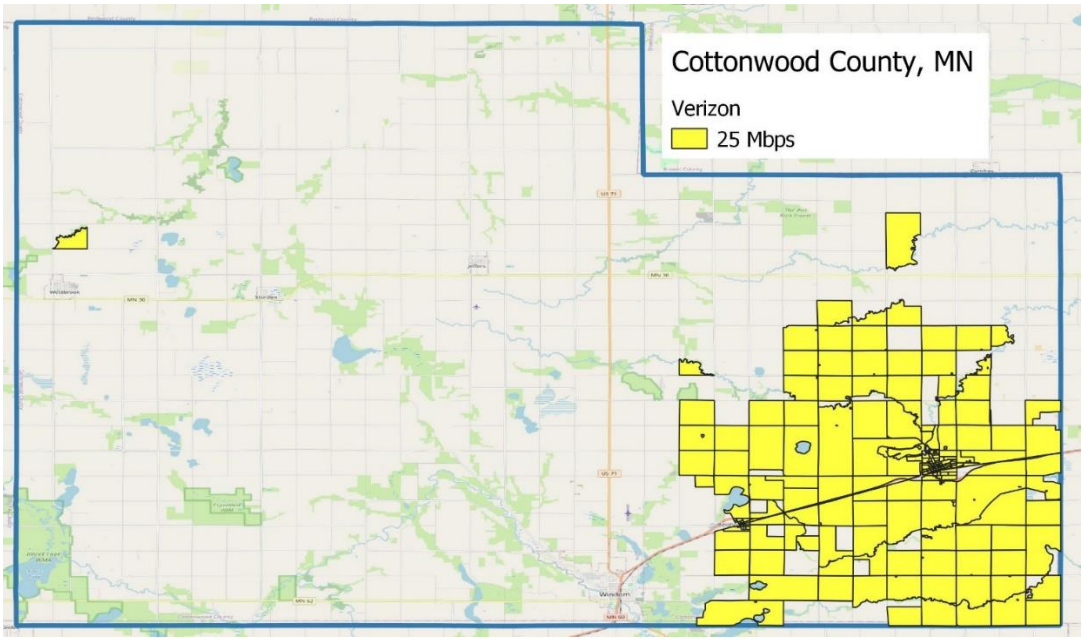
Map 14 – T-Mobile FCC 477 Data



Verizon

Verizon reports broadband coverage in the southeast corner of the county using its cellular spectrum. The speeds claimed on the map below likely represent areas where Verizon sells its traditional hotspots using 4G LTE spectrum. The company is starting to sell faster broadband using 5G spectrum, but those speeds are likely to be reported at 100 Mbps download. The company reports speeds of 25 Mbps (yellow) in the most recent FCC reporting. It's likely that the 25/3 Mbps broadband is not available everywhere shown on the map below.

Map 15 – Verizon FCC 477 Data



A Discussion about Wireless Broadband

As can be seen from the above maps, Cottonwood County has more overlapping wireless ISPs (WISPs) than any other county we've worked in. There are places in the county where as many as half a dozen wireless carriers claim to be offering broadband. The wireless carriers are largely claiming speeds between 25 Mbps download and 250 Mbps. We find most of the claimed speeds to be unlikely when we consider the Ookla speed test map shown earlier in the report that showed that the average speed tests in the rural areas are at 25 Mbps or slower. This raises an interesting question about the technical capabilities of these wireless networks, and in particular, about what happens when there are a lot of WISPs in the same areas.

It's important when talking about wireless carriers to know if a given wireless carrier is using licensed or unlicensed spectrum. A carrier obtains licensed spectrum by buying the exclusive rights to use a certain slice of spectrum in a given geographic area from the FCC. There is a huge benefit to having licensed spectrum because that carrier is the only one allowed to use the licensed frequencies in the areas where it owns a license. In the county, the two cellular companies, T-Mobile and Verizon, own the spectrum they use. Each of them can operate interference-free in the county without worry about the signals from other wireless carriers.

The only other ISPs that owned licensed spectrum in the county are Nuvera and Mediacom – and they are not using the spectrum to offer fixed wireless broadband. That means all of the other WISPs are using unlicensed spectrum – which includes Woodstock, Arvig, Lismore, MYTV Wireless, Federated Broadband, LTD Broadband, and Rise Broadband. This is a big deal because it means all of these WISPs are trying to use the same spectrum to compete with each other.

Before writing this section of the report, I consulted with several wireless engineers and technicians who work with rural wireless networks. The one consistent message I got from all of them is that interference can be a serious issue for WISPs deploying only unlicensed spectrum. There are only a handful of frequency channels that these ISPs can use. The unlicensed frequencies available for rural broadband are the same frequencies available to the public for WiFi inside the home. This includes 900 MHz, 2.4 GHz, and 5.7 GHz frequencies. All of these WISPs are sharing a handful of available channels in these WiFi frequencies.

There is a huge amount of interference when such a large number if WISPs are trying to use the same frequencies. Customer radios are bombarded by signals from all of the WISPs, and the process of filtering to find the right signal ends up slowing down the broadband transmission. But it gets even worse because WISPs are constantly jockeying to get a better signal. When WISP A turns up one of the unlicensed channels at a given transmitter, the signal automatically interferes with everybody else using that channel. In areas with multiple WISPs, each carrier fiddles with radios trying to get the best customer experience, and in doing so, interferes with somebody else. A market like Cottonwood County has a never-ending battle between WISPs, which means that coverage comes and goes over time. Unlicensed spectrum is just what the name implies – there are very few rules about the ways that a WISP can use the frequency, and a market with this many competing wireless carriers is largely a free-for-all – meaning that the customer experience changes from day to day as WISPs rearrange their networks.

Our expectation is that this interference causes a lot of degraded fixed wireless bandwidth. There are a number of WISPs claiming speeds of 40 Mbps or even significantly faster in the county, and it's likely that in many cases, the WISPs are delivering only a fraction of the advertised speeds.

There are other issues that can contribute to slow fixed wireless speeds. Some WISPs are still deploying lower quality and/or older radios that are not capable of the best speeds. ISPs often overload a neighborhood sector by trying to serve too many customers from one radio. One of the biggest issues for WISPs is inadequate backhaul. They will string together multiple wireless backhaul links to the point where each wireless transmitter is starved for bandwidth. But the biggest issue that I see in real practice is that some WISPs won't say no to customers even when the connection is poor. They will gladly install customers who live far past the reasonable range of the radios or who have restricted line-of-sight. These practices are okay if customers willingly accept the degraded broadband – but typically, customers are often given poor broadband for full price with no consultation or explanation.

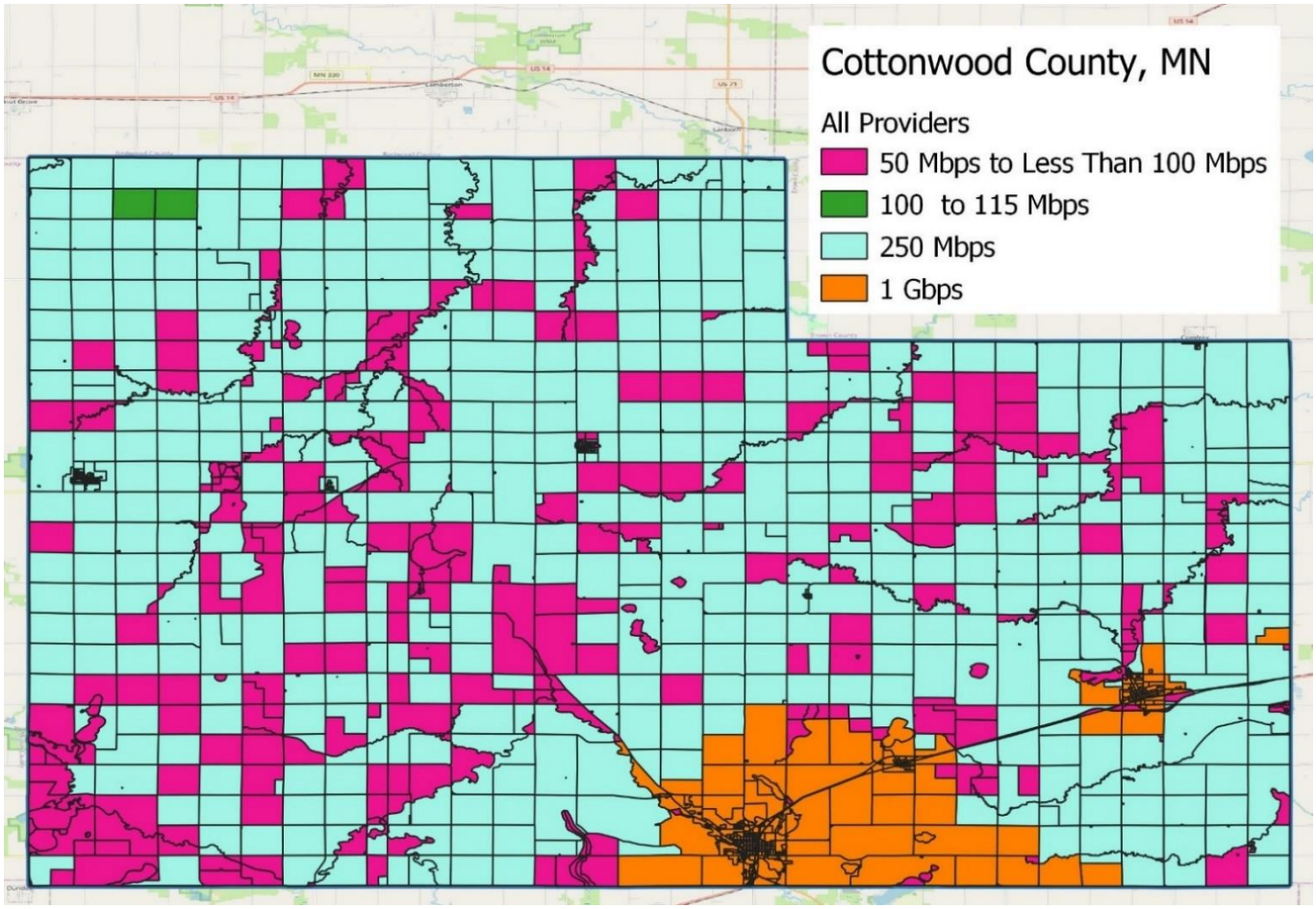
There are two new bands of unlicensed spectrum that will be available soon to WISPs. The biggest amount of frequency will come available from the 6.0 GHz frequency that was recently approved for outdoor broadband after a series of court challenges following the FCC order to allow the frequencies to be used outdoors. The courts just recently also approved the use of 5.9 GHz frequency. This frequency was formerly reserved for self-driving cars, an industry that never got off the ground. These new bands of spectrum will improve the bandwidth available to customers – but in a market with this many WISPs, there will still be significant interference. WISPs using unlicensed spectrum deliver the best signal when operating in places where there are only a few competitors – here the market is overloaded with WISPs.

Composite FCC Maps

The following map shows the fastest broadband speed that is reported to the FCC for each Census block in the county. If this map was accurate, there are no customers in the county that can't get buy speeds of at least 50 Mbps – something that we don't believe to be true. This is an important map because it is a visual summary of what the FCC reports to Congress to explain the availability of broadband in the county. The FCC is basically telling Congress that everybody in the county has access to broadband faster than 50 Mbps – which you know not to be true. Many people in rural areas cannot buy a product as fast as 25/3 Mbps.

The overstated speeds are almost entirely due to overstatements of speeds and coverage by the wireless ISPs.

Map 16 - Composite of all FCC 477 Data



Updating the Broadband Map

There are a few changes that must be made to Map 16 to properly show the state of broadband.

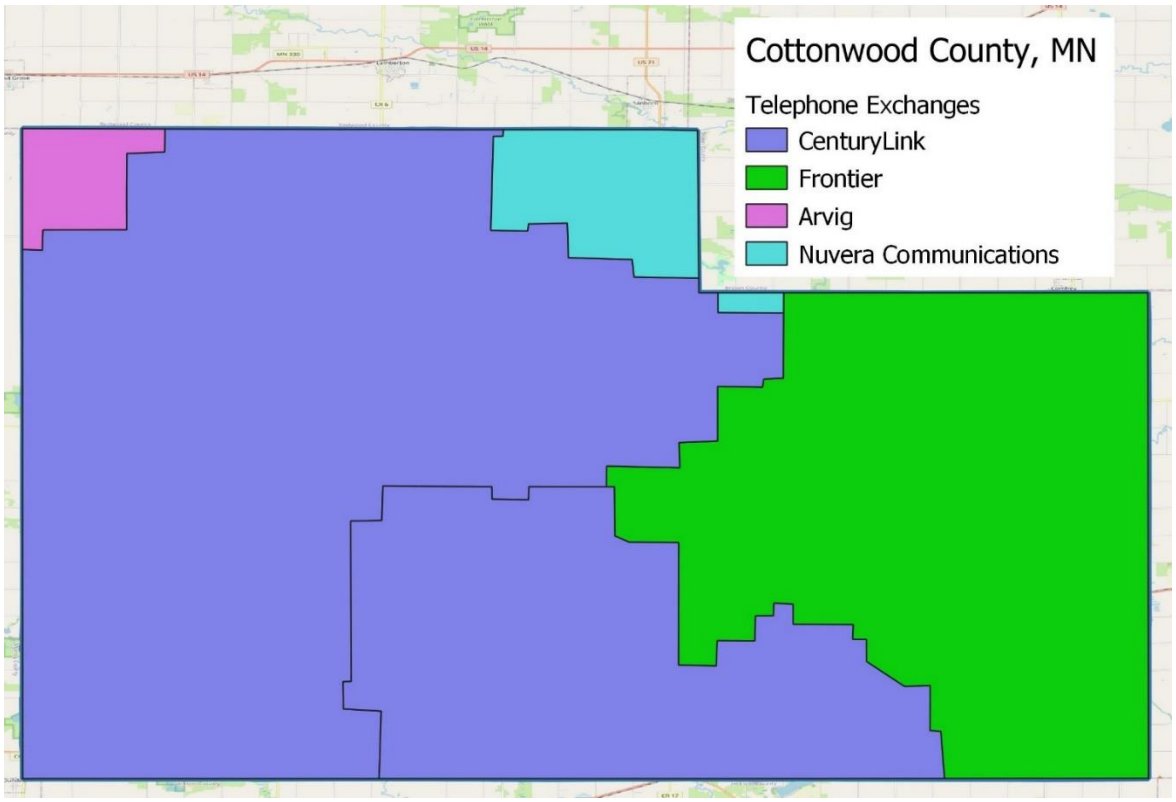
The Edge Issue

The map includes distortions along the edges of the ISP service areas. This is true around the areas served by Mediacom but also the areas served by fiber by Windomnet and Southwest Broadband. The reason for this is simple – the actual service areas of the various ISPs don't follow or match up with Census block boundaries. This means that most Census blocks along a border of an ISP claim areas that are served, but which are not served.

Telephone Company Exchange Boundaries.

The incumbent telephone companies in the county are CenturyLink, Frontier, Nuvera, and Arvig. The map below shows the historical monopoly boundaries for each telephone company. These boundaries were formally recognized by the Minnesota Public Utilities Commission, and each telephone company was given monopoly status within the borders shown on the map.

Map 17 Telephone Exchange Boundaries



Minnesota DEED Grant Eligible Areas in Cottonwood County

As detailed earlier, there are a lot of issues with the FCC 477 maps, and the Minnesota Department of Employment and Economic Development Office of Broadband Development creates its own broadband maps. The State also starts with data provided by the ISPs, but Minnesota corrects the shown speeds where marketing speeds are used instead of actual speeds. One of the interesting things about the state map is that ISPs provide shape files of broadband coverage instead of reporting by Census blocks. This allows much more accurate data regarding the speeds being delivered in the county. The State uses its own maps when analyzing grant applications for the Border-to-Border Grant program.

This discussion requires the introduction of a new term – passings. The industry uses passings to mean any home or business that can become a broadband customer.

Finley Engineering gathered GIS data in the county that allowed us to identify and count the homes and businesses in every Census block. This allowed us to compare the number of customers that are covered by the various technologies claimed by the ISPs. This means, for example, that we can count the number of potential customers that can buy services from various ISPs shown in the maps included in the section above.

For purposes of qualifying for current broadband grants, areas are typically categorized into the following speed classifications:

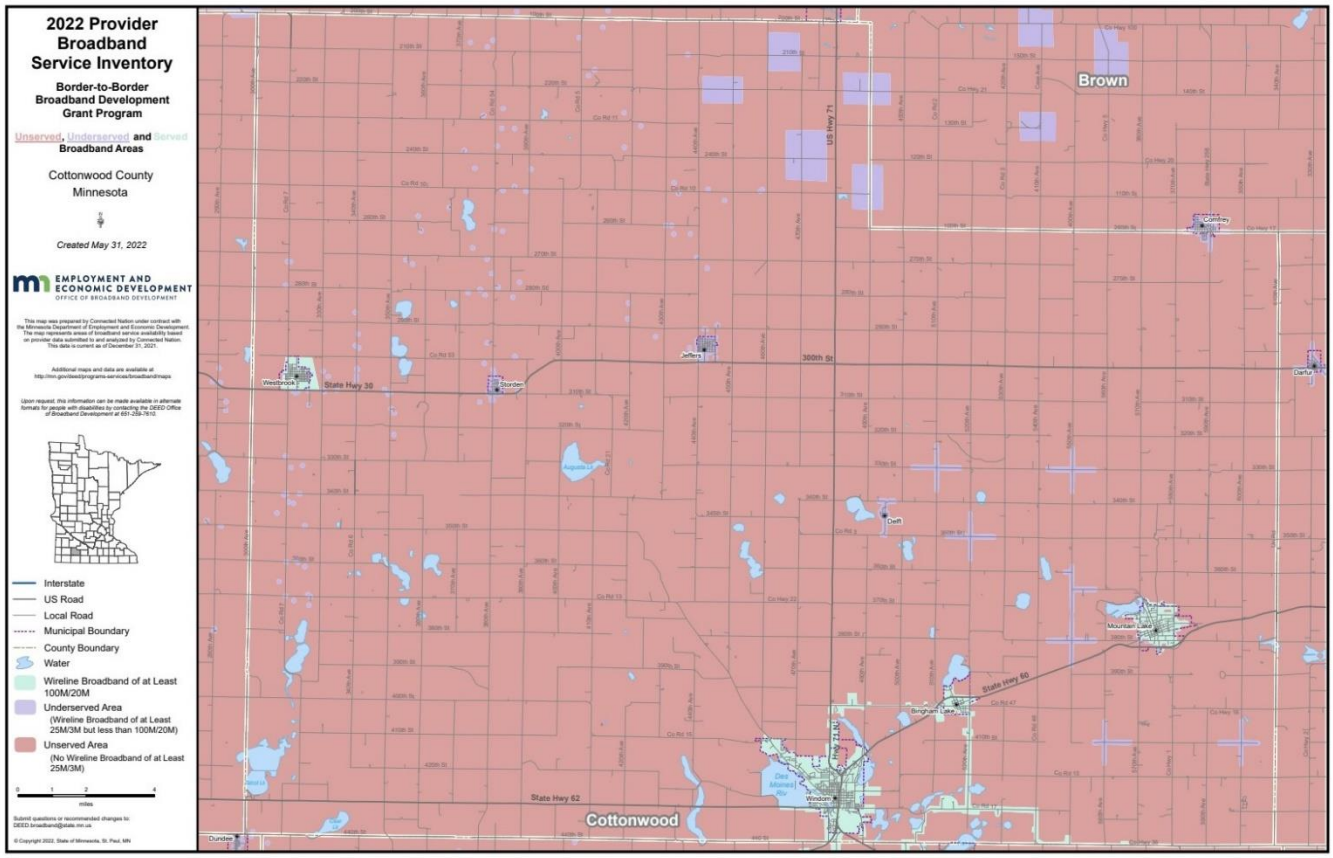
- Unserved - any place that has speeds of 25/3 Mbps or slower.
- Underserved – any place that has speeds between 25/3 Mbps and 100/20 Mbps
- Served – any place with broadband of 100/20 Mbps or faster.

Following are the number of grant-eligible (unserved and underserved) passings that match the reported speeds from the Minnesota DEED maps. Any grant that uses landline broadband speeds to define grant eligibility would categorize passings in the county as follows:

	Speeds	Passings
Unserved	Less than 25/3 Mbps	1,556
Underserved	From 25/3 Mbps to 100/20 Mbps	579
Total		2,135

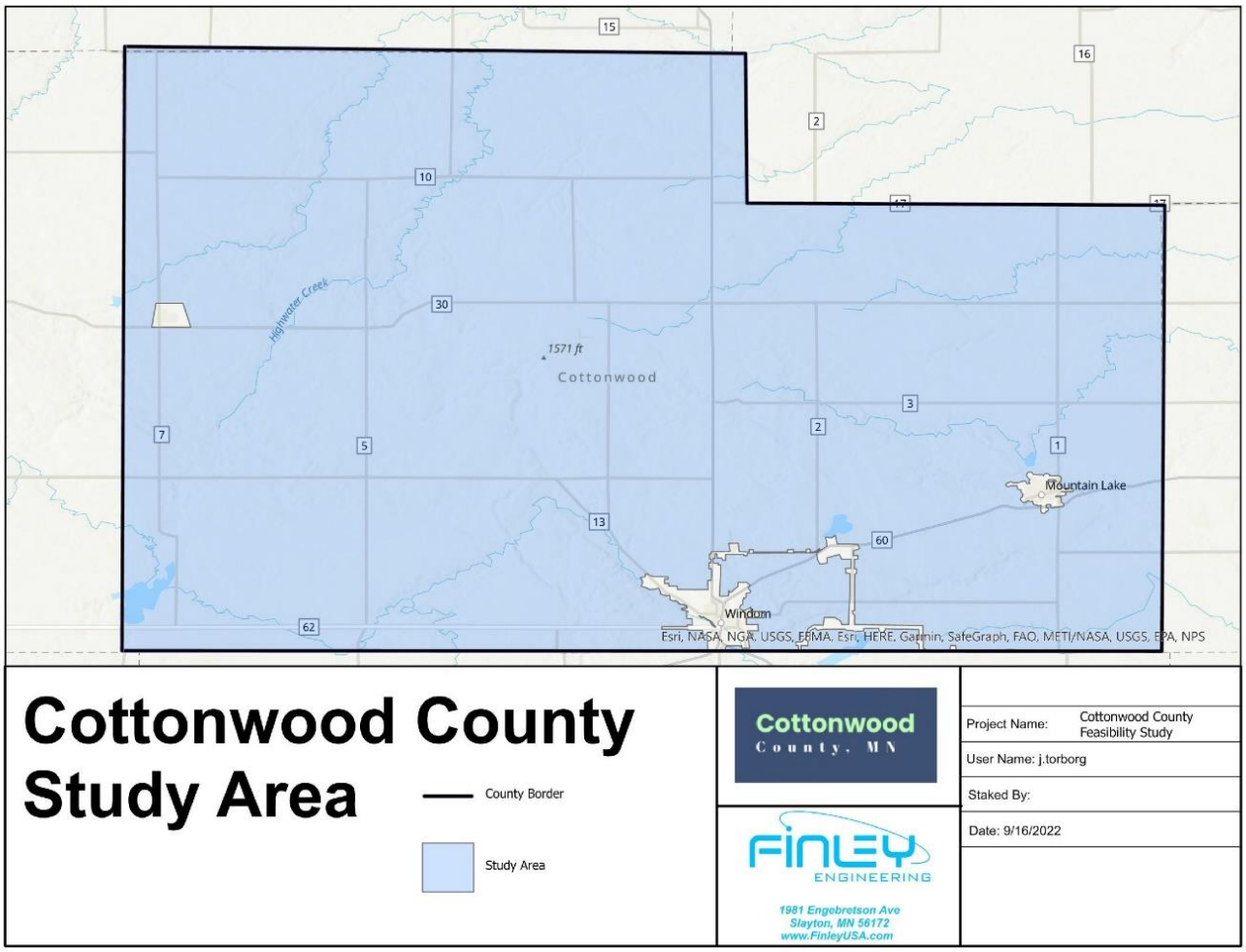
The following map comes from the Minnesota DEED maps and shows the areas of the county that match the above passing counts. On this map, the red areas (unserved) are where existing broadband speeds are slower than 25/3 Mbps. The purple areas (underserved) are where existing speeds are between 25/3 Mbps up to 100/20 Mbps. The green areas (served) are where speeds are at 100/20 Mbps or faster.

Map 18 Grant-Eligible Areas Defined by the Minnesota DEED



The study is based on the following map. The study area is everything in blue, which is everything outside the areas that have available broadband today of at least 100/20 Mbps.

Map 19 Grant-Eligible Study Area Map



C. Broadband GAP Analysis

A broadband gap is a situation where some residents of an area are disadvantaged in their ability to use the Internet. This report will look at the various kinds of broadband gaps as described below.

- The Gap in Broadband Speeds. The broadband speeds vary widely throughout the county, as documented in the preceding section of the report.
- The Gap in Broadband Availability. There are homes with no landline broadband available.
- The Gap in Broadband Affordability. In every community, there are residents who don't subscribe to broadband because of the cost.
- The Gap in Computer Ownership. There are residents who don't subscribe to broadband because they can't afford a computer.

- The Gap in Broadband Skills. There are residents who don't buy broadband because they lack the skills needed to operate in the digital age.
- Future Broadband Gaps. Even where there is adequate broadband today, we can expect the natural growth of broadband usage to create new broadband gaps in the future.

After describing the different broadband gaps, this report will look at the consequence of the broadband gaps and will ask the question if there are any practical solutions to the broadband gaps that the county could facilitate.

The Gap in Broadband Speeds

The mapping analysis above shows the coverage areas of the various ISPs in the county and the broadband speeds they claim are being delivered. This section of the report looks at other sources of information that can add to the narrative about broadband speeds in the county.

Microsoft Speed Data

Microsoft is in an interesting position when it comes to looking at broadband speeds. The vast majority of computers in the country download sizable upgrade files from Microsoft. Even many Apple computers are loaded with Microsoft Office products like Word, Excel, and PowerPoint.

Microsoft decided a few years ago to record download speeds of software upgrades. There is probably no better way to measure a broadband connection than during a big file download. Most speed tests only measure broadband speeds for a minute or less. There are a lot of ISPs in the country that deploy a technology generally referred to as burst. This technology provides a faster download for a customer for the first couple of minutes of a web event. It's easy for a customer to know if their ISP utilizes burst technology because, during a long download, such as one updating Microsoft Office, the user can see the download speeds drop to a slower speed after a minute or two. This burst technology has great benefits for customers since most web activities don't take very long. When customers visit a website, open a picture, or even take a speed test, the customer only needs bandwidth for a brief time. The burst technology gives customers the impression that they have a faster download speed than they actually have (or it could be conversely argued that they have a fast speed, but just for a minute or two).

Microsoft measured downloads starting in September 2018 and found:

- The 2019 FCC data claimed that 14.5 million people in the U.S. don't have access to download speeds of at least 25/3 Mbps. In October 2020, Microsoft claimed that 120.4 million people were downloading data at speeds slower than 25/3 Mbps.
- The FCC claimed in 2020 that 100% of households in Cottonwood County had access to broadband of at least 25/3 Mbps. In October 2020, Microsoft reported that 87.4% of all downloads in the county are made at speeds of less than 25 Mbps. That is an eye-opening difference between the Microsoft numbers and the FCC numbers.

It's important to note that the FCC and Microsoft are not measuring the same thing. The FCC is measuring the percentage of homes that have access and can purchase 25/3 Mbps broadband. Microsoft is measuring the actual speeds of downloads. There are a few reasons why the speeds might be different:

- Some people opt to buy broadband products slower than 25/3 Mbps, even when faster broadband is available.
- Some households receive slower speeds due to issues in the home, like poor-quality WiFi routers.
- The biggest difference is probably due to the wireless ISPs overstating the speeds to the FCC that they make available to the public. As stated earlier in this report, the FCC doesn't challenge speeds reported to them by ISPs. The Microsoft data highlights a big problem with the FCC data.

Comparing Cottonwood County with the Rest of the Country

There are numerous ways to compare Cottonwood County to the rest of the state and the country.

FCC Adoption Rate

How does Minnesota compare to other states? In the 2021 annual report to Congress, the FCC reported on broadband adoption at various speeds by state. The adoption rate is the percentage of households that have purchased broadband that meets or exceeds various speed thresholds. The FCC reported the following broadband adoption rates for Minnesota (meaning the percentage of customers who can buy the listed speeds at their home):

Homes buying at least 10/1 Mbps	71.0%
Homes buying at least 25/3 Mbps	64.5%
Homes buying at least 50/5 Mbps	59.1%
Homes buying at least 100/10 Mbps	37.1%
Homes buying at least 250/25 Mbps	5.3%

To put the FCC numbers into perspective, the percentage of homes that get at least 10/1 Mbps broadband (71.0%) puts Minnesota in the middle of the pack when compared to other states. The lowest coverage is in Mississippi at 50.4%, and the highest is Delaware at 92.7%. It's worth noting again that these numbers are based upon faulty FCC 477 data reported by the ISPs, and the actual speeds being purchased are not nearly as good as the numbers shown. As shown immediately below, the FCC numbers for Cottonwood County are overstated.

FCC Availability of Broadband

The FCC also looks at the availability of broadband by county, meaning the percentage of homes that could buy broadband at various speeds. This is where the FCC data and the faulty nature of the maps are quickly evident. The following is what the FCC reported to Congress in 2021 about Cottonwood County:

Urban population:	3,993
% that can buy at least 25/3 broadband	100%
% with 4G LTE coverage at 5/1 Mbps	100%
% with both	100%

Rural population:	7,203
% that can buy at least 25/3 broadband	100%
% with 4G LTE coverage at 5/1 Mbps	100%

% with both 100%

The FCC data clearly overstate the broadband coverage in the rural parts of the county. Our analysis, and the state of Minnesota broadband map both show that almost nobody in the rural areas can purchase broadband with speeds of at least 25/3 Mbps.

As shown in the mapping section of the report, broadband provided in the rural parts of the county is from fixed wireless or DSL, with dramatically overstated speeds.

Ookla Speed Test by State

Ookla collects speed tests across the country. It is the most popular speed test website, making it an excellent resource for looking at current broadband speeds in any area of interest. In 2020, Ookla started to report median download and upload speeds and latency by state. Median is the speed at which half of all broadband speeds are slower and half are faster. Below is what Ookla reports as the median download and upload speeds and latency for Minnesota.

	Download	Upload
Quarter 1 2021	90 Mbps	12 Mbps
Quarter 2 2021	94 Mbps	12 Mbps
Quarter 3 2021	95 Mbps	12 Mbps
Quarter 4 2021	103 Mbps	14 Mbps
Quarter 1 2022	110 Mbps	16 Mbps
Quarter 2 2022	108 Mbps	16 Mbps

As seen in the table above, download broadband speeds have been improving in Minnesota. Just since early 2021, the median download speed has increased from 90 Mbps to 108 Mbps this year. The are several reasons for these speed increases. The big cable companies have been unilaterally increasing the speeds delivered to customers without raising rates. There are also some ISPs building fiber networks. Finally, there is a trend nationwide for customers upgrading to faster broadband products, which will be discussed in more detail below.

It's harder to understand the increase in upload speeds, but it's likely because of some of the same reasons. The median upload speed has increased from 12 Mbps in early 2021 to 16 Mbps today. According to Ookla, USI is the fastest ISP in Minnesota, with a median download speed of 212 Mbps.

Comparing Cottonwood County with the Rest of Minnesota

According to FCC data, three counties in the state – Kanabec, Lake of the Woods, and Pine – have less than 70% broadband coverage. At the other end of the scale, the FCC says that there are 15 counties that have 100% coverage of 25/3 Mbps broadband. According to the FCC data, Cottonwood County has one of the higher amounts of broadband coverage in the state – which we don't think is true.

The Technology Gap

To a large degree, the broadband speed available to a customer is dependent upon the technology used to deliver the broadband. Our reports will discuss various technologies in more detail when we describe the engineering cost estimates to bring better broadband to the county.

The general speeds available on various technologies are as follows:

- DSL delivered on one copper pair can deliver speeds as fast as 25 Mbps for a mile or two from the DSL transmitter, assuming the copper is in good condition and other factors are ideal. There are older and slower types of DSL deployed that might have maximum speed capability of 3 Mbps, 6 Mbps, 12 Mbps, or 16 Mbps. DSL delivered on two copper pairs can deliver twice the speeds. This technology is usually only deployed using the latest types of DSL and has maximum speeds of around 50 Mbps – on perfect copper.
- High orbit satellite broadband can deliver speeds as fast as 75 Mbps. The problem with this broadband is that the satellites are so far above the earth that there is a lot of delays (latency) in the signal, and it's hard to do real-time web activities like streaming video, connecting to a corporate WAN, a school server, making VoIP calls, or even shopping on some websites. Satellite speeds are greatly reduced for customers that don't have a full view of the open sky – like customers with trees around their homes or located near hills and mountains.
- Fixed point-to-multipoint wireless is capable of download speeds up to 100 Mbps. There are new vendors claiming future speeds will be even faster. However, the fast speeds require new technology and also the use of additional spectrum, such as the CBRS spectrum. Any wireless equipment deployed even just a few years ago will deliver much slower speeds. As described elsewhere, issues like the distance between a customer and the tower will have a huge impact on the speed.
- A hybrid-fiber coaxial system (used by cable companies) can deliver fast broadband speeds. Networks using the DOCSIS 3.0 standard can deliver speeds up to around 400 Mbps. Mediacom has upgraded to the most recent DOCSIS 3.1 standard and can deliver speeds up to a gigabit.
- Fiber networks also deliver fast broadband. Fiber networks with the older BPON technology are limited to speeds of about 200 Mbps per system. More modern GPON technology can deliver speeds up to a symmetrical gigabit (same speed up and down). Newer XGS-PON technology can deliver download speeds as fast as 10 Gbps.

Every technology has real-life limitations that reduce broadband speeds. Consider as an example the following factors that can affect the broadband speeds delivered over DSL:

- DSL speed diminishes rapidly as the distance between the customer and the DSL transmitter increases.
- The size of the copper wire serving the customer matters – the larger the gauge of the copper wires, the stronger the DSL signal.
- The quality of the copper wire slowly degrades over time, particularly if the copper gets in direct contact with the elements or with long-standing water.
- The quality of the telephone wiring inside of a home can impede quality, particularly for wires that were installed by the homebuilder rather than by a telco.
- The type of DSL electronics used to serve a customer. There are still older DSL technologies in the field that have maximum download speeds of only a few Mbps and newer DSL that can deliver speeds as fast as 48 Mbps.

- DSL will underperform if there is not enough backhaul bandwidth provided to a neighborhood. DSL is like most broadband technologies, and bandwidth is shared between users in each neighborhood. If the total usage demanded by the neighborhood is greater than the bandwidth supplied to the neighborhood, then everybody gets slower speeds when the network is busy.
- And finally, speeds can be impacted by how a customer gets broadband to devices. For example, an old WiFi router can cut down the speed between what is delivered to the home and what makes it to computers and other devices inside the home.

All these factors mean that DSL speeds vary widely in the field. Two adjacent homes can have a significantly different DSL experience. It's almost impossible for an ISP to understand DSL speeds for each customer since the speeds can vary widely during the day.

As discussed above, the same sorts of factors also apply to fixed wireless. Customer speeds vary according to distance from a tower, the spectrum used for any given connection or impediments between the tower and a home (speeds are often slower in summer when the leaves are on trees). It's nearly impossible to map DSL and fixed wireless speeds in the field.

Oversubscription. Even when the latest and best technology is deployed, speeds can vary widely in real life due to something we call oversubscription. Oversubscription comes into play for any technology where customers share bandwidth somewhere in the network.

The easiest way to understand the concept is with an example. Consider a passive optical fiber network. The most commonly deployed fiber technology is GPON, where up to 32 homes share 2.4 gigabits of download data in a neighborhood fiber (called a PON).

If an ISP sells a 100 Mbps download connection to 20 customers on a PON, then in aggregate, those customers can use as much as 2 gigabits of download data at the same time (20 customers X 100 Mbps), meaning this example PON has unused capacity. In this example, every customer is guaranteed to be able to use the full 100 Mbps connection. However, if an ISP instead sells a gigabit connection to 20 customers, then there are 20 gigabits of potential customer usage that have been pledged over the same 2.4-gigabit physical path. The ISP has sold more than eight times more capacity to customers than is physically available, and this particular PON has an oversubscription ratio of eight to one.

When people first hear about oversubscription, they are often aghast – they think an ISP has done something shady and is selling more bandwidth than can be delivered. But ISPs understand how customers use bandwidth, and they can take advantage of the real behavior of customers in deciding the oversubscription ratios. ISPs know that a home subscribing to a gigabit connection almost never uses the full bandwidth capacity. A home doesn't use much bandwidth when people are asleep or away from home. The residents of a gigabit home might spend the evening watching a few simultaneous Netflix video streams and barely use any bandwidth. The ISP is banking on the normal behavior of its customers in determining a safe oversubscription ratio.

Most of my clients using GPON tell me that they average 40% to 50% utilization – meaning all of the customers on a PON collectively only use about 40% - 50% of the 2.4 gigabits of capacity at any given time. The extra capacity is there for those busy times when a neighborhood gets busier than normal. We know from experience in working with hundreds of ISPs that an ISP can give every customer gigabit

speeds on a residential GPON network and still deliver full speeds to customers more than 99% of the time. An oversubscription of 8 on a fiber network is a high-quality broadband network.

Even if this example PON got too busy, it would likely be temporary. For example, if a few doctors lived in this neighborhood and were downloading big MRI files at the same time, the neighborhood might temporarily cross the 2.4-gigabit available bandwidth limit. But broadband transactions happen quickly for a gigabit customer, and the overuse of the bandwidth would not last long. Even in this example, most neighbors of the doctors wouldn't notice a perceptible difference in performance.

Oversubscription is different for business customers. Businesses might use steady bandwidth, such as connecting VLANs to multiple branches, using software platforms in the cloud, using cloud-based VoIP, etc. An oversubscription ratio that works in a residential neighborhood might not work in business neighborhoods. An ISP gets to know its customers and decides how to configure the PONs in a business neighborhood according to the characteristics of the businesses in that neighborhood. There are a number of ways that an ISP can make sure that business customers get enough broadband.

The above example describes oversubscribing a fiber network. It's fairly routine for other technologies to run into big problems with oversubscription. Anybody who has used a cable company for broadband can remember back a decade ago when broadband on cable networks slowed to a crawl when homes first started watching Netflix in the evening. The cable company networks were not designed for steady video streaming and were oversubscribing bandwidth by 200 to 1 or higher. It became routine for the bandwidth demand for a neighborhood to significantly surpass the network capacity, and when that happened, the whole neighborhood experienced a slowdown. Since then, cable companies have lowered the number of households on a neighborhood node to reduce oversubscription problems.

One of the major reasons that DSL and fixed wireless networks have slow speeds is due to oversubscribing the neighborhood nodes. There is often far more demand on these networks than the bandwidth being delivered to the neighborhood.

Unfortunately, the impact of oversubscribed networks reared its head during the pandemic. The issue now is not so much the download path but the upload link. The upload links in neighborhoods get overloaded when multiple people try to work or school from home at the same time. It was widely reported across the country that people had trouble making and keeping connections to work and school servers and Zoom calls. This didn't just happen on older technologies like DSL, and there are many reports of this happening on the networks of the big cable companies. Customers are rightfully upset if they are buying 100 Mbps or faster download speeds and still can't work from home.

To make the issue even more complex, the sharing of bandwidth at the neighborhood level is only one place oversubscription comes into play. Any other place inside the ISP network where customer data is aggregated and combined will face the same oversubscription issues. The industry uses the term chokepoints to describe places in a network where bandwidth can become a constraint. There is a minimum of three chokepoints in every ISP network, and there can be many more. In addition to a chokepoint in the customer node, there is also always a chokepoint in any network at that point where all of the customer nodes come together in the core. The other big chokepoint is the path to the Internet, and it's possible for a company to not have enough bandwidth to the outside world to satisfy the demand from customers collectively.

The Gap in Broadband Availability

There are residents in every rural area who say they have no broadband available. What do people mean when they tell us there is no broadband at their home?

We know that DSL is often not available. Rural customers all over the country have been reporting for years that CenturyLink won't provide new DSL service. Even where CenturyLink adds a customer, the speeds can be extremely slow – and customers won't pay for broadband that only delivers 1 or 2 Mbps download speeds and barely any upload speeds.

A lot of homes won't consider satellite broadband as an option. We've talked to many rural residents who tried satellite broadband and rejected it. The speeds are often far below what is advertised since trees and hills can block a satellite signal. The latency is dreadful - in places where the speeds are impaired, high latency means a household can't hold a connection to a website, making basic things like shopping on the web impossible. Satellite plans also come with tiny data caps, and people find it impossible to make it through the month with a 40 - 60 gigabyte data cap. The killer issue with satellite broadband is the cost. Viasat told investors in 2021 that its average revenue per customer was over $93 per month. Rural homes refuse to pay that much for a broadband product that doesn't work.

There are a number of WISPs in the county using fixed wireless technology. There is a long list of reasons why fixed wireless might not work at a given home, many which were discussed earlier.

Rural homes might also have tried cellular hotspots. These are the plans that cellular companies have had for years that basically price home broadband at the same data rates as cellular broadband. During the pandemic, CCG heard from families who were spending $500 to $1,000 per month on a hotspot to enable home-schooling during the pandemic. Cellular coverage is often spotty and poor in most rural areas.

We believe it when a rural household tells us they have no broadband available. They will typically already have tried DSL, fixed wireless, satellite, and a cellular hotpot and decided that none of the technologies work well enough to be worth paying for.

The Gap in Broadband Affordability

The FCC reports that the broadband adoption for the country is around 87% - meaning that is the number of homes that are buying a broadband connection. Even after accounting for the rural areas that have no broadband option, there are many millions of customers that can get broadband at their homes but do not buy it. Numerous studies and surveys have asked why people don't buy broadband when it's available. The number one reason is almost always the price – people say they can't afford broadband.

Statistics on Affordability

In larger cities, it's somewhat easy to equate broadband penetration rates to household incomes. This is because a Census block in a city might be as small as a block or two, and it's easy to match Census data to broadband data from the FCC.

An analysis of recent FCC 477 data shows that there is a direct correlation between household income and buying a home broadband connection. The FCC data from the 2021 FCC Broadband Report shows that only 38.4% of households in the lowest quartile of earnings are buying broadband of at least 10/1 Mbps. The percentage that buys faster broadband drops to only 4.7% of households buying broadband of at least 250/25 Mbps.

Fig. 12
Average County Overall Adoption Rate for Fixed Terrestrial Services by County Level Demographic Variable (December 31, 2019)[166]

	10/1 Mbps	25/3 Mbps	50/5 Mbps	100/10 Mbps	250/25 Mbps
Median Household Income					
First Quartile (Lowest Median Household Income)	38.4%	28.3%	23.4%	20.2%	4.7%
Second Quartile	51.6%	41.6%	36.4%	31.0%	6.0%
Third Quartile	58.8%	47.6%	42.2%	35.2%	6.2%
Fourth Quartile (Highest Median Household Income)	71.2%	61.3%	56.7%	43.8%	8.1%
Population Density					
First Quartile (Lowest Population Density)	48.8%	34.2%	26.8%	22.7%	8.0%
Second Quartile	43.9%	34.3%	30.1%	25.0%	4.8%
Third Quartile	55.1%	46.5%	42.6%	36.0%	5.0%
Fourth Quartile (Highest Population Density)	72.0%	63.6%	58.8%	46.1%	7.8%

There are studies available for those who want to dig deeper into quantitative and qualitative research into broadband affordability for low-income households. The first was published by the Benton Foundation and authored by Dr. Colin Rhinesmith.[16] The second report is issued by the Quello Center and is authored by Bianca Reisdorf.[17] This report looks at a study conducted in three low-income neighborhoods of Detroit.

Both reports say that low-income households with a limited budget appreciate the advantage of having broadband at home but can't fit it into their budgets. They find it difficult or impossible to prioritize broadband compared to paying rent or buying food. These studies indicate that a big part of the solution for getting broadband into homes without it is going to have to involve finding a way to pay for the monthly broadband access.

[16] Digital Inclusion and Meaningful Broadband Initiatives. https://www.benton.org/publications/digital-inclusion-and-meaningful-broadband-adoption-initiatives

[17] Broadband to the Neighborhood. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3103457

The Pew Research Center shows a direct correlation between income and broadband adoption. They've had an ongoing investigation into broadband-related issues since 2000[18]. Pew shows that as of February 2021 that only 57% of homes with household incomes less than $30,000 have broadband, compared to 92% of homes with household incomes over $75,000.

Demographics in Cottonwood County

There are many studies that suggest that demographic factors are a considerable influence on whether homes can afford broadband. This section of the report looks at some of the key demographics in Cottonwood County. These statistics are based on the recent 2020 Census data.

- Population Growth. The 2020 Census reports that the county population declined by 1.5% from 2010 to 2020. The population in Minnesota grew by 7.6%. Most of the population loss in the county came near the end of the Census period and might be related to the pandemic.
- Population Ages. The county has a slightly higher percentage of children at 6.3% than the state average at 5.9%, and a slightly higher percentage of persons under 18 at 25.8% than the state average at 23.1%. Cottonwood County has a higher percentage of those over 65 at 22.4% than the Minnesota average of 16.7%.
- Homeownership. There is a higher percentage of homeownership in the county at 75.9% than the state average of 71.9%. The average home in the county costs $106,900 compared to the state average of $235,700.
- Education. The percentage of those with a high school diploma at 90.1% is slightly lower than the state average of 93.4%. The percentage with a bachelor's degree or higher at 20.7% is significantly lower than the state average of 36.8%.
- Income. The median household income of $51,067 is significantly below the state average of $73,382. Per capita income at $27,709 is lower than the statewide average of $38,881. The percentage of homes in poverty at 11.2% is above the statewide average of 8.3%.

There is a mixed story in the demographics in terms of predicting affordability as an issue. The higher percentage of folks living in poverty indicates that some households might have a problem affording broadband. This finding is bolstered by the high levels of homes classified as low-to-moderate income in Windom and Mountain Lake as identified by HUD and described in detail below. But the lower cost of housing and the high level of home ownership would indicate that a lot of homes can probably afford broadband, even with lower average household incomes.

Income Statistics for Cottonwood County

One of the best sources of demographic data comes from the Department of Housing and Urban Development (HUD). HUD collects nationwide data that is often used when awarding broadband grants. HUD data is used to identify lower-income parts of a community – areas that are often given preference in grants related to housing, economic development, and broadband deployment. Following is what HUD says about Cottonwood County.

[18] Demographics of Internet and Home Broadband Usage in the United States | Pew Research Center. https://www.pewresearch.org/internet/fact-sheet/internet-broadband/?menuItem=2ab2b0be-6364-4d3a-8db7-ae134dbc05cd

HUD (Department of Housing and Urban Development)

The Department of Housing and Urban Development (HUD) was established as a Cabinet Department in 1965. HUD is the federal agency responsible for the national policies and programs that address America's housing needs, enforce fair housing laws, and look for ways to improve neighborhoods with below-average incomes.

HUD Community Development Block Grant (CDBG)

The Community Development Block Grant is a program that must actively benefit low and moderate-income (LMI) persons. The grants can benefit things like housing and jobs. Additionally, services may qualify for CDBG assistance if the activity will benefit all residents of a residential area where at least 51% of the residents are low- and moderate-income persons. The CDBG program is discussed in detail in the funding for broadband networks section of the report.

HUD uses two sources of statistical information to calculate income levels around the country. The two sources are:

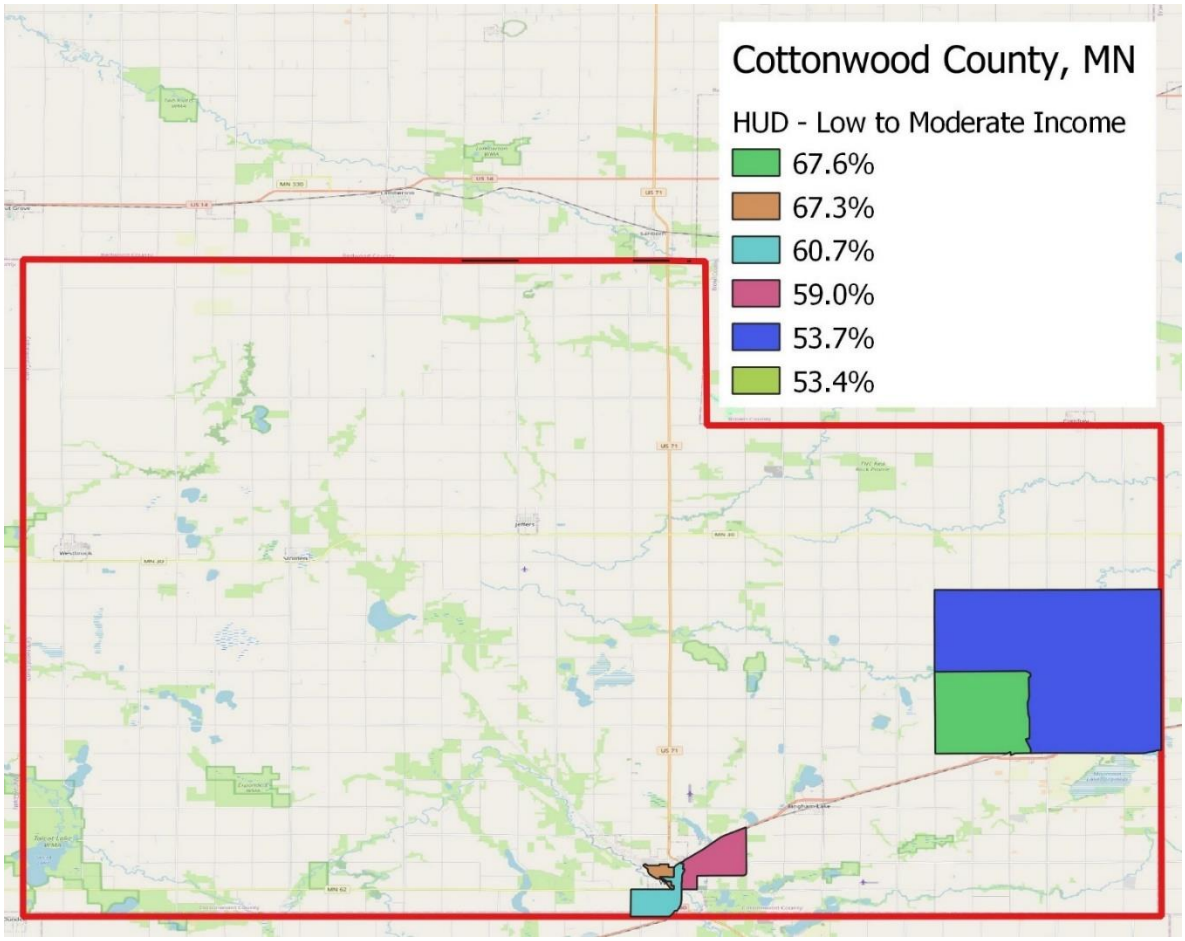
1. The American Community Survey (ACS), and
2. The Income Limits for Metropolitan Areas and for Non-Metropolitan Counties.

HUD calculates the area median income for any area of interest and uses the sources to estimate a community's income. Income levels are classified into three categories:

- Low Income (up to 50% of the Area Median Income (AMI))
- Moderate Income (greater than 50% AMI and up to 80% AMI)
- Medium Income (greater than 80% AMI and 120% AMI)

The CDBG identifies areas where 51% of the population is considered low or moderate-income.

As seen in the map below, HUD identified parts of the cities of Windom and Mountain Lake and areas surrounding Mountain Lake as having over 51% of the population as low to moderate-income. The map reinforces the need to make sure that these parts of the count have an affordable broadband alternative.



American Community Survey (ACS)

The American Community Survey (ACS) is an ongoing nationwide survey conducted by the U.S. Census Bureau that updates information about communities between the 10-year census periods. The ACS gathers information on jobs, occupations, educational attainment, veterans, whether people own or rent their homes, and other topics. The ACS helps local officials, community leaders, and businesses understand the changes taking place in their communities.

ACS Poverty. Household incomes are collected in the ACS survey to measure areas with poverty. This report has detailed the correlation between income and broadband adoption. Lower-income homes often want broadband but can't afford it. The report has also described the importance of having broadband for both students and adults. In Cottonwood County, no areas were identified, with 20% or more of the population in poverty.

The Computer Gap

One of the things that digital inclusion advocates have learned is that it's not enough to get affordable broadband to a home that can't afford a computer or other device to use the broadband. It's also now clear that cell phones are good tools for things like shopping online, but they are inadequate for students trying to do homework. Any plan to close the digital divide must find solutions for closing the computer gap.

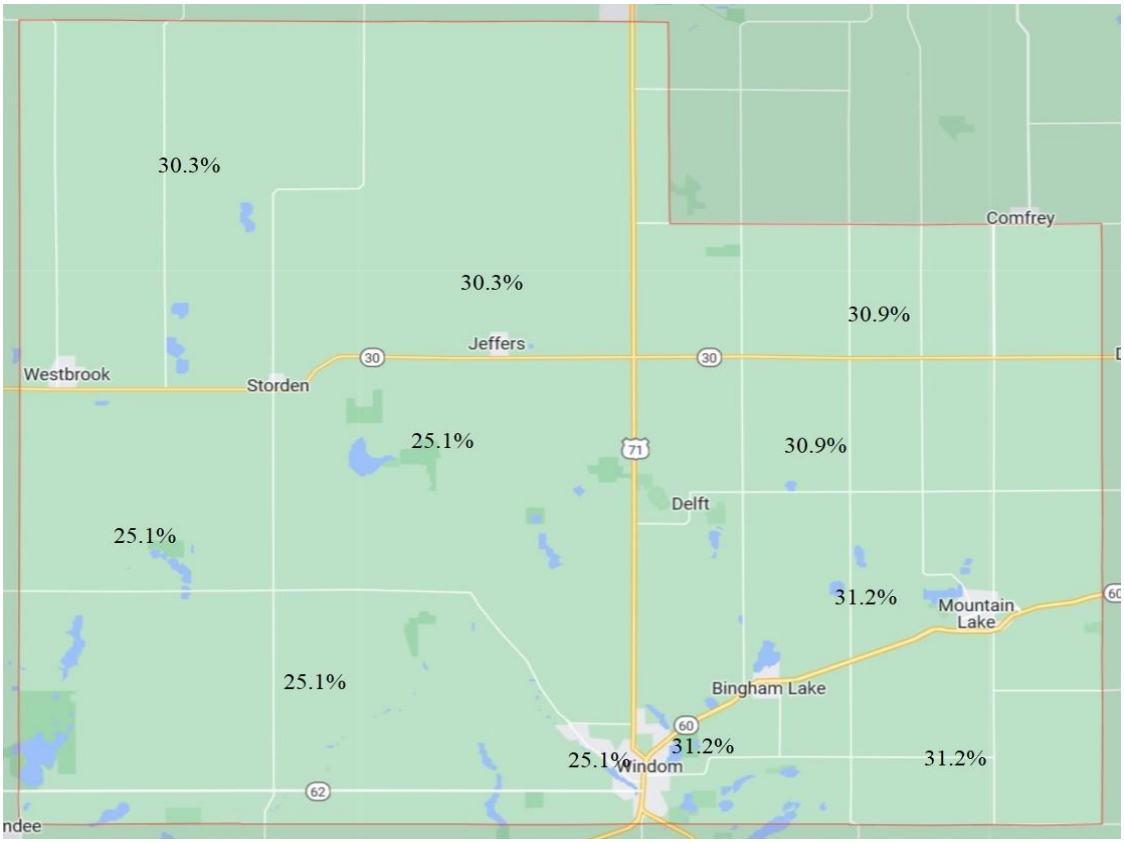
A survey by Pew Research Center in 2021 shows a huge disparity between income and technology adoption. Consider the following results of that poll:

	Less than $30,000	$30,000 to $100,000	Over $100,000
Home Broadband	57%	83%	93%
Smartphone	76%	87%	97%
Desktop	59%	84%	92%
Tablet	41%	53%	68%
All the Above	23%	42%	63%

Other studies have shown that the percentage of homes that have any of these technology tools is even smaller for homes making under $25,000 per year.

A big problem for low-income homes is that they can't afford both broadband and the cost of buying and maintaining a computer or similar device. Computers are some of the shortest-lived electronics we can buy and typically must be replaced every 3 or 4 years.

We created the following map that shows the different levels of computer ownership around the county as calculated by the U.S. Census. The percentage shown represent homes without computers, which varies from 25.1% to 31.2% in different parts of the county.



The percentage of homes without a computer highlights the challenge of bringing a new broadband network to people - a solution is needed for many homes for both a broadband connection and a computer. As will be discussed below, many homes also need computer training.

The historical solution to a lack of computers was to put computers in libraries and public places. However, in communities like the rural parts of counties, this solution is inadequate for many reasons. First, it requires students to travel to where the computers are. In communities where a lot of students don't have computers, it's difficult to have enough to meet the demand. There is the additional issue that rural libraries often don't have good enough broadband to support multiple simultaneous users.

However, the best reason to get computers into homes instead of libraries is that numerous studies have shown that computers in the home have a huge positive impact on students compared to any other alternative. Computers have the biggest positive impact on students when they are a part of daily life and convenient to use when needed.

We can't forget that computers aren't only for students. Adults need computers to participate in the modern world. Computers are needed to hunt for a job. Computers are needed to pursue online training and education. Computers are needed to consider jobs that allow working from home. Computers are needed today to interface with many government programs.

The Gap in Broadband Skills

The current U.S. job market appears to be robust due to the low unemployment rate, which is low by historical standards. However, a closer look at the statistics tells a different story.

Workers with upper-income jobs are faring extremely well. For example, starting demand for computer scientists, engineers, and similar tech jobs is at an all-time high. However, over half of all job openings in the country are classified as middle-skill jobs (with the three categories being high-skilled jobs, middle-skill jobs, and unskilled jobs). These jobs generally don't require a college degree. An analysis by the Benton Foundation a few years ago showed that over 80% of middle-skill jobs require some degree of digital literacy. Unfortunately, a lot of people seeking middle-skill jobs lack the digital skills needed to land these jobs.

This lack of sufficient digital literacy to find middle-skill jobs is perhaps the best way to describe the broadband skills gap. These are not jobs that need coders but rather need people to know basic computer skills like knowing how to use Microsoft Word or Excel. It means being able to type fast enough to do data entry, write emails, or do other expected tasks in the average workplace.

In the early days of the computer age, the federal government operated many training programs that taught basic computer skills. Today it seems to be assumed that students graduate from high school with these skills. However, a student who has never had a home broadband connection or a computer and who only did homework on a cellphone probably doesn't have the needed digital skills. Since the federal and most state governments don't offer any significant training programs in computer literacy, it's up to local communities to find their own solutions.

A Pew Research Center survey in 2016 showed that a lot of adults were interested in digital training. 60% of adults were interested in learning how to use online resources to find trustworthy information. In today's world of misinformation, I would think that percentage is even higher today. 54% of adults were interested in training that would make them more confident in using computers and the Internet.

Future Broadband Gaps

This gap analysis so far has discussed existing broadband gaps. It's important to realize that there will be new broadband gaps coming in the future that we can already predict. One of the issues to consider when looking forward is that broadband speeds are a moving target – that is, the demand for residential and business bandwidth grows every year. This is not a new phenomenon, and the need for bandwidth has been growing at the same rate since the early 1980s. Home and business requirements for bandwidth have been doubling every 3 to 4 years since then.

As an example, 1 Mbps DSL felt really fast in the late 1990s when it was introduced as an upgrade from dial-up Internet. The first 1 Mbps DSL connection was 20 times faster than dial-up, and many people thought that speed would be adequate for many years. However, over time, households needed more speed, and the 1 Mbps connections started to feel too slow; ISPs introduced faster generations of DSL and cable modems that delivered speeds like 6 Mbps, 10 Mbps, and 15 Mbps. Cable modem speeds continued to grow in capacity and eventually surpassed DSL, and in most cities, cable companies have captured the lion's share of the market by offering Internet speeds starting between 100 Mbps and 200 Mbps.

Bandwidth requirements are continuing to grow. Firms like Cisco and Opensignal track speeds achieved by large numbers of households by examining Internet traffic that passes through the major Internet hubs. Both companies estimate that home Internet demand for broadband speeds is growing currently at about 21% annually. Business requirements for broadband speeds are growing at 23% annually.

This report earlier discussed how the FCC set the definition of bandwidth speed in 2015 at 25/3 Mbps. If you accept that speed as an adequate definition of bandwidth in 2015, then growing the requirement for speed every year by 21% would result in the following speed requirements by year.

Download Speeds in Megabits / Second

2015	2016	2017	2018	2019	2020	2021	2022
25	30	37	44	54	65	79	95

This is somewhat arbitrary because it assumes that the broadband needs in 2015 were exactly 25 Mbps. What is not arbitrary is that the need for bandwidth and speed increases over time.

If we accept the premise that 25 Mbps was the right definition of broadband in 2015, then it's reasonable to believe that the definition of download broadband by the end of 2022 ought to be almost 100 Mbps. This is the discussion being held at the federal level, and the FCC has been thinking about changing the definition of download speeds to 100 Mbps. Doing so would say that households that cannot buy a product of at least 100 Mbps download do not have a broadband option.

Broadband is not only measured by speed, and there are firms that track the volume of data that households and businesses use. The firm OpenVault measures total usage by households using software deployed by the biggest ISPs around the country and around the world. Consider the following statistics that show the average nationwide broadband usage by homes. These numbers combine download and upload usage.

1st Quarter 2018	215 Gigabytes
1st Quarter 2019	274 Gigabytes
1st Quarter 2020	403 Gigabytes
1st Quarter 2021	462 Gigabytes
2nd Quarter 2021	433 Gigabytes
3rd Quarter 2021	435 Gigabytes
4th Quarter 2021	536 Gigabytes
1st Quarter 2022	514 Gigabytes

This data shows several things. First, it shows extraordinary growth in the average use of broadband across the country. From the first quarter of 2018 to the first quarter of 2019, the average use of household broadband grew by 27%. Usage skyrocketed due to the pandemic. From the first quarter of 2019 to the first quarter of 2020, during the pandemic, the average use of household broadband grew by an astonishing 47%. During the pandemic in 2020, the average household broadband usage grew by another 20%. In 2021 the use of broadband grew 23% from the end of the first quarter through the end of the year. Broadband usage grew by 11% between the first quarter of 2021 to the first quarter of 2022.

OpenVault only recently began reporting upload and download speeds separately. At the end of the third quarter of 2020, the average home downloaded 359 gigabytes of data and uploaded 25 gigabytes of data. By the end of 2020, average usage had grown to an average of 483 gigabytes of download data and 31 gigabytes of upload data. OpenVault reports an average monthly upload usage of 26 gigabytes at the end of 2021. In the first quarter of 2022, OpenVault reports an average of 481 gigabytes of download data and 33 gigabytes of upload data.

One of the most startling numbers to come from OpenVault is what they call power users – homes that use more than one terabyte of data per month (1,000 gigabytes). Consider the following statistics showing the percentage of homes that use a terabyte of data per month:

4th Quarter 2018	4.0%
4th Quarter 2019	7.3%
1st Quarter 2020	10.0%
4th Quarter 2020	14.1%
2nd Quarter 2021	12.3%
3rd Quarter 2021	10.1%
4th Quarter 2021	15.1%
1st Quarter 2022	14.1%

Within these numbers are also what OpenVault calls extreme power users, which are households that use more than two terabytes of data per month. That's grown from 0.3% of households in 2019 to 2.4% in the first quarter of 2022.

The most interesting recent statistic is the migration of customers to faster broadband tiers. The following table shows the percentage of nationwide households subscribed to various broadband speed plans in 2020, 2021, and 2022.

	June 2020	June 2021	Sept 2021	Dec 2021	Mar 2022
Under 50 Mbps	18.4%	10.5%	9.8%	9.4%	7.6%
50 - 99 Mbps	20.4%	9.6%	8.0%	7.6%	6.3%
100 - 199 Mbps	37.8%	47.5%	38.4%	36.9%	17.0%
200 - 499 Mbps	13.5%	17.2%	27.4%	28.5%	49.7%
500 - 999 Mbps	5.0%	4.7%	5.1%	5.5%	6.1%
1 Gbps	4.9%	10.5%	11.4%	12.2%	13.4%

Between June 2020 and March 2022, the number of households subscribed to gigabit broadband has doubled, while the number subscribed to slower speeds is dropping precipitously. Many millions of homes have upgraded to faster broadband plans.

OpenVault provides some clues as to why homes are upgrading to faster broadband. Consider the following table that shows the percentage of households using different amounts of total monthly broadband.

	June 2018	June 2019	June 2020	June 2021
Less than 100 GB	51.6%	42.7%	34.2%	29.5%
100 - 499 GB	37.7%	39.5%	37.6%	38.6%
500 - 999 GB	8.9%	13.7%	19.4%	21.1%
1 -2 TB	1.7%	3.7%	7.8%	9.3%
Greater than 2 TB	0.1%	0.4%	1.0%	1.5%

The percentage of homes using less than 100 gigabytes per month has dropped by 43% over three years. At the same time, the number of homes using more than a terabyte of data per month has grown by 500% over three years. While there may be no direct correlation between having a faster broadband plan and using more broadband, total broadband usage is one of the factors leading residential customers to upgrade. Another key factor pushing upgrades is customers looking for faster upload speeds to support work and school from home.

The OpenVault data validates what's been reported widely by ISPs – that the pattern of broadband usage is changing by the time of day. For the last decade, the peak period for broadband usage – the busy hour – was always in the evenings. During the pandemic, the volume of usage in the evenings has remained flat while students and home workers increased the broadband used during the daytime.

OpenVault says that nationwide broadband usage peaked in the third week of March 2020. It will be interesting going forward to see how home usage changes. OpenVault doesn't have any better crystal ball than the rest of us, but they are predicting that broadband usage will never return to the historical patterns. They predict that a lot of people will continue to work from home, meaning increased broadband demand during the day. They believe there will be continued pressure on the upload data paths. A lot of people now routinely use video calling, a practice that is likely to continue into the future. Companies and employees that realize they can be productive at home are likely to work more from home, even if only on a part-time basis.

These various statistics are a clear indication that the FCC should be periodically increasing the definition of broadband. The agency looked at broadband speeds in a docket in 2018 and 2020 and decided to keep the definition at 25/3 Mbps. However, there were a lot of compelling filings in that docket that argued that the definition of broadband should be 50 Mbps to 100 Mbps. As this report was being written, Jessica Rosenworcel, the FCC Chairman, suggested to the rest of the FCC that the time has come to raise the definition of broadband to 100/20 Mbps.

The point of this section of the report is that we can't get hung up on the FCC's definition of broadband when looking at the broadband gap. Most people who use broadband would acknowledge that they download and upload a lot more data today than they did just a few years ago.

It's also important to look toward the future when considering broadband needs. For example, if an ISP builds a new broadband solution today, that solution should be prepared to handle the broadband requirements a decade from now. Consider the following chart that predicts broadband needs moving forward. The chart applies the 21% historical annual growth rate for broadband speed, assuming that 100 Mbps is the right definition of broadband in 2022. Forward-looking predictions are often criticized for being too aggressive, but when considering that the demand for broadband speeds has been growing at the same rate since the early 1980s, it is not a big stretch to predict broadband needs into the future.

Download Speeds in Megabits / Second

2022	2023	2024	2025	2026	2027	2028	2029
100	121	146	177	214	259	314	380

The download speeds in this table get really large if extended even further into the future. If the demand for broadband download speed continues to grow at 21% annually, then the need in 2040 would be 2.9 Gbps. It's easy to say that such future speeds are not possible, but recall that just 20 years ago, a 1 Mbps DSL connection was considered to be a blazingly fast broadband connection. The only current technologies that can keep up with this growth in demand are fiber and cable coaxial networks. There is already fiber gear today that can deliver 10 Gbps download speeds, and coaxial networks are expected to have the same capabilities within five or six years.

But for a cable company to grow to meet future speed demand is going to require several major technology upgrades. DOCSIS 3.1 networks can deliver download speeds up to a gigabit today. However, the secret that cable companies don't want to talk about is that they can't give that much speed to everybody unless they build a lot more fiber and further reduce node sizes. There will have to be an expensive upgrade to DOCSIS 4.0 to get speeds faster than 1 gigabit. Cable companies are already failing to meet the demand for upload speeds.

It's not hard to put this prediction into perspective. The large cable companies serve around 65% of all broadband customers in the country, and almost all now advertise a minimum speed of 200 Mbps. The marketing departments at cable companies have regularly been keeping ahead of the demand curve to keep customers happy.

It's not hard to imagine that seven years from now that the national definition of broadband ought to be around 400 Mbps. That doesn't mean that the FCC will continue to increase the regulatory definition.

There is a political downside when the FCC increases the definition of broadband – it reclassifies millions of homes as not having broadband. Today, the 25/3 Mbps definition of broadband is ludicrously lower than the speeds that households want to buy – but politics is always likely to keep a lower regulatory definition than what the market demands.

One of the conclusions that can be reached by this analysis is that any new network built today ought to be capable of meeting the expected broadband speeds for the next decade. The only technologies capable of meeting the projected future needs for download bandwidth are fiber-to-the-premise and cable company hybrid-fiber technology. Cable companies are only going to be able to provide speeds above 1 gigabit by implementing another round of expensive upgrades. There is a lot of speculation in the industry that cable companies will upgrade to fiber-to-the-home rather than make another expensive upgrade on old copper. We're already seeing that commitment from Altice and in some markets by Cox Communications.

D. Benefits of Better Broadband

This section of the report examines the benefits of adequate broadband.

Community Benefits from a Fiber Network

The following are the most common benefits that have been reported for communities that are upgraded to fiber:

Choice

In many parts of the county, residents only have a limited choice for buying broadband. For example, most people living in a city will say that the cable company is the only reasonable choice. Many rural customers don't have any high-quality ISPs.

Lower Prices

We know that overall broadband prices are lower in markets that have multiple competing ISPs. A fiber network in the community would provide a major new competitor. One only has to compare broadband prices in places where Google Fiber or a municipality has built a fiber network to see that it makes a difference. Cable companies typically react to competition by lowering prices to meet (but not beat the competitor) and by stepping up customer service.

Improves Network Maintenance

We know that competition forces all ISPs to keep up with maintenance. This won't happen overnight, but it's inevitable due to the way that big ISPs operate. There is always pressure from corporate headquarters for local managers to cut costs - this is the primary reason that there are problems with cable company networks today. Cable companies don't conspire to be poor ISPs at the corporate level, but they have budgetary practices and a bonus structure that rewards local managers for cutting corners and costs. One of the easiest things to eliminate in a monopoly environment is maintenance. The local managers for the cable companies likely will not eliminate jobs but rather fail to fill vacant positions over time. We've seen

this in practice for decades from the big telcos, which have eliminated a huge percentage of technicians over the last few decades.

Faster Broadband Speeds

A fiber network in the cities would put pressure on the cable companies to offer better speeds, particularly upload speeds. The upload speed issue was described in detail in the broadband GAP analysis. The pandemic highlighted the problems with upload speeds as people experienced problems working and schooling from home. The current technologies deployed by cable companies offer a meager upload data path. The cable companies would need to make a significant investment to achieve faster upload speeds.

Cable technology has been improving rapidly over the last decade. In a few years, the cable companies will have the option to upgrade again to DOCSIS 4.0 – an upgrade that will allow for symmetrical gigabit broadband products to compete against fiber. Cable companies are not motivated to upgrade in a monopoly market. They may end up doing so over time as part of a corporate-wide effort to have the same technology everywhere. But the companies will always upgrade competitive markets before non-competitive ones.

Fiber networks can provide symmetrical uploads data speeds that can easily handle the newly created demands from homes and businesses. There is a lot of consensus among industry experts that a lot of the uses we've found for upload broadband are not going to go away when the pandemic is over. Many employers now understand that employees can be productive working from home while saving the company from operating expensive office space. Telemedicine is likely going to become a routine way to connect with doctors for visits that don't require a physical examination. Video chat has now become a routine way for people to communicate. Gaming continues to grow explosively.

Impact on Housing

There are numerous studies showing that homes without broadband are worth less than similarly placed homes with broadband. Realtors have been reporting across the country that broadband is at or near the top of the wish list for most homebuyers today. From everything we hear, it is now difficult to attract people to move to rural places that don't have good broadband. Without a broadband solution, the rural parts of Labette County will become undesirable places to live, and this is only going to get worse over time as broadband speeds keep increasing in the places that have broadband.

Improved Medical Care

Telemedicine is becoming a routine part of healthcare. Telemedicine requires both a solid upstream and downstream connection and often requires more bandwidth than a connection to a school or office. In the past year, telemedicine visits have skyrocketed. During March and April of 2021, the billings for telemedicine were almost $4 billion, compared to only $60 million for the same months just before the pandemic.

According to a report released by McKinsey & Company[19], we are on the verge of seeing a major shift toward health care performed in the home. The report says that as much as $265 billion in annual fees to Medicare and Medicare Advantage could shift to homes by 2025.

We've already seen the start of the trend toward telemedicine. The spending on telemedicine was 38 times higher in 2021 compared to 2020. Much of that shift is obviously due to the pandemic. The report suggests that by 2025, in-home medical care will increase to three to four times the 2021 level.

The report cites several changes in the healthcare industry that are contributing to the trend for more in-home healthcare:

- 40% of patients who have used telemedicine say they expect to keep using it in the future. It's a big burden on working families to try to get to a doctor's office during the workday, and telemedicine makes it easier for many families to seek health care.
- There are new technologies that make it easier to deal with remote patients. As an example, 20% of all medical practices in April 2021 were using devices that allow for electronic patient monitoring.
- There has been a huge investment made in the digital healthcare market. Venture capital for digital healthcare companies was $29.1 billion in 2021, up from $14.9 billion in 2020 and $8.2 billion in 2019.
- There is a rapidly growing industry that brings health care to the home. I probably don't pay as much attention to this industry as I should, but this is the first time I heard the term Care at Home providers. These are health care professionals that visit patients at home.

The report points out that there are still a lot of changes needed for the industry to fully adopt the Care at Home model. For example, insurance companies must recognize and reimburse in-home care at the same levels as for doctor office and hospital care.

The report suggests that the biggest change will come from the general public, who will insist on in-home care if that is an option. Very few people want to trudge to a health care facility for repetitive treatments like dialysis and infusions. The report predicts that more physician groups will adopt care at home after seeing case studies of the effectiveness of treating patients at home.

The biggest benefit of telemedicine is being able to talk to a specialist without having to make a long trip to some distant city. Another common use of telemedicine is for non-intrusive assistance for things like counseling. Patients can make scheduled appointments without major disruption to work schedules.

A growing area of telemedicine is the use of medical telemetry devices, which can monitor patients after they've had medical procedures. For example, Saint Vincent Health System in Erie, Pennsylvania, has been using these technologies and has lowered the readmission rates of patients after surgery by 44%. CoBank recently sponsored a trial in Georgia for rural diabetes patients and showed a significant improvement for patients who could be monitored daily and who could communicate easily with doctors.

[19] https://www.mckinsey.com/industries/healthcare-systems-and-services/our-insights/from-facility-to-home-how-healthcare-could-shift-by-2025

Amazon recently invested $3.9 billion to buy a healthcare company that concentrates on telemedicine. Amazon thinks it's time to shake up the medical industry as a way to lower costs.

Improved Education

Schools today want to be able to assign computer-based homework but can't when many students don't have good home Internet. Schools want students to be able to use broadband outside the school. An increasingly common practice in places with adequate broadband is to have students watch video content at home as homework and then discuss it later in the classroom. That frees valuable classroom time from watching videos in class. The whole education process is increasingly moving to the web, and kids without access to the web lack the tools that their peers take for granted.

It's getting exceedingly hard to raise kids in a home without adequate broadband. The issue is not just data speeds but also the total amount of downloaded data that even elementary school students need to do homework. This is one of the major problems with satellite broadband, which has speeds up to 50 Mbps, but with tiny data caps and high latency, the satellite broadband is inadequate for doing homework. The same is true with cellular hotspots, and we've heard horror stories of homes with kids with astronomical broadband bills for using broadband hotspots for homework.

The trend is for a huge amount of schoolwork to be offered online. Already before the pandemic, 37% of all graduate degrees contained a significant portion of the coursework online. Fiber is one of the only technologies that allows a busy household with multiple family members to easily pursue online schoolwork or training.

The pandemic showed how hard it could be to connect to a school or the office from home. A connection between a student and a school is typically activated through the creation of a VPN (virtual private network). This is a dedicated connection of bandwidth that is carved out of the Internet path, and that remains open for as long as the connection to the school WAN is open. One of the important aspects of a VPN is that it carves out upload bandwidth as well as download bandwidth. All of the broadband technologies other than fiber have much lower upload speeds than download speeds.

There are characteristics other than broadband speeds that matter. Both VPN connections and video conferencing require reasonable latency (delay) to maintain a connection. Doing schoolwork from home also means using a significant amount of bandwidth during a month, and that raises the issue of data caps and data overage charges.

Education is not only for K-12. Adults are using broadband to train for new job skills or to take advanced courses online. There is a huge range of undergraduate and advanced degrees that are offered mostly online. Online training courses require decent broadband speeds but also low latency since the training is usually done in real time.

The U.S. Bureau of Labor Statistics reported in 2021 that the average American baby boomer held 12.3 different jobs between the ages of 18 and 52. It's much harder to measure a change in careers, meaning a change to doing something drastically different than prior jobs, but researchers have looked at the data and said that most people change careers at least several times during their work life. The above statistics

don't tell the whole story because many people are now working well past 65 years of age, including many older workers starting a new career at the end of their working life.

Many new jobs and careers today require online training. New employees are often expected to complete online training courses at the start of a new job. Many out-of-work adults pursue online training to learn a new career. Anecdotal evidence suggests that taking training or educational courses from a distance (across the country) requires more bandwidth since it's harder to hold a VPN session when the bandwidth varies.

The biggest group of online learners (outside of the COVID-19 crisis) are students pursuing a post-secondary education online. There are almost 20 million college and graduate students across the country, many of whom routinely have a part of a college curriculum online, even if they attend live classes. Secondary education has already been in the process of migrating online. Eduventures estimated that the percentage of students already tackling an online degree before the pandemic was 29% of those pursuing an associate degree, 42% for a bachelor's degree, 27% for a master's degree, and 3% of those working towards a doctorate.

There was a major study performed to look at what is being called the homework gap by the National Center for Education Statistics (NCES),[20] an agency within the U.S. Department of Education. That study compared test scores for 8th-grade students both with and without a home computer. The results showed:

- On tests of reading comprehension, students who have a computer at home had an average score of 268 compared to a score of 247 for students without a computer.
- In testing for mathematics, students with a computer at home scored 285, while those without it scored 262.
- In testing science, students with a computer scored 156 compared to 136 for students without a computer.
- In testing competency in information and communication technology, students with a home computer scored 152, compared to 128 for students without a home computer.

There was recently a definitive study that quantified the impact of the homework gap. The study was released in March 2020 and was done by the Quello Center, part of the Department of Media and Information at Michigan State University.[21] I call this a definite study because it used study techniques that isolate the impact of broadband from other factors such as sex, race, and family incomes. The study involved 3,258 students in Michigan in grades 8 – 11 from schools described as being in rural areas. The study was done in such a way to get results of schoolwork concerning students without violating student confidentiality.

The study showed significant performance differences for students with and without home broadband. Students with no Internet access at home tested lower on a range of metrics, including digital skills, homework completion, and grade point average. Some of the specific findings include

- Students with home Internet access had an overall grade point average of 3.18, while students with no Internet access at home had a GPA of 2.81.

[20] https://nces.ed.gov/pubs2017/2017098/index.asp

[21] http://quello.msu.edu/wp-content/uploads/2020/03/Broadband_Gap_Quello_Report_MSU.pdf

- During the study, 64% of students with no home Internet access sometimes left homework undone, compared to only 17% of students with a high-speed connection at home.
- Students without home Internet access spend an average of 30 minutes longer doing homework each evening.
- The study showed that students with no Internet at home often had no alternative access to broadband, such as a library. 35% of students with no broadband also didn't have a computer at home. 34% of students had no access to alternate sources of broadband such as a library, church, community center, or the home of a neighbor or relative.

One of the most important findings was that there is a huge gap in digital skills for students without home broadband. To quote the study, "*The gap in digital skills between students with no home access or cell phone only and those with fast or slow home Internet access is equivalent to the gap in digital skills between 8th and 11th grade students*." Digital skills not only require competence in working with technology but also means the ability to work efficiently, communicate effectively with others, and manage and evaluate information. This is a devastating finding that students without home broadband fall three grades behind other students in terms of developing digital skills.

Lower digital skills correlate directly to performance on standardized tests. A student who is even modestly below average in digital skills (one standard deviation below the mean) tends to rank nearly seven percentiles lower on the total SAT/PSAT score, five percentiles lower in math, and eight percentiles lower in evidence-based reading and writing.

The study also showed lower expectations for students without broadband at home. For example, 65% of students with fast home broadband have plans to pursue post-secondary education. Only 47% of students with no Internet access have such plans. Students who are even moderately lower in digital skills also are 19% less likely to consider a STEM-related career (that's science, technology, engineering, and math).

Another recent survey[22] was released by the Pew Research Center that looked at the problems uncovered when we sent kids home to learn.

93% of parents in the survey said that K-12 children received some online learning during the pandemic. That alone is big news because it means that 7% of students didn't partake in any online learning.

30% of the parents in homes that tried online learning said that it was somewhat or very difficult to use technology and broadband needed to take classes from home. I think it's fair to say that students who struggled with the technology or who didn't have adequate broadband fared poorly in terms of learning during the pandemic period.

As might be expected, the households that struggled varied by demographic. Low-income homes were twice as prone to struggle with technology, with 36% of low-income homes reporting the problem. Rural areas (39%) had more problems with technology and the Internet than other groups like urban (33%) and suburban (18%). What's scariest about this survey response is that almost one in five suburban kids – areas that likely have the best broadband – struggled with technology and the Internet.

[22] https://www.pewresearch.org/fact-tank/2021/10/01/what-we-know-about-online-learning-and-the-homework-gap-amid-the-pandemic/

About one-third of parents said that children experienced technology issues that were obstacles in completing schoolwork. 27% of parents said students struggled to do homework on cell phones. 16% said students did not have access to computers. 14% said that kids left home to use public WiFi to complete schoolwork and homework. 46% of low-income homes had the biggest technology obstacles compared to 31% of homes with mid-range incomes and 18% of homes with higher incomes.

Black teens were the most heavily disadvantaged during the pandemic. 13% of black students said they were regularly unable to complete homework due to technical issues compared to 4% for white teens and 6% for Hispanic teens.

Household incomes affected the ability to complete schoolwork. 24% of teens from households making less than $30,000 annually said that the lack of a dependable computer or internet connection sometimes hindered them from completing schoolwork, compared to 9% of students living in homes making more than $75,000 annually.

Hopefully, the pandemic is now behind us, and we won't close so many schools again – although even now, schools are closing temporarily due to Covid outbreaks. But even as we return to a normal school year, we need to pause and recognize that the students without home broadband and computers are at a disadvantage compared to their peers even when school is back to normal. Hopefully, we won't stop caring about the homework gap.

Working at Home

An increasing number of jobs today can be done at home, even if only part-time. But people without adequate home broadband can't participate in this part of the economy. Increasingly, companies are willing to hire people who work out of their homes. The beauty of such jobs is that they can be done from anywhere. Working from home is one of the fastest-growing parts of the national economy. Many of your residents could find work that would allow them to work at home and to make a larger income than they can make today locally – if they have great broadband. After years of experiments with telecommuting, companies have seen that employees are often more productive from home due to missing the various distractions that are in the work environment.

The COVID-19 crisis highlighted the need for good home broadband when as many as 30% of the nationwide workforce was sent home to work in March 2020. Across the country, employees that live in rural areas have been unable to work from home due to inadequate broadband.

Working at home requires an encrypted VPN connection for most corporate and government WANs, in the same manner as described above for connecting to school WANs. Working at home is also coming to mean connecting by video conference with others as an alternative to face-to-face meetings. This requires a dedicated 1 – 3 Mbps connection for both upload and download – again, something that is a challenge for somebody working from home with a slow Internet connection.

Both VPN connections and video conferencing require reasonable latency (delay) to maintain a connection. This makes it nearly impossible to make either kind of connection reliably over satellite broadband.

What's become painfully obvious due to the coronavirus crisis is that homes need more than the ability for a student to do homework or a person to work from home – because many homes have multiple students and possibly also more than one adult all trying to function on the Internet at the same time.

U.S.A Today recently reported on the results of the fifth annual survey of the State of Remote Work[23] conducted by Owl Labs and Global Workplace Analytics. The nationwide survey was done last summer at a time when almost one-fourth of workers continued to work at least partially from home.

The survey showed a strong desire of employees to work from home, at least part-time. Here are a few of the most interesting findings from the survey:

- A little more than half of all employees would choose to work full-time from home. 74% of those interviewed said that working at home made them happier.
- Almost half of the workers said they would take a 5% pay cut to continue to work remotely, at least part time.
- 91% of those working at home say they are as productive or more productive than when in the office. 55% say they work more hours at home than when they are in the office.
- Almost one-fourth of employees said they would quit their jobs if they couldn't work remotely. For context, this survey was done at a time when employees were quitting jobs at historic rates.
- A lot of employees changed jobs during the pandemic. 90% of them were looking for a better career. 88% also wanted a better work-life balance. 87% were looking for less stress. 84% wanted more flexibility for where they work, and 82% wanted more flexibility for when they work.
- A lot of people relocated during the pandemic, which was made easier when working from home. Two-thirds of employees who relocated were between the ages of 26 and 40. Interestingly to those reading this paper, 63% of employees who moved from urban areas to rural areas were in this age group. More than half of those that moved from suburban to rural areas also were in the younger age group.

This survey shows similar results to other surveys taken over the last few years. It seems that many people got a taste of working from home and decided that they liked it more than going to the office every day. A lot of employers are starting to demand that workers return to the office, and many have been reporting a mass exodus of employees who don't wish to come back.

This has a lot of implications for rural and suburban communities. Many people want to get away from the stress of urban life and lead a more relaxing lifestyle – but they need good broadband to do so. Remote workers don't want mediocre broadband and need reliable broadband that allows them to always connect remotely as needed. 56% of younger workers said they would love to incorporate virtual reality and virtual meetings into the workday – something that will require fast upload and download speeds.

From an economic development perspective, work-from-home employees are a huge boon to a rural community that has likely been aging and slowly shrinking over time. Employees making good salaries can provide a huge boost to a local economy. For years, rural communities have sunk big tax incentives into trying to attract new employers. It probably costs a lot less to attract one hundred remote workers than to lure a traditional employer that will bring a hundred jobs.

[23] https://www.usatoday.com/story/money/2021/11/11/workplace-survey-remote-pay-cut-covid/6367601001/

I have rural clients that operate rural fiber networks who tell me that their communities are seeing a new demand for building new homes and that housing prices are increasing as people want to move to the community. This presents an interesting challenge to rural communities wondering how to get the word out to prospective work-from-home employees. This is a new challenge that is a 180-degree turn from traditional economic development efforts, but communities that master it ought to grow and thrive and bring fresh breath into aging communities.

Taking Part in the Modern World

People with good broadband have access to features of the web that require bandwidth. Households with good bandwidth routinely use broadband for things like watching videos on services like Netflix, talking to friends and family on services like Skype, playing video games (many of which have largely moved online), taking online courses from numerous colleges, or even just browsing today's video-rich Internet. Many of the businesses people now interact with (utilities, insurance companies, shipping companies, etc.) assume that people have a broadband connection. Many people's social lives, for better or worse, have moved to the web; it is not uncommon to now have friends all over the country based upon some shared interest instead of based upon geographic proximity. Homes without broadband can't participate in any of these many activities and services available on the web.

Taking part in the modern world has grown to mean a lot more than just watching videos. Consider some of the following ways that a lot of households routinely use bandwidth:

- Security. Millions of homes now have video cameras at the front door or elsewhere on their property that they can view remotely. A video camera requires a 1 – 3 Mbps upload connection for low-resolution cameras and up to 16 Mbps upload for an HD-quality camera.
- Machine-to-Machine Traffic. Our devices often connect with the Internet without human intervention. Our computers and smartphones automatically upgrade software and apps. Many homes have files automatically backed-up in cloud storage. Numerous appliances and devices in our home periodically connect with the cloud, whether providing updates or just making sure that the connection is still live. Many cars now communicate with the cloud when they get into range of a home broadband connection to provide a log of all car sensors and to upload driving data that can later be used by the car owner. Cisco predicted early this year that this traffic would represent over 50% of all the traffic on the web by 2023.
- Online Everything. Many of the functions we do have migrated to being only online – we couldn't even begin to make a full list of things that are largely now online. This includes both major and minor functions, including things like applying for a job, applying for government benefits, making insurance claims, making reservations for a restaurant, banking, and a slew of other activities. Homes without broadband are being left out of numerous activities that everybody else takes for granted.

Keeping Talent at Home

An issue we often hear about in rural communities is what is called the "rural brain drain." Most rural counties don't have enough good-paying jobs to keep recent graduates home, and so large percentages of each graduating class migrate to larger cities and towns to pursue careers. One of the promises of fiber is

the ability to create new jobs and to provide the opportunity for people to either work at home or to create new businesses that allow them to stay where they want to live.

Entrepreneurship

Many communities have success stories of companies that started in a home that are now significant employers in the community. Many communities have developed business incubator sites to support and promote start-up businesses. Good home broadband is essential for a start-up ecosystem.

Economic Development

Many communities claim huge economic development benefits from building fiber. Communities often tout fiber as part of the package used to attract new businesses and industries. An example is Lafayette, Louisiana, which leveraged fiber to attract several major companies that engage in computer animation – and much of the animation and special effects for movies is now created there. One of the biggest claims for the benefits of municipal broadband is detailed in a study by Bento J. Lobo that quantifies the benefits of fiber in Chattanooga, Tennessee, to be $2.69 billion over ten years.[24]

But economic development successes don't have to be that dramatic. The pandemic has convinced millions of people that they no longer want to live in major cities. Almost every community that CCG is working with is seeing an influx of people looking to live in smaller and less hectic communities. A giant piece of the new economy are folks who can work from home – and many of them can work from anywhere. Traditional economic development efforts would normally be thrilled to attract a new business with a hundred high-paying jobs. The same economic benefit can be achieved by attracting the same number of high-paid workers who work out of their homes.

Of course, affordable fiber also benefits traditional economic development and can be used to help lure new businesses to the city. Communities without ubiquitous fiber are now at a major economic disadvantage compared to communities with fiber.

Keeping Profits at Home

The profits from retail telecom and broadband have always left the county and gone into the coffers of the big telcos and cable companies. Economists universally estimate that keeping such profits within the community has an overall multiplier benefit of 7 to 9 times the cash that doesn't leave town. A local ISP network would keep much of this profit within the community.

Better Cellular Networks

5G is going to eventually allow for faster cellular networks in cities. For 5G to work optimally, a cell site must be closer to customers than today's cellular network. That means placing smaller cellular transmitters

[24] https://assets.epb.com/media/Lobo%20-%20Ten%20Years%20of%20Fiber%20Infrastructure%20in%20Hamilton%20County%20TN_Published.pdf

on utility poles and light poles throughout the city. A city with a fiber network will be able to accommodate the best 5G network since cellular companies will be able to place small cell sites in the optimum locations.

Ubiquitous or Expanded Public WiFi

Many communities provide some WiFi access to citizens in places like libraries, city halls, and perhaps in a few locations like parks or other commonly used public spaces. However, with a fiber network, a community can offer WiFi in many more places since the WiFi hot spot transmitters could be connected to almost any pole. This ability comes at a time when outdoor hotspots have improved significantly, and it's a viable idea to provide wide WiFi coverage.

This idea also comes with a word of caution. Many cities have been sold on the idea that they can generate enough revenues from public WiFi systems to cover the cost of the network. We have never heard of a WiFi network that was able to generate enough revenues to cover costs. We recommend looking at WiFi as an awesome public benefit but not as a profit center.

More Efficient Businesses

One of the biggest beneficiaries of fiber broadband is the business community. CCG has conducted interviews with businesses all over the country both before and after they got fiber broadband, and almost universally, we find that fiber frees businesses to fully take advantage of all of the ways that broadband can help their business. Many of the benefits come from better upload speeds because businesses can be far more restricted by poor upload speeds than residents. Following are some of the most important ways that businesses use broadband. Faster, low latency broadband makes it easier to do most of the following:

- Communicating with Customers. Businesses routinely have portals that make it easy for customers to place and track orders and communicate with the business. Inadequate broadband means lower sales. The old days of calling purchasing agents are slowly passing away, and most commerce between companies is becoming automated – which improves accuracy and speeds up the ordering process. A business that operates a busy e-commerce ordering site needs enormous amounts of bandwidth to make sure that all customers have a successful purchasing experience.
- Communicating with Vendors. Businesses also routinely use the portals of their own vendors and suppliers to buy whatever they need to operate.
- Communicating with Other Branches of the Company. Many businesses are part of larger corporations and maintain open data connections to communicate with other parts of the company and with headquarters. It's not unusual for a business to operate a constant VPN connection back to the parent company.
- Working in the Cloud. It's now common for companies to work in the cloud using data that's stored somewhere offsite. This can be in one of the big public clouds like the ones offered by Amazon, Google, Microsoft, or a private cloud available only to employees of the business. This is the change in the ways that companies operate that has probably created the biggest growth in the need for business bandwidth. Much of the routine software that companies use now works in the cloud, meaning that employees retrieve and save documents and data constantly to and from the cloud servers. A company that relies on the cloud comes to a halt when the Internet connection isn't working. This is leading businesses to seek broadband connections from more than one ISP.

- Security Systems. Businesses often have their security monitored by offsite firms. Security today also means the use of numerous video cameras (and the ensuing video streams) used to monitor the inside and outside of a business. Video cameras can require significant upload bandwidth.
- Sending and Receiving Large Data Files. Most businesses report that the size of data files they routinely transmit and receive has grown significantly larger over the last few years.
- VoIP. Many businesses now provide voice communications between their various branches using Voice over IP. A reliable VoIP system needs to have dedicated bandwidth that is guaranteed and that won't vary according to other demands for bandwidth within the business.
- Communicating via Video. We've finally reached the time when employees routinely communicate via video conferences like Zoom. We saw a huge surge in this during the pandemic as students and employees increasingly used video conferencing services, but these services had already started to become routine for businesses before the crisis.
- Collaborative Software. While many businesses still rely on email, many have gone to more advanced communications systems that let parties connect in a wide variety of ways. Businesses are using collaborative tools that let multiple employees from various locations work on documents or other materials in real time. This software requires a steady upload and download data path.
- Supporting Remote Employees. Supporting employees that work from home is a major new requirement for many businesses. Communicating with remote employees most generally is done by creating a virtual private network (VPN) connection with each employee. For a business, this means establishing both a dedicated upload and download link for each remote employee. These connections can vary between 1 – 3 Mbps per second in both the upload and download directions.
- Data Backup. Companies are wary of hacking and ransomware and routinely maintain several remote copies of all critical data to allow them to restore data after a problem.
- Internet of Things Sensors. Companies of all sizes now routinely use devices that include sensors that communicate with the Internet. Common uses of sensors might be for burglar alarm systems or manufacturing equipment. A lot of office equipment like printers, copiers, postage machines, and others only function properly when connected to the Internet.

Smart Government

Over the years, the idea of smart government has evolved. A decade ago, the vision meant having a city full of surveillance cameras to cut down on crime and smart traffic systems to eliminate traffic congestion. But over time, the vision has expanded. Consider some of the following smart government applications:

- Environmental Monitoring. Sensors are used to monitor air, water, and noise pollution.
- Smart Watering Systems. This means using sensors to water public parks and lands only when needed and only with as much water as needed. This reduces labor and saves on water.
- Parking Management. Smart monitors can keep track of open parking spaces to make it easier for the public to park. Smart systems can also increase revenues from parking fees. Monitors can also identify illegal parking that might block first responders.
- Smart Lighting. Smart lighting can save huge amounts of money by turning lights on and off as needed. Smart lighting also identifies broken or burned-out lights.
- Waste Management. Public trashcans can signal when they need to be emptied. Some communities are also considering the idea of waste pickup on demand for businesses that generate a lot of waste.
- Outdoor WiFi. Communities are providing powerful and temporary WiFi networks to support street fairs, parades, and other outdoor events.

- Smart Traffic. It turns out that smart traffic systems are a lot harder to make work than once imagined. But we are seeing cities like Pittsburgh that are using software to reduce traffic congestion during rush hour by as much as 40%. Cities can study traffic at intersections to identify needed changes to signals or signs. Cities are automating public transportation to be more efficient.
- Smart Law Enforcement. Video is becoming a big part of law enforcement and having a broadband network makes this easier and more functional. Many jurisdictions have gone to a virtual arraignment where prisoners don't have to be transported from jail to court to make an appearance before a judge. With broadband everywhere, this can be expanded to work from anywhere. We know courts during the pandemic that now allow virtual witnesses. Broadband sites around the community can make it easier for police to upload files from personal cameras. For example, the community can create numerous high-bandwidth hotspots in places that are convenient for squad cars. Files can be automatically uploaded by parking near these locations. Many communities are also partnering with citizens to create surveillance networks based on Ring security cameras. 911 systems are being expanded to allow for information for first responders, like a floor plan of a building that is on fire.

Smart Water Systems

It's been estimated that as much as 50% of drinking water is lost to leaks in some systems, with even good systems losing as much as 20% of water. A smart water system starts with placing numerous sensors throughout a water network to gather information on water flow and pressure. Once engineers understand the normal water flow in a system, then any deviations and drops in water pressure are an immediate signal that there is a new leak in the system.

Another big improvement is to upgrade to more accurate water meters that are connected to broadband. Engineers have estimated that as many as 40% of the meters used to serve high-volume commercial customers underreport the amount of water being used and consequently underbill for water usage.

Once more accurate water meters are installed, it becomes possible to start identifying long-standing water leak problems. It's possible to build computer models for small sections of a water system to be able to compare the amount of water entering a neighborhood compared to what is reaching meters.

Smart Grid

Smart grid represents a number of technologies used to improve the local power grid. Most of these technologies can be improved by better broadband.

- Smart Meters. Accurately measuring electric consumption gives customers the ability to monitor and change electric consumption easily.
- Load Controls. This allows the utility to understand usage by neighborhood. It allows utilities to turn off a customer's air conditioning at times of peak usage.
- Integrating Renewable Power. The characteristics of renewable power are far different than generated power. Smart grid technology helps to seamlessly integrate solar, wind, and generated power.

- Controlling Devices. The grid operator can monitor and control transformers, reclosers, and any other field electric device. This saves on truck rolls, speeds up outage repairs, and makes the grid more efficient.
- Monitoring the Network. Electric companies have historically monitored the performance of substations to identify when neighborhoods lose power. However, a ubiquitous fiber network can effectively pinpoint power outages to the exact homes that have lost power and can significantly speed up restoring outages.

Resiliency

Having a widespread fiber network provides an alternative source of broadband for key anchor institutions like hospitals, schools, the 911 center, and fire stations. This can also be a vital benefit to large employers. Connecting the important parts of a community to more than one ISP can help assure that critical services don't go offline.

We have seen fiber networks stay connected when other networks fail. As an example, the municipal fiber network in Lafayette, Louisiana, was the only network that didn't go dark during Hurricane Katrina. Both the telephone and cable TV companies went dark for several days. Part of this reason is that fiber wires are smaller, lighter, and stronger than some other kinds of wires - fiber doesn't break as easily from falling limbs. But fiber also doesn't carry electricity, and the loss of electrical power is often the reason that other networks go dead.

Specific Industries

Almost every part of the economy has unique and specific uses for broadband. Following are two examples that we think are germane to the county. We could make a similar list for dozens of major industries, so the following are just a few examples of how various industries have adopted software and processes that require broadband.

Agriculture Goes Digital

Farmers often say today that they feel more like an IT professional than a farmer because modern farms have automated many functions that need broadband connectivity, including the following:

Controlling Equipment and Machinery. Almost all farm equipment used for plowing, seeding, weeding, and harvesting are now available as self-driving units. Broadband is required to direct the equipment precisely where to operate. Many farms still send along a person to make sure the equipment does what it's supposed to, but we already see farms where the equipment works autonomously. There are also many other forms of automated equipment, like corn dryers, watering systems, etc. that have been automated and can be controlled by the farmers from anywhere.

Tracking Soil Conditions. Many farms now do an annual census of soil conditions to identify the nutrient and other important aspects of each part of every field. These censuses are done using tractors or drones and can develop terabyte-sized files that must be loaded

into the cloud to be analyzed by agronomists. We are getting close to having 24/7 field monitoring through sensors scattered around fields.

Monitoring Herds. Livestock farms are probably the most advanced in terms of automation. Dairy farmers track the status of each cow in detail in order to keep cows in top health to produce the most milk.

Tracking the Market. Farmers have gotten sophisticated and can directly sell their crops on worldwide markets, which means staying abreast of crop prices across the world market.

Supporting Farm Workers. Farmers that need seasonal labor are in competition with other farmers since there is a shortage of workers. Farmers that can provide broadband so that workers can stay in touch with their families have a better chance of finding the help they need. There are also online forums for finding workers.

Smart Factories

New factories have gotten highly sophisticated in terms of automation, which usually requires connections to cloud software. Some of the ways that smart factories need broadband include:

Controlling Robots. Modern factories have automated as many manufacturing processes as possible. Moving materials around the factory, assembling, packing, and shipping are automated as much as possible. The workforce in a modern factory is there to perform the functions that can't be automated and to maintain the automated equipment. Much of the instructions that control machinery come from the cloud in real time.

Controlling Manufacturing Processes. Processes that involve the mixing of chemicals and other complex processes have been automated as much as possible. This allows for precisely following the detailed steps needed for chemical processes, which allows for the manufacture of complex drugs and other chemicals and materials that can't be done manually.

Customization of Products. Smart factories are adept at customizing products and tracking each permutation of a project from start to shipping.

Supply Chain Management. Factories are saving a lot of money by not having to warehouse raw components and materials. The goal is to have components show up at the factory only when needed. This requires a highly sophisticated ordering and shipping program.

II. Engineering Design and Cost

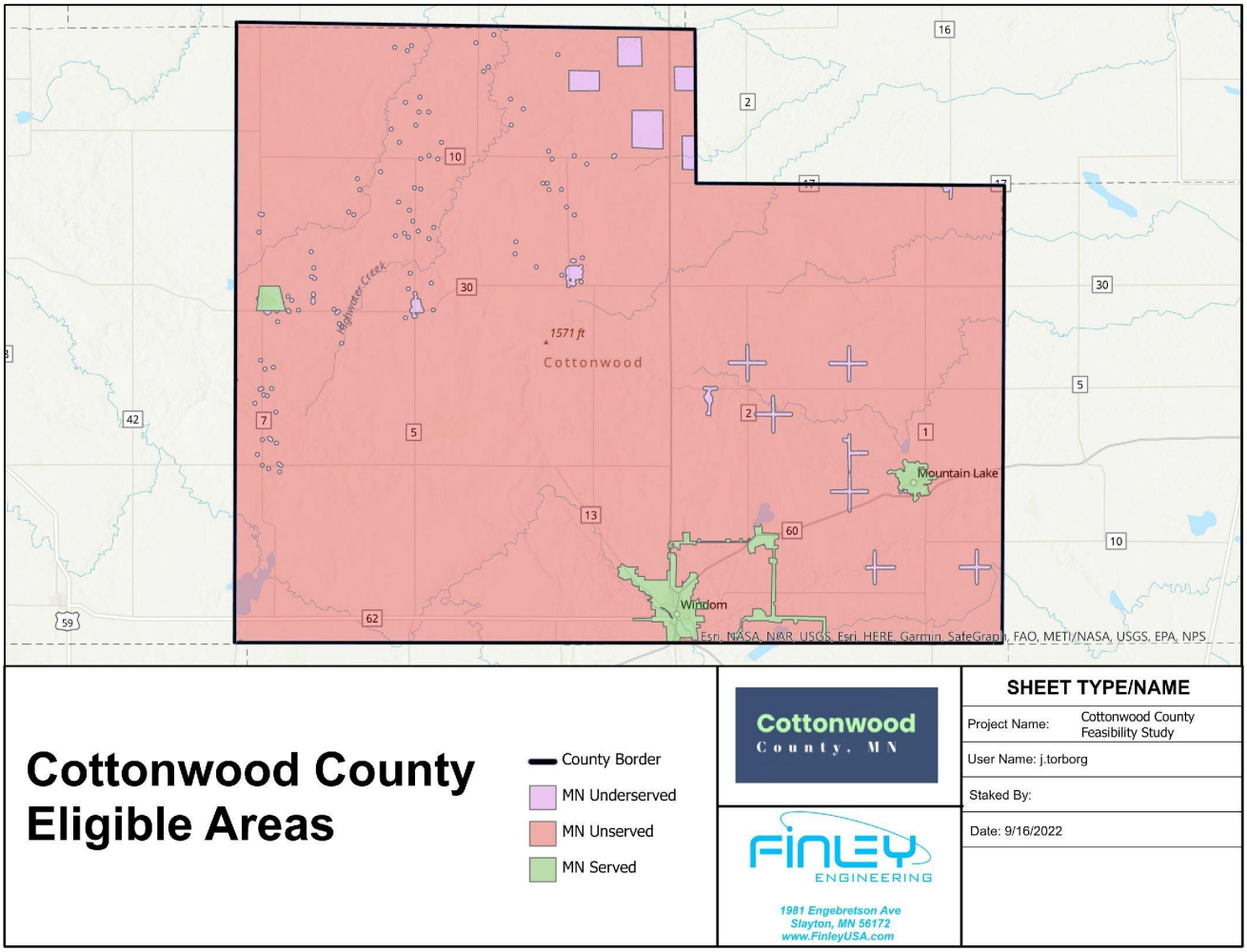
The first section below looks at the parameters used to design a fiber solution for the county. The second section looks at existing technologies in the county as well as technologies on the near horizon.

A. Fiber Network Design

Finley Engineering performed an engineering analysis and prepared a cost estimate of the cost of building broadband in unserved and underserved parts of Cottonwood County. Before looking at the specific network designs, we gathered information about the county and the existing broadband services in the county for use in all of the scenarios. Following is a description of the data we gathered and the approach we took to the engineering analysis.

The Study Area

The county asked us to study bringing fiber to all parts of the county that are either unserved or underserved today, and for which there are no plans to bring fiber in the next few years. The following map shows these areas in red and purple. A larger copy of the map is available in Exhibit I.

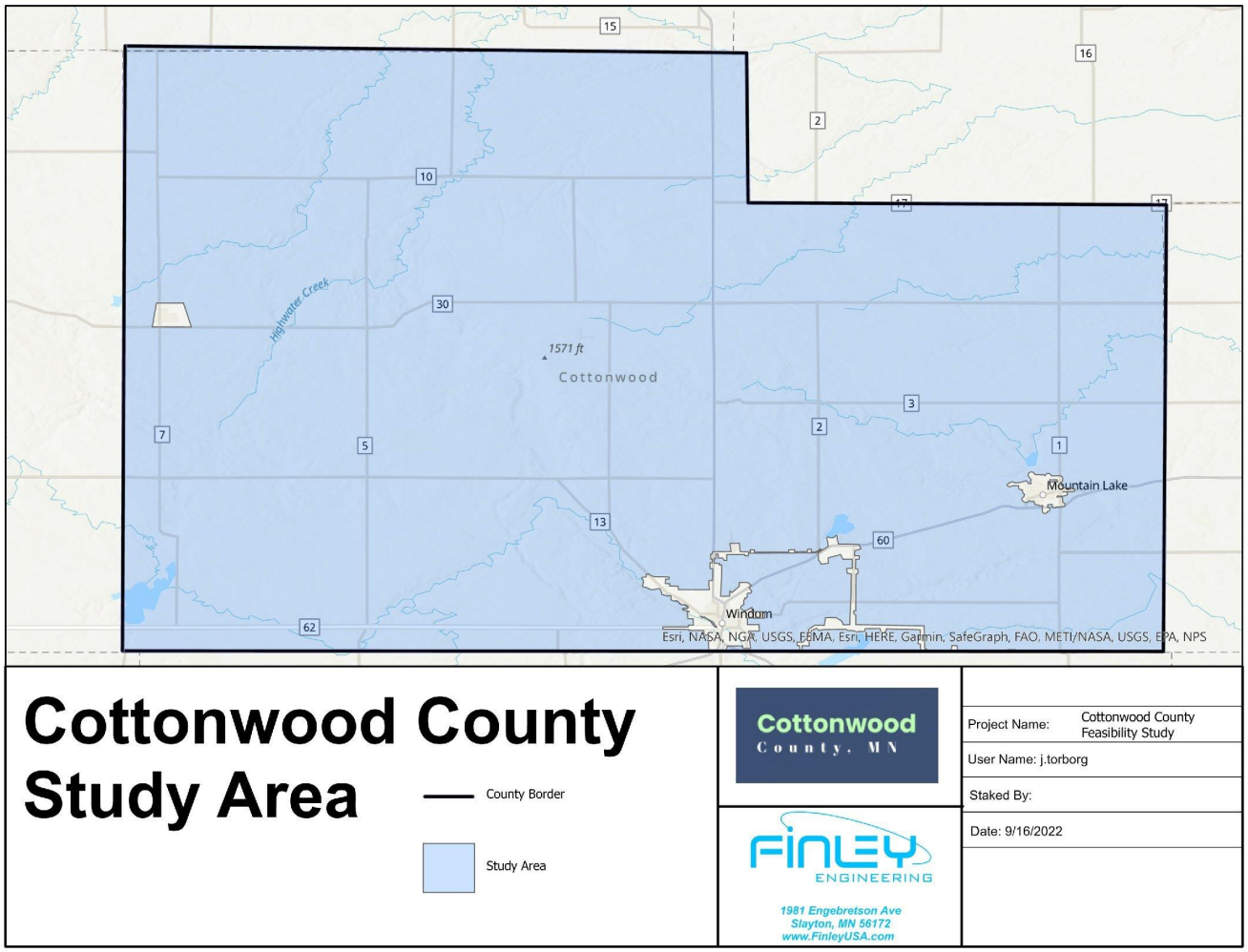


We defined unserved and underserved areas using maps and data from both the State of Minnesota and federal databases. Current state and federal grants define an unserved location as one that lacks access to 25/3 Mbps. Underserved is defined as locations that lack access to speeds between 25/3 Mbps and 100/20 Mbps. Served locations are that that have access to broadband at 100/20 Mbps or faster from any provider.

We also researched and talked to wireline ISPs that operate in the county. We looked at data from recent FCC 477 filings and asked ISPs about the level of service they offer today and any plans for future upgrades. Below is a summary of what we learned about the ISPs.

- CenturyLink. This incumbent telephone company provides service in several exchanges in the southern and western part of the county. The company mostly provides DSL service on copper wires. The company has used FCC CAF II funding to upgrade existing DSL nodes, drive fiber farther into their network, and shorten copper loop lengths to increase speeds. However, these upgrades have limited effectiveness in rural areas because of the aging copper infrastructure and the long rural loops. These upgrades do not provide a long-term path for upgrading to fiber-to-the-home. All CenturyLink rural areas are included in the study area.
- Frontier. – This incumbent telephone company provides service in several exchanges in the north and eastern parts of the county. Like CenturyLink, the technology deployed is DSL, and these areas are included in the study area.
- Nuvera. – This incumbent telephone company serves a small area south of Sanborn. The company provides a mixture of DSL on copper lines and some fixed wireless technology. These areas were included in the study area.
- Arvig – This incumbent telephone company provides DSL service on copper wires in the Walnut Grove area. This area was included in the study area.
- Mediacom. This is an incumbent cable company that provides broadband and the triple-play services in Mountain Lake. The company can provide speeds faster than 100/20 Mbps and its customers are considered served. This area was excluded from the study area.
- Woodstock Communications. The company provides broadband using fiber-to-the-home in Westbrook. This area was excluded from the study area.
- Windomnet. This is a municipal ISP that provides fiber-to-the-home in Windom and a small outlying area. These areas are excluded from the study area.
- Southwest Minnesota Broadband Services (SMBS) This is a municipally-owned business that provides fiber-to-the-home to an area outside of Windom. These areas are excluded from the study area.
- Fixed Wireless – LTD Broadband, Lismore Telephone Company, Federated Broadband, Nuvera, Rise Broadband, and MVTV all provided fixed wireless services in the county. T-Mobile and Verizon provide cellular hot spots in various parts of the county. These areas were included in the study area.

In summary, we found that the towns of Bingham Lake, Westbrook, Windom, and Mountain Lake are considered served along with a few rural areas east of Windom. These areas were removed from the study area. The following map shows the study area in blue. A larger version of the map is available in Exhibit I.



Passings

The telecom industry uses the term passing to mean any home or business is an eligible broadband customer.

Cottonwood County does not have an extensive GIS system. We contacted the South Central Electric Association, which is the rural electric cooperative that services the majority of the rural areas in the county. We worked with them to evaluate passing locations through their GIS meter data. This information was used as the primary resource for determining the passings. The GIS data shows 2,135 passings in the study area that do not currently have access to 100/20 Mbps broadband. Following is a list of the passings by Township.

In Townships	Study Area
Amboy	97
Amo	80
Ann	82
Carson	152
Dale	89

Delton	74
Germantown	95
Great Bend	121
Highwater	87
Lakeside	71
Midway	101
Mountain Lake	102
Rose Hill	88
Selma	97
Southbrook	54
Springfield	74
Storden	108
Westbrook	132
Subtotal	1,704

In Cities	Study Area
Bingham Lake	6
Jeffers	250
Storden	175
Subtotal	431
Grand Total	**2,135**

Road Miles. We used a combination of GIS data, satellite imagery, and MNDOT maps of streets and roads were used to determine the fiber routes in the study area. We determined that 707 miles of fiber construction are required to reach every home and business in the study area.

Aerial Versus Buried Construction

We considered both aerial and buried construction for the fiber. The following are a few key issues that we use to decide the best method of construction.

Cost. Most fiber overbuilders will choose the lowest-cost construction option. There will be places in a network where it saves money to bury fiber rather than put it on a pole. This could be due to costly aerial construction due to poles that are already full of wires from other utilities. It could be a timing issue where the delay involved in waiting to coordinate getting onto busy poles adds too much cost to a project. It's important to note that labor is the highest cost of building fiber – so choosing a construction method with the least amount of labor effort is almost always the lowest cost alternative.

Topography. There are always local factors that might favor either aerial or buried construction. For example, areas with underlying rock and escarpment can make it too expensive to bury fiber. Building through heavy woods might make it too expensive for aerial fiber.

Special Circumstances. There are special circumstances that can make it more expensive and time-consuming to build fiber. For example, it's often expensive and time-consuming to gain the needed rights-of-way to build fiber across bridges, under railroad tracks, or under freeway overpasses. There are sometimes extra steps and costs to build along state highways. Some communities insist on burying fiber for aesthetic reasons.

Rights-of-Way. Most public roads already have a defined public right-of-way along the sides of roads. Such areas are usually designated by state laws or local ordinances that specifically define the right-of-way. Utilities are allowed to construct in existing rights-of-way, but only to the extent that they do so without harming existing utility infrastructure. Construction can be quickly more complicated if the project needs to build in areas where there are no pre-defined public rights-of-way, such as building on private lands or roads.

Maintenance. Sometimes there are external factors that influence the aerial versus buried discussion. Aerial fiber can be more expensive in the long run where there is expected damage from weather, such as hurricanes, ice storms, or high winds. Some ISPS choose aerial fiber in areas with recurring flooding. The threat of expensive repairs can make it worth spending more to bury the fiber.

Aerial Fiber Basics. There are several factors that can influence the cost of aerial cable. Probably the key factor is the location of the new fiber on existing poles. There are two possible ways to put fiber on poles. Electric utilities have the option of putting fiber in the power space, meaning close to the existing electric lines. If the new fiber is to be placed closer than 40 inches from the neutral wire, the installation must be done using contractors who are qualified to work in the energized supply space. This adds to the installation cost since qualified installers with that skill generally are paid higher salaries than other installers. Electric companies rarely allow anybody else to use the power space.

All other fiber must be placed in what's called the communications space, which is everything more than 40 inches below the electric neutral wire. The biggest issue with using the communications space is if there is enough room for the new fiber wire. The NESC electrical code requires specific clearances between distinct kinds of cables on poles, and any new construction is expected to meet these codes. There must be sufficient space between the different providers on a pole. For example, a new fiber must be separated 18 inches from the cable above or below it. There are also minimum clearance rules for the lowest that any cable can be above ground for the safety of those beneath the pole. These rules are in place to provide safety for technicians that work on cables during and after storm damage.

Invariably there will be poles that have sufficient room for new fiber and other poles that are too full, where the spacing is not adequate for new fiber. This often differs from pole to pole, even on the same street. Some of the spacing issues might be due to poles that are too short or where shoddy construction was used in the past by other utilities.

When there is not enough room to put new fiber, something called make-ready is triggered. Make-ready rules have been established by the FCC and by state regulators and are a highly specific set of processes that must be followed to add a new wire to a pole that is too full. The most important aspect of make-ready is that federal rules dictate that cost of make-ready is fully the responsibility of the new provider.

That seems particularly unfair when many of the problems might be due to poor practices by a cable or telephone company that hung wires that didn't meet the code.

Make-ready costs are of two types – rearranging poles or replacing poles. On many poles, the space can be made for a new provider by moving existing wires higher or lower to make space. This can be time-consuming because the rules require that the existing wire owners be given the opportunity to do the work themselves. It can take a while to coordinate this process when there are multiple companies with facilities on a pole. It's also fairly common for competitors of a new fiber provider to take as much time as possible in this process.

Sometimes poles are so full or in bad shape that the only way to fit a new fiber is to replace a pole with a taller one. The cost of placing the new pole and of moving everybody else's wires to the new pole is also the responsibility and cost for a new fiber builder. This process can take even a longer time than the process of moving wires.

It's not unusual for a fiber builder to decide in some cases that it's far easier and less expensive to bury the fiber rather than slog through the time-consuming and expensive make-ready process. A new fiber builder might decide on certain streets that the time saved by burying might be worth the extra cost.

One-Touch Make-Ready. The FCC passed new rules that went into effect in May of 2019 that are supposed to make it easier to get onto poles. The new rules apply only in the thirty states that follow FCC pole attachment rules, and Minnesota is one of those states.

The most meaningful change in the rules is a new classification of poles as either simple or complex make-ready. The order defines how to make this classification. Simple poles are generally those where rearranging wires is all that is needed to fit in a new fiber wire. Complex poles are those that either need extensive work or full replacement. In practice, the new attacher will suggest this determination, although it could get overruled by the pole owner.

There are streamlined new rules and timelines for completing the make-ready on simple poles. If the pole owner is unwilling to commit to fixing simple poles in the needed time frame, then the new attacher can make the changes after properly notifying the pole owner. The new attacher is free to rearrange any existing wires as needed after having properly notified all the parties. These new rules eliminate situations where a pole owner refuses to cooperate with a new attacher, as happened in a few cities where AT&T fought Google Fiber. Something to consider is that the rules require using a make-ready contractor that has been pre-approved by the pole owner – but there are ways around this in some circumstances.

These new rules can mean a significant improvement in the construction schedule where the needed changes are for simple poles. However, the new rules are not necessarily faster for complex poles. Those are poles where the make-ready could cause damage to existing wires or where the old pole must be replaced. The make-ready process for complex poles has always been slow. The new rules tighten up time frames a little, but it can still take a long time to get onto a complex pole.

For complex poles, the process still allows the existing wire owners to work sequentially – meaning that existing companies get to do their own work, one company at a time. This coordination must be scheduled by the pole owner. The process of fixing a single complex pole can take six months, even if done perfectly.

The new rules don't seem to provide a solution for when the pole owner or the existing attachers drag their feet on complex poles. Other than some slightly improved timelines, the work on complex poles looks to still be as dreadful and slow as the old make-ready rules.

It's a fairly minor issue when considering the big picture and cost of building a new network, but there are pole attachment fees that must be paid annually to existing pole owners. We've seen the rates vary across the country from under $10 per pole per year to over $50. Burying fiber bypasses these rent payments.

Considerations for Burying Fiber. There are two key issues that impact the cost of burying fiber. The major issue is the conditions of the soil in terms of being easy or hard to bury fiber. Cottonwood County is like a lot of other areas in the Midwest, where the soil is deep and relatively soft. But that's not true everywhere, and rocks in the soil add cost to buying fiber. There are other situations that can increase the cost of burying fiber, such as when rights-of-way go through heavy woods.

The other issue that impacts the cost of burying fiber is the chosen method of construction. For example, it costs more at the construction stage to install a conduit, but eventually, the conduit makes it relatively inexpensive to add or replace fiber. Following are the primary methods used to bury fiber:

> Trenching. This is buried construction where a 12-inch-wide ditch is dug in the street or along the side of the road, the fiber is placed in the open ditch, and then the ditch is refilled. This is generally the most expensive type of construction, particularly if ditches have to be dug in city streets – the cost of digging and then replacing asphalt can be costly. Trenching is also disruptive, and city streets must be blocked off until a new surface has been poured and cured in the ditch. Trenching is typically used only in situations where other methods of construction won't work. In a typical urban build, you would expect less than a small percentage of the total construction to involve trenching.
>
> Boring. Boring is the most common method of burying fiber. In boring, a "pothole" is dug in the street, which means a hole approximately 2 feet by 2 feet. A boring machine is inserted into the empty pothole and laterally drills a hole through the substrate of the street. An empty conduit is then pulled through the freshly dug hole. Conduit is a flexible and durable plastic tube. Eventually, the fiber building will push or pull fiber through the empty conduit. Boring costs can vary widely depending upon the composition of the substrate. If roads were originally dug out to a three feet depth when constructed, then it's relatively easy to bore through an area. Boring is much harder and expensive, and sometimes impossible, in areas where there is native rock close to the surface of the street. There is often an intermediate condition called cobble, where the substrate under the street includes boulders that were put back into the hole when a street was repaved.
>
> Plowing / Direct Burying. In rural areas where there is an unpaved shoulder along roads, a common construction method is to direct bury the fiber into the ground. This involves using a heaving truck that plows a furrow in the ground, just as would be done by a tractor on a farm. The plow pushes fiber into the ground at the same time that it buries. There is most often not even any follow-up construction since the plowed furrow naturally closes after the plow passes. Direct burying needs a reasonably wide right-of-way and shoulder along a road. It's not going to work where trees and tree roots are in the right-of-way.

The Components of a Fiber Network. There are several major components of a fiber network, and sometimes the design decisions depend upon which type of fiber is being constructed. For example, there might be different decisions made for fiber that goes along a major business corridor versus fiber that is built in an older residential neighborhood. Fiber networks generically have the following major elements:

- Feeder Fiber. This is the fiber that starts at the core of the network and stretches to the various neighborhoods to be served. In a large enough network, the feeder fiber is built in a ring configuration in a closed loop or circle of some type. This allows the use of electronics that can transmit in both directions on the ring so that a single fiber cut doesn't disrupt service.
- Distribution Fiber. This is the fiber that generally is built up and down streets to pass each potential residential or business customer.
- Drop Fiber. This is the fiber that is built from the street to reach the premise of each customer served by the network.

Note that these three network components are not necessarily exclusive. Some fibers along a main street might be fulfilling all three of these functions. For example, there might be fibers along the street that are part of a fiber ring that reaches the various parts of the network and other fibers used to serve customers.

In Cottonwood County, the soil is mostly soft and deep and would allow for easy construction for buried fiber. We have accounted for the increased construction cost for areas with rock around Jeffers as well as some increased bore costs around lakes and waterways. Finley determined that it is probably not any more costly to bury the rural fiber than to put the fiber on poles in those places where there are poles. An all-buried design has the added advantage of having lower future maintenance costs. The one downside to a buried network is that it is more susceptible to fiber cuts by anybody doing rural excavation near roads or at the end of driveways, and it is likely that a buried fiber network would incur these fiber cuts from time to time.

Most of the network would be plowed along public road rights-of-way. These roads are maintained all year, meaning they are plowed when it snows. Our study is conservative in that it assumes that fiber would be built along almost every stretch of road in the study area. It's likely in a detailed design that some efficiencies can be found that would result in small reductions in the road miles of needed fiber.

Basic Network Design

Finley considered an all-fiber design. There are several key factors to consider in the design of a rural fiber network:

- Whether to use buried fiber, aerial fiber, or some mix of the two,
- The choice of the fiber electronics.

We don't know which ISPs might eventually build fiber to the unserved parts of the county. In our experience, it's often likely that more than one ISP might tackle the building fiber in different parts of a county.

We designed a network for the whole study area that stands on its own in terms of design. As will be described below, the network includes a fiber backbone and the construction of three fiber nodes to house electronics.

However, should one or more of the existing ISPs in the area decide to build out from an existing network, it's likely that there would be some savings from our cost estimates. For example, a network might be designed with fewer huts if existing huts could be utilized. A new network might not require a backbone fiber and electronics if the different parts of the county are served by different ISPs.

We took the most conservative approach to the design. The network has been designed as if only one ISP would serve the whole area. In doing so, we also assumed that there is no existing fiber that might benefit this network, although some such fiber probably exists – depending on the ISP that decides to tackle building in the county. Our estimated costs are, by definition, conservatively high.

A map of the proposed fiber construction is shown on the following page. A larger copy of the map is included in Exhibit I.

Fiber Backbone

The network design includes the construction of a backbone fiber. On the map below, this is shown as the bright green line. The purpose of this backbone fiber is to connect to the three hut locations needed to operate the electronics.

The backbone we have chosen is nearly 40 miles long. It is possible that other routes could be chosen to reach the same or similar locations. The network could also be constructed in phases or utilize existing fiber. Typically, large networks like this would have multiple paths or rings to provide redundant connection points. These alternate paths allow the network to self-heal and would not lose service from a single fiber cut. Our design includes multiple diverse routes that could be used to create rings if that was desired.

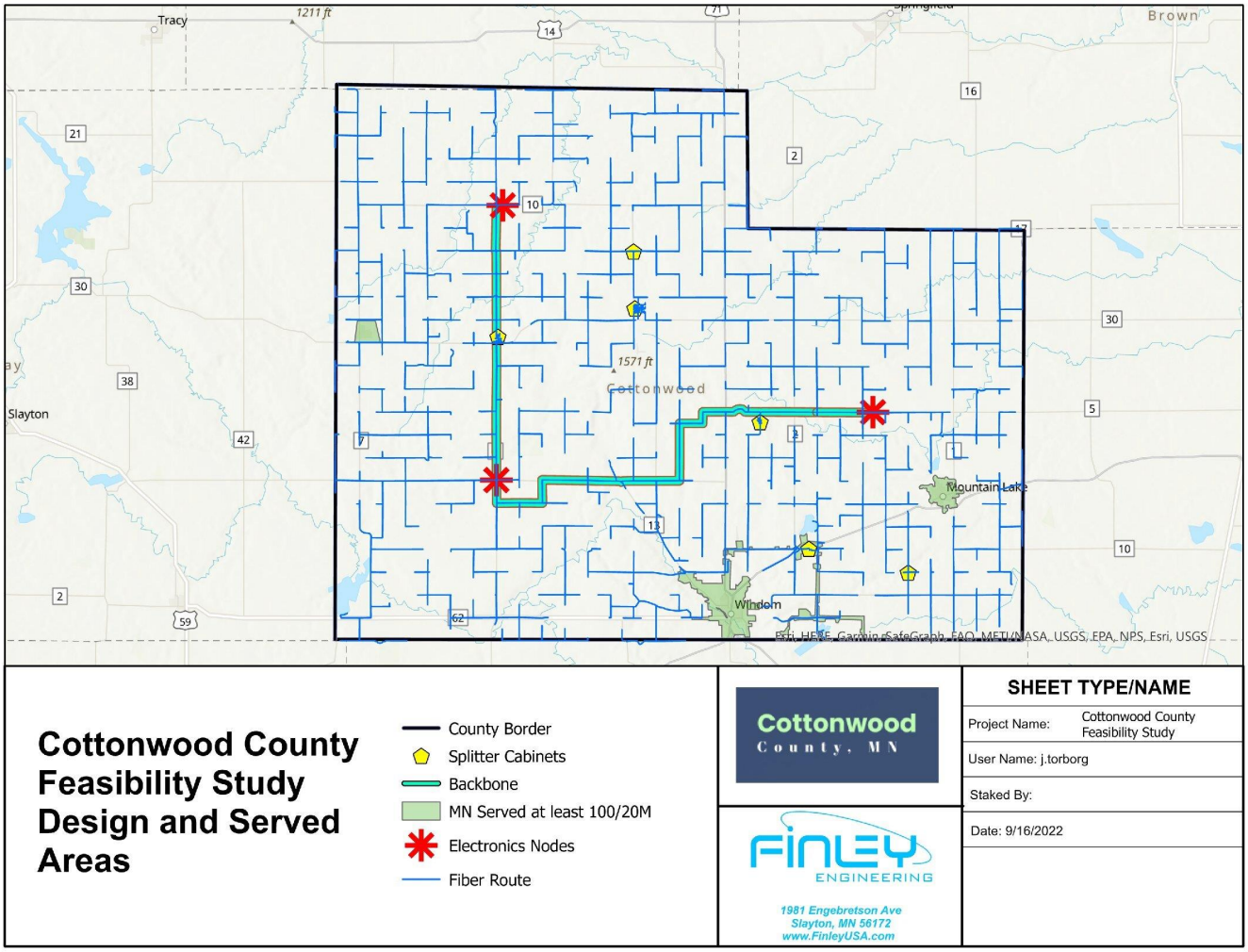
It's likely that an actual network will be constructed by edging out from networks of one or more existing ISPs in the county. If that happens, the backbone fiber and associated electronics might not be required. However, even in an edge-out, the total miles of fiber needed to reach everybody is the same, so there would be no savings on fiber construction costs.

The network design placed electronics at the three locations identified with the stars. These are approximated locations, and the huts and nodes could be placed elsewhere. At each node is a hut, cabinet, or enclosure to house the equipment and fiber optic splitters needed to distribute fiber to customers. Our design assigned passings to each of the three nodes as follows:

Name	Passings
Northwest	1,094
Southwest	260
Southeast	781
Total	2,135

The remote electronics locations would be sized to be large enough to accommodate all electronics, batteries, and equipment that would be required for the expected number of customers to be served. There would also be room for spare capacity, and to accommodate future growth. In most cases, Finley would

recommend a small building. However, an outdoor remote cabinet could also serve the purpose at a reduced cost.



In the design, Finley used large enough fibers for each part of the network to accommodate potential customers in a given area. In a competitive environment, you are not going to know at the time of design where customers are going to be on the network. Over the long life of fiber, it is to be expected that many of the homes in the rural areas might become customers, and it's certainly possible over time for many more homes to be built throughout the service area.

The fibers were sized to potentially serve everybody in the rural areas, with additional spare fiber strands to act as replacements for any fibers that go bad and to accommodate future new homes.

In pricing the fiber construction, Finley used pricing from the recent construction of fiber in similar conditions (soil type). The labor in the forecasts was estimated at current market rates and did not include the prevailing wage rate.

Fiber Drops

The drop is a fiber that reaches from the road to a customer's location. The customer drop is typically a small-count fiber (two to six fibers). There are two primary methods to connect a drop to the network. First is fusion splicing, where the glass in the drop is melted and fused to the class on the network. The splices are housed in a splice case that is sized for each location depending upon the number of homes or businesses that can be served. Splice cases are installed everywhere in the network to provide future access for connecting customers – even in locations where there are homes or businesses that might not initially take service.

The other kind of drop is pre-connectorized. Drop cables of various lengths come with pre-installed connectors that are snapped into the network connection (much like connecting a cable to a TV or computer).

In examining the county, we found that the length of the drops varied. For example, farms have relatively long drops while shorter drops were needed for small towns and for areas along lakes. We calculated an average loop length of 300 feet – which is longer than in many studies we've done.

The Type of Electronics

One major decision to make in designing a fiber network is to determine the type of fiber electronics to use. There are two basic types of fiber electronics used in last-mile networks – active or passive. Following is a discussion of the two types of electronics.

GPON / XGS-PON – Passive Fiber Technology

For the last fifteen years, the industry standard for passive optical networks has been GPON. This technology delivers 2.4 gigabits of bandwidth to serve up to 32 customers. More recently, we see an industry shift to 10-gigabit technology. As recently as 2021, there was still a 15% or greater price penalty for buying 10-gigabit PON technology using the XGS-PON standard. But recently, we've seen quotes for XGS-PON that are nearly identical in price to buying the GPON that's been the industry standard.

The XGS-PON standard provides a lot more speed. The industry standard GPON technology delivers 2.4 Gbps download, and 1 Gbps upload speed to a group of customers – mostly often configured at 32 passings. XGS-PON technology delivers 10 Gbps downstream and 2.5 Gbps upstream to the same group of customers—a big step up in bandwidth over GPON.

The price has dropped for XGS-PON primarily from the use pf the technology by AT&T in the U.S. and Vodaphone in Europe. These large ISPs and others have finally purchased enough gear to drive down the cost for manufacturers. One of the best features of XGS-PON is some manufacturers are offering this as an overlay onto GPON. The new technology requires swapping out some cards in a GPON network to the faster 10 Gbps speed. This means that anybody using GPON technology ought to be able to ease into the technology without a forklift upgrade.

XGS-PON is not a new technology, and it's been around for at least five years. But the price differential stopped most network owners from considering the technology. Most CCG clients claim that their

residential GPON networks average around 40% utilization, so there have been no performance reasons to need to upgrade to faster technology. But averages are just that, and some PONs (neighborhood nodes) are a lot busier, meaning that ISPs are having to shuffle customers to maintain performance.

With the price difference finally closing, anybody building a new residential network should consider the faster technology. Over the next five years, as customers start using virtual reality and telepresence technology, there is likely to be a big jump up in bandwidth demand from neighborhoods. This is fueled by the fact that over 14% of homes nationwide are now subscribed to gigabit broadband service – and that's enough homes for vendors to finally roll out applications that can use faster speeds.

A PON network can be designed in numerous configurations, but all designs include the same key elements. All networks start at a network core where the connection is made to the Internet. At this core, the ISP generally inserts the signals for the various products being delivered to customers.

From the core, there are direct fibers to Optical Line Terminal (OLT), which are the devices that provide the light source for customers. These OLTs can be located in the same location as the fiber core or can be spread around the city in neighborhood nodes, generally in huts or large cabinets.

There is one fiber leaving an OLT for each "PON," which is the local network consisting of up to 32 customers. These fibers go to splitter cabinets, where each fiber is then "split" into the 32 separate fibers that go to customers. The splitter cabinets can be located at the same location as the OLT electronics, or they can be moved deeper into the network to be closer to customers. The name "passive" for the technology comes from the fact that the splitter site doesn't require electronics or power – the splitting is just what it sounds like – one fiber is spliced and split into 32 individual paths. The paths between the splitter and each customer are "home runs," meaning that there is a single dedicated fiber between a splitter site and each customer.

One of the biggest benefits of the PON network is a saving in fibers in the network. Only one fiber is needed to serve an OLT, and one fiber goes from the OLT to each splitter. The fiber is only divided into individual customer fibers at the splitters, which can happen deep into the network.

One consideration when designing PON networks is the optical distance from an OLT port to the customer Optical Network Terminal (ONT). A design that allows for a 1 to 32 customer split has a distance limitation of 20 km (12.4 miles). That distance limitation is generally not a problem in a city network but can be a challenge in rural areas.

The current vendors for PON equipment include Alcatel-Lucent, Adtran, DZS, Nokia, Juniper, and Calix.

<u>PON Advantages</u>

- <u>No electronics in the field</u>. PON uses passive splitters to distribute the bandwidth over the fiber to the customers. There are only two active components in the PON distribution network – the Optical Line Terminal (OLT) and the Optical Network Terminal (ONT). The OLT sits in an environmentally controlled hut or building, and the ONT sits on the side of the home or inside of the home.
- <u>Less field maintenance and more reliability</u>. Because PON uses passive splitters in the field, there are fewer powered network elements in the distribution network. This equates to less maintenance,

fewer field personnel required, more reliability, and fewer managed network elements in the distribution network. A PON network also means less land and rights-of-way required due to less need for large powered huts.

- Less fiber needed. PON uses significantly fewer fibers than an active system. A PON network carries up to 64 customers (we recommend not more than 32) on one fiber, while an active network needs a home run fiber for each customer. Less fiber means lower capital costs, less loading on poles, quicker fiber installations with less splicing, and smaller fiber management systems.
- Higher density electronics. Because PON electronics have only one optical port for every 32 customers, the PON chassis in the OLT can serve a large number of customers in a small space. This means less space for electronics, less power usage, less air conditioning, and reduced backup power requirements.
- Ability to still use active Ethernet. Most PON manufacturers offer the option to serve some customers on active Ethernet in the same chassis by the use of a separate core card.
- Location Flexibility There are a lot more options for locating passive devices and placing them close to customers. Network owners can deploy both large, centralized splitter sites and widely distributed tiny splitter cabinets.
- Takes the best advantage of oversubscription. All of the customers in a neighborhood node share the bandwidth delivered to the node. This is a more efficient use of bandwidth than sending a dedicated amount of bandwidth to each customer.

PON Weaknesses

- Distance Limitation. Customers have to be within 12 miles of the OLT core electronics. This can present a challenge in large rural networks.
- More Complex Engineering. Because of distance limitations and splitter requirements, a PON network requires an engineering plan to make sure that the OLTs and ONT operate within the limitations of the network. This is not a major issue since industry engineers are well versed in designing PON networks.
- More customers are affected by a single fiber cut. Cutting one neighborhood fiber could put up to 32 to 64 subscribers out of service.

Active Ethernet (Active E**)**

An Active E network is essentially a fiber "home run" from the central electronics core, meaning that one fiber goes from the core electronics directly to each customer. This technology has several advantages and is well-suited for serving large businesses where the customer requires more stringent network uptime and higher bandwidth. An Active E network also can provide symmetrical data capabilities (upstream and downstream data rates are the same) at high data speeds. The downside to Active E is that more fibers are required in the network since fibers are not shared between customers. Electronic costs are generally also higher since there is a dedicated laser at both ends of the connection to every customer. Active E also has higher data capabilities and can inexpensively provide data rates up to 10 gigabits per second. Faster speeds are possible, but with significantly higher electronics costs. One of the biggest advantages of Active E is that it's easy to change the connection to a single customer as customer requirements change – the laser serving that customer can be changed without affecting any other part of the network.

The primary vendors in the Active E equipment market are Cisco, Calix, Adtran, and Nokia-Alcatel-Lucent. Since PON equipment has won a much greater market share than Active E equipment, this part of the industry has been in a bit of a decline for a few years.

Active Ethernet Strengths

- Greater distance. Where a PON has a 12-mile limit between the core electronics and the customer, an active connection can reach over 50 miles.
- Less engineering and planning. Since every fiber run is a home run between the electronics chassis and the customer, there is less engineering and planning needed to design and deploy an AON network. Engineering means just planning one fiber per passing.
- Pure IP Network. The active Ethernet network delivers pure native IP, meaning it could be plugged directly into customer modems or switches.
- Can deliver greater bandwidth. Lasers are available that can deliver speeds greater than 10 Gbps. Such lasers can be expensive, but they are easy to integrate into an active network.

Active Ethernet Weaknesses

- Uses more fiber than PON. With one fiber home run per customer, Active networks require significantly more fiber. This means larger fiber bundles to the same number of electronic chassis. This has an effect on capital costs, pole loading, conduit, hand-hole sizing, etc. Larger fiber bundles require larger field huts to handle the larger fiber entrance. In a densely populated area, the size of the fibers can be unwieldy.
- Less dense electronics. Since there is a core laser for every customer connection, the electronic chassis support fewer customers in the same rack space. This means a larger chassis and more rack space, which equates to more environmentally conditioned space and more and larger power and backup power at the electronics locations.
- More powered network elements. There are more field locations that require power. This means more failure points in the network, more field huts, more power, more battery backup, and more generators.
- Expensive growth after construction. This may be the biggest drawback. It can be expensive to add new customers in the middle of the network because that means somehow adding more fiber between the electronics and customers.

The Electronics Design

After considering the various pros and cons, Finley Engineering chose a network design that could accommodate PON or active technology. We expect that ISPs will use PON technology, but the design could accommodate an ISP that wants to instead use active electronics.

The next decision to make is whether to centralize or distribute the electronics in the network. We chose the locations of the huts so that no customer was more than 12 miles away from an electronics location, the maximum recommended distance for a signal on a PON network. That is 12 miles of fiber along a road, not a 12-mile circle. The study shows the need for three locations to act as PON local originating points.

The huts were designed using prefabricated buildings that are designed for all seasons of the year. These buildings are relatively inexpensive and allow for future flexibility. From each hut, there is a dedicated

fiber built to each customer. This would allow for the option of serving customers with either Passive Optical Network (PON) electronics or with active Ethernet (only for high bandwidth customers).

The cost of the network was determined using the prices of GPON electronics. The pricing could easily have instead used XGS-PON. The Finley design could also accommodate active electronics. There are not likely to be any customers in the rural parts of the county who would insist on having a dedicated Ethernet feed – but we've allowed for that option. In all scenarios, we based pricing upon recent quotes we have received from vendors like Calix, AdTran, Clearfield, Cienna, and others. Finley is not proposing any specific vendors, and we are vendor-neutral. The costs chosen are representative of current electronic costs.

When designing FTTH networks, there are options for how many customers to serve from one neighborhood fiber point. Since there are not many customers in the rural areas, the rural network was designed with a 1 by 16 fiber split, and the towns were designed with a 1 by 32 fiber split. Having a lower split allows the signal to travel farther. In in the final design there are a few customers more than 12 miles from a hut that could be accommodated by placing them on a fiber that has a split of 1 by 8 or even lower.

Customer Electronics

The customer electronic device used to serve customers is referred to in the industry as an ONT (Optical Network Terminal). This is an electronic device that contains a laser which connects to the light signal coming from the network and converts the signal into traditional Ethernet on the customer side of the network.

Traditionally, ONTs were placed on the outside of buildings in a small enclosure and powered by tapping into the electricity after the power meter. Today there is also an ONT that can be placed indoors, and which plugs into an outlet, much like the cable modems used by cable companies. Some companies still put the ONT on the outside of the home to give their technicians 24/7 access to the units. Other providers are electing internal units because of the greater protection from the weather. The industry is split on this choice, but it appears that internal ONTs are becoming the most predominant choice for new construction. The cost of the two kinds of units is nearly identical, so the study doesn't choose between the two options.

ONTs are also available in multiple configurations. The most common unit is the one that can be used to serve either homes or small businesses, with larger units designed to serve large businesses. The study assumes that only the smaller standard units are used since we don't think there are any complex businesses in the service area. The network could easily accommodate the larger ONTs, if needed.

B. Competing Technologies

There are at least seven broadband technologies used in the county today to deliver broadband. Each of these technologies will be explained below.

- CenturyLink, Frontier, and Nuvera Communications serve Cottonwood County with copper telephone wires using DSL technology.
- Mediacom uses Hybrid Fiber Coaxial (HFC) technology.
- There are a lot of wireless ISPs (WISPs) that are delivering broadband using point-to-multipoint fixed wireless technology.

- The county has several ISPs that provide fiber-to-the-premise.
- Rural homes can buy broadband from satellites, including the new low orbit satellites offered by Starlink.
- We've recently started to see a new broadband product offered by cellular companies – home broadband using 5G spectrum. There are older similar products called hotspots, which are still in use but will be phasing out.
- Some residents get all of their broadband from their cellphone data plan.
- Metro Ethernet is used to bring fiber directly to large businesses, schools, cell towers, etc.

Technology is Improving

CCG recently reviewed all of these technologies, and we realized that every technology in use for broadband is better now than just three years ago. We don't spend enough time talking about how the vendors in this industry keep improving technology.

Consider fiber. We recently have been recommending that new fiber builders consider XGS-PON. While this technology has been around for almost five years, the technology was originally too expensive and cutting edge to consider for most ISPs. But AT&T and Vodaphone have built enough of the technology that the prices for the hardware have dropped to be comparable to the commonly used GPON technology. This means we now need to start talking about FTTP as a 10-gigabit technology – a huge increase in capacity that blows away every other technology. The vendors of the equipment recently released an update that provides 25-gigabit speeds for customers.

There have been big improvements in fixed wireless technology. Some of this improvement is due to the FCC getting serious about providing more broadband for rural fixed wireless. During the last three years, the agency has approved CBRS spectrum and white space spectrum that is now being routinely used in rural deployments. The FCC also approved the use of 6 GHz WiFi spectrum in 2021, which will add even more horsepower. But there have also been big improvements in the radios. One of the improvements that isn't mentioned much is new algorithms that speed up the wireless switching function. Three years ago, we talked about fixed wireless speeds of 25 Mbps to 50 Mbps, and now we're talking about speeds over 100 Mbps in ideal conditions.

Cellular data speeds have gotten much better across the country as the cellular carriers have introduced additional bands of spectrum. Cellular speeds in a lot of the country are now double or triple the speeds of just a few years ago.

Three years ago, the low-orbit satellites from Starlink were just hype. Starlink now has over 2,200 satellites in orbit and is still in beta test mode. Customers are reporting download speeds from 50 Mbps to 150 Mbps. We also see serious progress from One Web and Jeff Bezos's Project Kuiper, so this industry segment is on the way to finally being a reality. There is still a lot of hype, but that will diminish when homes can finally freely buy satellite broadband.

Three years ago, Verizon was in the early testing stage of the fiber-to-the-curb product it calls Verizon Home. After an early beta test and a pause to improve the product, Verizon is now talking about offering broadband to 25 million homes with this technology by 2025. This product uses mostly millimeter-wave

spectrum to get from the curb to homes. For now, the speeds are reported to be about 300 Mbps, but Verizon says this will get faster.

We've also seen big progress with millimeter-wave mesh networks. Siklu has a wireless product that they advertise as an ideal way to bring gigabit speeds to a small shopping district. The technology delivers a gigabit connection to a few customers, and the broadband is then bounced from those locations to others.

Cable company technology has also improved over the last three years. During that time, a lot of urban areas saw the upgrade to DOCSIS 3.1 with download speeds of up to a gigabit. CableLabs also recently announced DOCSIS 4.0, which will allow for symmetrical gigabit speeds but won't be available for 3-5 years.

While you never hear much about it, DSL technology over copper has gotten better. There are new versions of G.Fast that are being used to distribute broadband inside apartment buildings with speeds up to 500 Mbps – for short distances.

Interestingly, the product that got the most hype during the last three years is 5G. If you believe the advertising, 5G is now everywhere. There is no actual 5G in the market yet, but the cellular carriers are now using new spectrum bands that are labeled as 5G to offer home broadband. The carriers are also using the new frequencies to speed up cell phone data speeds.

DSL over Copper Wires

CenturyLink, Frontier, and Nuvera Communications provide broadband using DSL (Digital Subscriber Line). DSL is used to provide a broadband path over telephone copper wire. The copper networks were mostly built between the 1950s and early 1970s. The copper networks were originally expected to have an economic life of perhaps 40 years and have now far exceeded the economic life of the assets. The copper networks are deteriorating as a natural process of decay due to sitting in the elements. Maybe even more importantly, the copper networks have deteriorated due to neglect by the big telcos that started to cut back on the maintenance of copper in the 1980s as the companies were deregulated from some of their historical obligations.

DSL works by using frequency on the copper that sits just above the frequencies used for telephone service. There are distinct kinds of DSL standards, each of which has a different characteristic in terms of the amount of bandwidth that can be delivered and how far the signal will travel. The most efficient forms of DSL can deliver up to 24 Mbps service over a single telephone wire. Most of the DSL in the county is of older varieties and delivers slower speeds.

The most important characteristic of DSL is that data speed delivered to customers decreases with the distance the signal travels. The general rule of thumb is that most types of DSL can deliver a decent amount of bandwidth for about two miles over copper – that's miles of copper wires, not two miles as the crow flies. DSL signal strength is also affected by the quality of the copper – newer copper and larger gauge copper wires mean better bandwidth.

Hybrid Fiber Coaxial Network

Cable companies use a technology called Hybrid Fiber Coaxial (HFC). Hybrid refers to the fact that an HFC network uses a fiber backbone network to bring bandwidth to neighborhoods and a copper network of coaxial cables to deliver service to customers. HFC networks are considered lean fiber networks (meaning relatively few fiber strands) since the fiber is only used to deliver bandwidth between the headend core and neighborhood nodes. At each node is a broadband optical receiver that accepts the fiber signal from the headend and converts it into a signal that is sent over coaxial cable to reach homes and businesses.

The coaxial copper wires in the networks are aging, and most of the coaxial networks were likely built in the 1970s. Coaxial cable networks exhibit signs of aging sooner than telephone copper networks because the wires act as a huge antenna, and older networks attract a lot of interference and noise that it becomes harder to transmit the signals through the wires.

An HFC system delivers customer services differently than an all-fiber network. For example, in an HFC network, all of the cable television channels are transmitted to every customer, and various techniques are then used to block the channels a given customer doesn't subscribe to.

There is a distance limitation on coaxial cable. Unamplified signals are not generally transmitted more than about 2.5 miles over a coaxial network from a network node. This limitation is based mainly on the number of amplifiers needed on a single coax distribution route. Amplifiers are needed to boost the signal strength for coaxial distribution over a few thousand feet. Modern cable companies try to limit the number of amplifiers on a coaxial route to five or fewer since adding amplifiers reduces broadband speeds.

In an HFC network, all of the customers in a given node share the broadband in that node. This means that the number of customers sharing a node is a significant factor—the fewer the customers, the stronger and more reliable the broadband signal. Before cable systems offered broadband, they often had over 1,000 customers on a node. But today, the sizes of the nodes have been "split" by building fibers deeper into neighborhoods so that fewer homes share a fiber data pipe for a given neighborhood. The architecture of using neighborhood nodes is what has given cable companies the reputation that data speeds slow down during peak usage times, like evenings. However, if nodes are made small enough, then this slowdown doesn't have to occur.

The amount of bandwidth available to deliver Internet access that is available at a given node is a function of how many "channels" of video the cable company has dedicated to broadband. Historically, a cable network was used only for television service, but in order to provide broadband, the cable company had to find ways to create empty channel slots that no longer carry TV programming. Most cable systems have undergone a digital conversion, done for the purpose of freeing up channel slots. In a digital conversion, a cable company compresses video signals and puts multiple channels into a slot that historically carried only one channel.

The technology that allows broadband to be delivered over an HFC system follows a standard called DOCSIS (Data Over Cable Interface Specification) that was created by CableLabs. Most of the large cable companies upgraded about a decade ago to the DOCSIS 3.0 standard that allows them to bond together enough channels to create broadband speeds as fast as about 400 Mbps download. By now, most big cable

companies have upgraded their networks a second time to a new standard, DOCSIS 3.1, that theoretically could produce broadband speeds as fast as 8–10 Gbps if a network carried only broadband and had zero television channels. Since there are still a lot of TV channels on most cable systems, most cable companies have increased the maximum broadband speeds to between 500 Mbps and 1 Gbps using DOCSIS 3.1.

One limitation of a DOCSIS network is that the standard does not allow for symmetrical data speeds, meaning that download speeds are generally much faster than upload speeds. This is an inherent design characteristic of DOCSIS 3.0 and DOCSIS 3.1, where no more than 1/8 of the bandwidth can be used for upload. Most cable companies have allocated even less than the allowable bandwidth to upload. Earlier in the report was a lengthy discussion about the upgrade speed crisis that has become apparent during the pandemic. The cable companies are likely hoping that issue will diminish in importance at the end of the pandemic because upgrades to provide more upload speeds are expensive.

One of the interesting parameters of a cable network is the use of radio frequencies to transmit data, meaning a cable network is essentially a captive radio network kept inside of the copper coaxial wires. As such, the signals inside a coaxial system share the same characteristics as any wireless network. Higher frequencies carry more data bits than lower frequencies. All of the signals are subject to interference if external frequencies leak into the cable transmission path.

The DOCSIS specification for cable broadband sets aside the lowest frequencies in the system for upload bandwidth – the bandwidth between 5 MHz and 42 MHz. This happens to be the noisiest part of cable TV frequency – it's where outside sources like appliances or running engines can cause interference with the signal inside the cable network.

The DOCSIS 3.0 specification, released in 2006, allows for other parts of the spectrum to be used for upload data speeds, but very few cable companies took advantage of the expanded upload capability, so it's laid dormant. This DOCSIS 3.0 standard allowed a mid-split option to increase the frequency for upload to 85 MHz or a more aggressive high-split option to assign all of the bandwidth up to 204 MHz for data upload. DOCSIS 4.0 is going to offer an even wider range of upload speeds, as high as 684 MHz of spectrum.

Almost no cable companies have made the upgrade of upload bandwidth using the mid-split option. Doing so could significantly increase upload speeds. But this upgrade is expensive. Rearranging how the bandwidth is used inside of a cable network means replacing many of the key components of the network, including neighborhood nodes, amplifiers, and power taps. It could mean replacing all cable modems.

CableLabs has developed the new DOCSIS 4.0 standard that was released in March 2020. The DOCSIS 4.0 standard allows for a theoretical transmission of 10 Gbps downstream and 6 Gbps upstream. Comcast just did a lab test of the technology and achieved symmetrical 4 Gbps bandwidth. Don't expect this to mean that cable companies will be offering fast symmetrical broadband any time soon. There is a long way to go from the first lab test to a product deployed in the field. Lab scientists will first work on perfecting the DOCSIS 4.0 chip based on whatever they found during the trial. It typically takes most of a year to create a new chip, and it wouldn't be surprising for Comcast to spend several years and a few iterations to solidify the chip design. Assuming Comcast or some cable company is ready to buy a significant quantity of the new chips, it would be put into the product design cycle at a manufacturer to be integrated into the CMTS core and into home cable modems.

An upgrade to DOCSIS 4.0 isn't going to be cheap. It first means replacing all existing electronics in a rip-and-replace upgrade. That includes cable modems at every customer premise. DOCSIS 4.0 will require network capacity to be increased to at least 1.2 GHz. This likely means the replacement of power taps and network amplifiers throughout the outside plant network.

There is also the bigger issue that the copper plant in cable networks is aging in the same manner as telco copper. There are already portions of many cable networks that underperform today. Increasing the overall bandwidth of the network might result in the need for a lot of copper replacement. And that is going to create a pause for cable company management. While the upgrade to DOCSIS 3.1 was expensive, it's going to cost more to upgrade again to DOCSIS 4.0. At what point does it make sense to upgrade to fiber rather than undertake another costly upgrade on an aging copper network?

That's the point when cable companies will face to tough choice of pursuing the new standard or instead building fiber. When the new technology was announced in 2020, most of the CTOs of the big cable companies were quoted as saying that they didn't see the implementation of the new standard for at least a decade. This is understandable in that the cable companies recently made the expensive upgrade to DOCSIS 3.1. However, there is a lot of demand for faster upload speeds, and cable companies like Cox, Midco, and Altice have announced plans to convert properties to fiber.

Fixed Wireless

This technology is used by the large number of wireless ISPs (WISPs) in the county. The key to making this technology work is to use multiple bands of wireless spectrum to be able to maximize the bandwidth to any one customer based on local conditions. There are several current frequencies of spectrum that can be used for this purpose:

- WiFi: WiFi is a marketing term used to create a public-friendly term that was easier to remember than the 802.11 series of names. The FCC has currently set aside three swaths of frequency for WiFi: 2.4 GHz, 5.7 GHz, and 6.0 GHz (the equipment is just now becoming available). In a point-to-multipoint network, these three frequencies are often used together. The most common way is to use the higher 5.7 and 6.0 GHz to reach the closest customers and save the lower frequency for customers who are farther away.

  In practical use, in wide-open conditions, these frequencies can be used to serve customers up to about 6 miles from a transmitter, although speeds can be slow after the first few miles. Many wireless carriers advertise speeds in the range of 25 to 50 Mbps. We know of networks doing speeds up to 75 Mbps for short distances. Such a network must have fiber built to the radio transmitters and limit the number of customers on a given radio system.

- CBRS Spectrum - 3.5 GHz: In 2019, the FCC approved the use of the 3.5 GHz spectrum band known as the Citizens Broadband Radio Service or CBRS. This is a huge swath of spectrum covering 150 MHz of spectrum between 3550 and 3700 MHz.

The FCC has set aside 80 MHz of this spectrum for public use, similar to WiFi, and auctioned the remaining spectrum of 70 MHz in June 2020. In all cases, this spectrum is shared with the military, which always gets priority to use the spectrum.

The spectrum also must be shared among users in the public space – something that will be monitored by authorized SAS administrators. The FCC has named five administrators: Amdocs, CommScope, Federated Wireless, Google, and Sony. The second wave of potential SAS administrators have applications pending with the FCC; however, a schedule has not been published as to when they will be approved. The marketplace is also starting to see SAS administration brokers looking to aggregate numerous smaller CBRS operators and relieve them of the effort required to get registered with the current SAS Administrators. It's expected that the cellular carriers are going to heavily use the free public spectrum to deliver 5G, so in many places, this spectrum might be too busy to allow for a point-to-point application. However, in rural markets, the public spectrum might go unused, in which case it would be available to boost the speeds for fixed wireless broadband.

There are already rural ISPs using the public portions of the spectrum for fixed wireless service. This spectrum sits in the middle between the 2.4 and 5 GHz WiFi bands used for fixed wireless today and has great operating characteristics.

- White Space Spectrum: The FCC has approved deployments of point-to-multipoint radios in what is called white space spectrum. This is spectrum in the same range as TV channels 13 through 51, in four bands of frequencies in the VHF and UHF regions of 54–72 MHz, 76–88 MHz, 174–216 MHz, and 470–698 MHz. The key advantage of TV White Space is the low, non-line of site frequencies can fill in the gaps (valleys, back side of ridges, dense tree cover, etc.) that defeat other GHz frequencies. Range is also significantly longer; however, the throughput per channel is much lower than WiFi or CBRS. The extended range comes with a burden since use of the spectrum can interfere with television stations 100s of miles away, limiting deployment in areas with numerous active TV broadcast stations. The FCC order refers to whitespace radio devices that will work in the spectrum as TVBD devices.

  The FCC auctioned a lot of this frequency in 2018, with the buyers ranging from the big cellular companies to Comcast. This was called an incentive auction because TV stations that gave up their spectrum got a share of the sale proceeds. The FCC is now expected to make some of this spectrum available for rural broadband. The rules have not yet been worked out, but they will probably be something similar to what governs WiFi and be available to anybody.

  There are two possible uses for the spectrum. On a broadcast basis, this can be used to make better hotspots. A low-power 2.4 GHz WiFi signal can deliver just under 100 Mbps out to about 100 meters (300 feet). But it dies quickly after that, and there may be only 30 Mbps left at 200 meters and nothing much after that. Whitespace spectrum can deliver just under 50 Mbps out to 600 feet and 25 Mbps out to 1,200 feet.

  There is potential for the spectrum to extend point-to-multipoint radio systems in rural areas. White space radios should be able to deliver about 45 Mbps up to about 6 miles from the transmitter.

One issue in using the spectrum is that FCC rules require the radios using this frequency to use what they are calling cognitive sensing. This means that an unlicensed user of the spectrum must yield usage to any requests for spectrum from a licensed user. While this would not be a problem in rural areas where there is only one user of the white space spectrum, where there is a mix of licensed and unlicensed users, the unlicensed provider needs to pair radios with other spectrums to be able to serve customers when they have to cede usage to a licensed user.

There are several factors that are critical to a successful deployment of point-to-multipoint radios for rural broadband:

- Using Multiple Frequencies. The newest radios are much improved over radios from just a few years ago because they use spectrum bands including 2.4 GHz, 3.5 GHz, and 5.0 GHz. Radios are now starting to integrate white space spectrum and CBRS spectrum. Having more spectrum matters because each frequency band has different operating characteristics in terms of distance and ability to penetrate obstacles. Using multiple frequencies provides an increased opportunity to find a workable solution for each customer in the service area.
- Adequate Backhaul. The best fixed wireless coverage comes when there is fiber at the transmitter that supplies the needed bandwidth. Customer broadband speeds are diminished if a tower doesn't receive enough bandwidth – lack of backhaul bandwidth is the primary reason why many WISPs deliver speeds under 10 Mbps.
- Terrain/Topology. There are often physical barriers like hills or heavy woods that can limit or block customer bandwidth. With the exception of TVWS, the spectrum used for this technology requires a good line-of-sight, meaning that there must be a clear, unimpeded visual path between the tower and the customer. Customers that live in valleys or behind hills generally can't get service. If the signal passes through trees to reach a customer, the strength of the signal is diminished.
- Height of the Tower. The taller the transmitting radio, the better because the high placement of the antenna provides a better opportunity to look down on homes without having to pass through trees.

There are a few other issues to consider with fixed wireless:

- There are already many WISPs operating in the county, and that means there is going to be interference with the radio signals. Interference translates into slower broadband speeds. The biggest drawback to using unlicensed spectrum is the fact that it is unlicensed, meaning there is no entity around that can settle disputes between WISPs. The WISP environment is often described as the Wild West, where WISPs grab channels and spectrum to make their own signals better to the detriment of other WISPs. This results in a never-ending battle for frequency and means that customers speeds go up and down.
- Compared to fiber technology, a wireless system has a relatively short expected life. Most of our clients have found that customer radios have to be replaced every seven years or less.

Wireless equipment is rarely eligible for federal or state grants. For example, the BEAD grants require speeds of 100/100 Mbps. While fixed wireless technology can achieve that, the practical limitations in the field make those speeds unlikely except for customers living close to a tower.

Geostationary Satellite Broadband

Viasat (which was formerly marketed as Exede or Wildblue) and HughesNet provide broadband using geostationary satellites (GEO). The technology is called geostationary because the satellites sit in a parked

location over 22,000 miles above the earth. For both, the availability depends upon a customer having a clear line of sight from a satellite dish at a customer location to a satellite.

The most limiting aspect of GEO satellite broadband is latency, which means a delay in the signal. These satellites are parked at over 22,000 miles above the earth, and when an Internet connection must travel to and from a satellite, there is a noticeable delay; that delay makes it hard or impossible to do real-time transactions on the web. Current satellite latency can be as high as 900 milliseconds. Any latency above 100 milliseconds creates a problem with real-time applications such as streaming video, voice-over-IP, gaming, online education, or making connections to corporate WANs (for working at home). Any website or service that requires a constant connection will perform poorly, if at all, with a satellite connection. Satellite broadband also comes with tiny data caps, meaning a customer is highly limited by the amount of data they can send or receive during a month.

Low Earth Orbit Satellites

The newest satellite option is low earth orbit (LEO) technology, which places satellites in orbit between 200 and 800 miles above the earth. Low-orbit satellites have one major benefit over geostationary satellites. By being significantly closer to the earth, the data transmitted from low-orbit satellites have a latency of around 35 milliseconds—about the same as experienced in a cable TV broadband network. This is much better than the current latency for high-orbit satellites. The low-orbit satellites can easily support real-time applications like VoIP, video streaming, live Internet connections like Skype, or distance learning.

One of the most interesting aspects of the technology is that a given satellite passes through the horizon above a given customer in about 90 minutes. This means that there must be a large fleet of satellites so that there is always a satellite in the sky over every customer.

There has been a lot of recent news concerning the three primary companies that are vying in the market. Starlink and SpaceX are all over the news. Starlink has been in beta test mode since 2020. Starlink has over 2,200 satellites in orbit. The company has nearly half a million customers worldwide, with something over 200,000 in the U.S. The monthly rate is $110, and the receiver costs $599. Starlink claims it will eventually launch 30,000 satellites, with over 11,000 in the first constellation.

Starlink download speeds have been between 50 Mbps and 150 Mbps – a great upgrade for customers using rural DSL or fixed wireless broadband. Elon Musk says that speeds will approach 300 Mbps, but this is doubted by many industry engineers who question the ability of the constellation to handle a significant number of customers.

Starlink's biggest challenge will be in having enough frequency to be able to pass data between the cloud and the earth. The company lost a battle at the FCC trying to get access to frequency owned by Dish Networks. The battle is over the spectrum between 12.2 – 12.7 GHz. Dish wants to use this spectrum for terrestrial 5G, and this would greatly curtail Starlink's backhaul capabilities. A recent FCC ruling warned Starlink that it might not get access to the spectrum. There is some movement at the FCC to open up the 17 GHz spectrum band for satellite backhaul.

The other active satellite company is OneWeb. Eutelsat, one of the world's largest operators of satellites, recently made an investment and took a 24% stake in the company. This adds to the existing ownership by the U.K. government and Bharti Global, a large cellular carrier in India.

OneWeb plans to launch a 648-satellite fleet with larger satellites that are basically floating data centers. The company says it will be able to serve the whole globe by the end of 2022. The latest news from the company suggests it might not sell broadband to residential customers but will concentrate on cell sites, governments, and large businesses.

The final big player is Jeff Bezos and Project Kuiper, which is still likely to get a brand name at some point, perhaps something as simple as Amazon Broadband. The company has recently contracted a large number of launches to start later in 2022. It's been speculated that these launches will carry around 500 satellites into orbit – including the company's first test satellites.

Project Kuiper has plans to launch 3,236 satellites, and the company says it will need 578 satellites to begin offering limited service. The company reached an agreement with the FCC to launch half of the total satellites before 2026, although it appears the company intends to reach that number sooner.

Project Kuiper is taking a different strategy than Starlink and is launching larger, more capable satellites rather than swarms of cheaper disposable satellites. It will be interesting to see what this difference means in terms of customer coverage and bandwidth. The company has already been funded with $10 billion from Jeff Bezos, and it seems likely that the company will eventually do what's been announced.

5G Home FWA Broadband

We are starting to see cellular carriers deploying a new generation of home cellular products. The cellular carriers are calling this FWA (fixed wireless access), and these products are competing with home broadband. Most reports from customers are that speeds are in the range of 100 Mbps download, and the plans offer unlimited usage.

These plans use the new frequencies that have been deployed in recent years to offer both faster broadband speeds and larger data caps. These new plans are being marketed as 5G. Anybody who watches TV knows that the cellular carriers are in full 5G marketing mode. If you believe the TV commercials, you'd now think that the country is blanketed by 5G, as each cellular carrier claims a bigger coverage area than its competitors. However, these claims are marketing hype. Currently, there are no cellular deployments that can be legitimately called 5G. Full 5G will not arrive until the carriers have implemented the bulk of the new features described in the 5G specifications.

The adoption of these new home broadband products is growing quickly. In the first quarter of 2022, there were about 1 million net new broadband customers in the U.S. – half of them came from the FWA products of Verizon and T-Mobile. T-Mobile says it was surprising that a lot of new customers are in urban and suburban markets.

4G Cellphone Broadband

Some customers are using their cellphones as the only source of broadband and are not buying a home landline broadband connection. Today's cellular networks use a technology called 4G LTE. While the cellular companies have been advertising 4G for a decade, the first fully compliant 4G cell site was only launched in late 2018.

There is a gigantic difference between cellular broadband speeds in major cities and the rural parts of the county. Cellular data speeds are faster in cities for several reasons. First, there are more cell sites in cities. More importantly, the data speed a customer receives on a cell phone is largely a function of how far the customer is from a cell site. In cities, most customers are within a mile of the closest cellular tower. Rural customers can easily be miles from the nearest tower. Finally, the cellular carriers have introduced additional bands of spectrum in urban areas that are not available outside cities.

The real problem with using cell phones for broadband is the tiny monthly data caps. Anybody using a cell phone for home broadband is, by definition, a light broadband user.

Metro Ethernet

Metro Ethernet is the primary technology used to deliver large bandwidth to a single customer over fiber. This technology is used in the county to deliver fiber today to locations like schools, cell towers, and some businesses. This technology is often also referred to as active Ethernet.

Metro Ethernet technology generally uses lasers that can deliver speeds between 1 gigabit and 10 gigabits, although lasers as fast as 300 Gbps are available. ISPs can choke these speeds to slower levels based on what a customer is willing to pay for.

Many ISPs dedicate a fiber for each metro Ethernet customer, but that's not mandatory. For example, an ISP could light a fiber to deliver 10 Gbps and string that fiber to multiple customers, each buying 1 Gbps service.

Future Technologies

These broadband products are not available in the county today, but they could be coming in the future.

Millimeter-Wave Point-to-Multipoint Broadband

Another new technology that got a lot of press in the last few years is 5G point-to-multipoint radios using millimeter-wave spectrum. Verizon built this technology in a few neighborhoods in Sacramento and a few other cities in 2018. Verizon took a break after the initial tests and started deploying the technology again in 2020 in a few markets like Detroit. The technology consists of deploying small cell sites on telephone or power poles and then beaming broadband to a small receiver attached to homes or attached to the inside of a window. This technology requires fiber to the small cell sites to achieve the fastest speeds. Verizon achieved speeds in the trials of 300 Mbps – with a hope over time that they can get speeds up to a gigabit.

This technology has historically been referred to as fiber-to-the-curb (FTTC). The technology requires building fiber close to every potential customer and then using wireless to bring the broadband into each customer's premise.

Millimeter-wave spectrum is at extremely high frequencies of 24 GHz and higher. The only other common use of this spectrum has been in the full-body scanners at airports. The primary operating characteristic of millimeter-wave spectrum is that the signal doesn't travel far. Most engineers set the realistic top distance of this technology at about 1,000 feet from a wireless transmitter – and probably less in field deployment.

The biggest impediment to the business plan is that it requires building fiber along each street served, making this at least as costly as building fiber-to-the-home. The cost of putting fiber on poles can be expensive if there are already a lot of other wires on the poles (from the electric, cable, and telephone companies). In neighborhoods where other utilities are underground, the cost of constructing fiber can be even higher. Another challenge for the technology is that the millimeter-wave spectrum requires a clear path between the transmitter and a dish placed on the home – and that means that 5G is best deployed on straight streets without curves, hills, or dense tree cover.

The technology will only make financial sense in some circumstances. This means neighborhoods without a lot of impediments like hills, curvy roads, heavy foliage, or other impediments that would restrict the performance of the wireless network. It also means avoiding neighborhoods where the poles are short or don't have enough room to add a new fiber. It means avoiding neighborhoods where the utilities are already buried. An ideal 5G neighborhood is also going to have significant housing density, with houses relatively close together without a lot of empty lots.

Verizon recently announced it is mixing millimeter-wave and CBRS spectrum as it expands the product. The company plans to pass 25 million homes with the technology by the end of 2025. Analysts expect this expansion to occur in major cities and surrounding suburbs and will not likely be extended to places like the county.

Wireless Mesh Wireless - Starry

This is the technology used by Starry, a company owned by Chet Kanojia, an inventor and entrepreneur who has developed several proprietary wireless technologies. He's been operating wireless networks in major markets like Boston, Washington DC, Denver, New York City, and Los Angeles. Starry beams broadband to apartment units in high-rises through receivers placed in windows.[25] The technology uses the 37 GHz spectrum band obtained as a test frequency from the FCC. The product delivers roughly 200 Mbps upload and download – the latest speeds are always posted on the website.

Starry recently introduced a new kind of wireless technology that is probably best described as a wireless mesh. The technology begins with a fiber-fed radio and then bounces the signal from the first customer to subsequent customers. Stary launched this product last year throughout the Columbus, Ohio, metropolitan area. The technology is available to anybody from high-rises to single-family homes and will cover downtown and stretch into nearby suburbs.

[25] https://starry.com/

Starry is taking a different approach from other wireless technologies and is using Time Division Duplex (TDD). This is the same technology that has been used in the telecom industry for decades and is used to deliver T1s. The benefit of the technology is that there are both download and upload timeslots built automatically into the transmission path. This allows a single frequency and channel to handle both upload and download functions simultaneously. One user in a household can download while somebody else uploads at the same time using a single frequency channel. Other radio technologies use separate radio paths for upload and download, which adds to radio costs. Starry can easily vary the number of upload or download time slots depending upon demand, and it's the TDD feature that lets Starry deliver symmetrical upload and download speeds.

Starry launched in Columbus with a $25 introductory price for early adopters but will likely soon get back to its standard $50 rate. Starry has big plans to eventually pass up to 40 million households with the technology.

III. FINANCIAL PROJECTIONS

This section of the report looks at the detailed assumptions that were made in creating the financial business plans. The business plans created are detailed and contemplate all aspects of operating a broadband business. The business plan assumptions represent our best estimate of the operating characteristics of such a business. As a firm, CCG consults for hundreds of communications entities that provide rural broadband. This has given us a lot of insight into how rural ISPs operate. We believe that the financial results shown in these models are characteristic of similar operations elsewhere, and we believe our assumptions are realistic.

The primary goal of the business models is to look at the various scenarios from the perspective of an ISP that would operate the business. The purpose of these models is to provide a way for ISPs to understand the broadband opportunities in Cottonwood County. We've learned with experience that almost every ISP is theoretically interested in expanding. However, no ISP is really interested until they understand the numbers. Only then can they decide if the opportunity is something they can get financed and that meets their requirements as an investment opportunity. These studies help the ISPs understand the opportunity of expanding broadband into the rural parts of the counties.

A. Ownership Models

The proposal offers to consider different ownership models for a network solution. The following section looks at the most common ownership models found around the country. This includes a retail model where a single ISP owns and operates the network – this can be done by the local government or by a commercial ISP. Open-access is an ownership model where the local government owns the network and invites multiple ISPs to use the network. Another common model is public-private partnerships, where the local government and a commercial ISP somehow share ownership. Another possible ownership structure comes with the creation of a broadband cooperative. The final option discussed is ownership by a non-profit.

Retail Model – Single Provider as the ISP

This scenario considers the network being built and operated by a single entity. From an ownership perspective, this is the simplest operating model. A retail ISP is a single entity (could be the local government or a single ISP) that operates a retail broadband network. A retail ISP normally owns the network, hires the staff, operates the business, and benefits from any profits. It's not hard to cite examples of single-operator networks since most broadband networks in the country are owned and operated by a single ISP.

CCG has learned from experience that if a market can't be profitable with one provider, then the other options discussed below, like partnerships and open-access can't be successful since these other operating models divvy up profits among multiple entities. If there's not enough profit to sustain one owner, then there is not enough profit to support multiple owners.

Advantages

Profits. A single owner/operator can make all of the profits from a fiber business.

Flexibility. A single owner/operator makes all of the decisions related to building, funding, and operating the business.

Disadvantages

Risk. The flip side of the ability to make all of the profits is that a single owner/operator also takes all of the risks. If a commercial ISP doesn't succeed, the ISP can lose any investments in the new business and also can risk the entire business if the parent company is pledged to secure debt.

If a municipal venture doesn't succeed, the business can fold. In many cases, even with revenue bonds, the municipality is still on the hook to cover bond payments even after a business fails.

Financing. The primary impediment to building and operating a fiber ISP is raising the funding to pay for the network.

Cities often wonder why commercial ISPs aren't building fiber networks if a business plan shows a broadband business can be profitable. There are a few reasons why ISPs are not rushing around the country building fiber networks. The first is borrowing power – most small ISPs have a limited borrowing capacity and can only borrow to finance projects up to a relatively small limit. Cities are often surprised to find how few ISPs are able to borrow tens of millions of dollars.

Even if funding is available, a lot of investors and ISPs are not interested in the slow and low return that comes from building broadband networks. In the industry, the returns that can be made on broadband projects are referred to as "making infrastructure returns." This means an entity investing in fiber likely will make a return under 10% over the long run, and it often takes many years for a new fiber business to show any return. Most ISPs concentrate on broadband projects with the highest returns. This might mean building broadband only to businesses or building very selectively in neighborhoods with better-than-average expected returns. Many of the large ISPs like AT&T and Verizon only build selectively. This means that there is a limited number of ISPs willing to tackle a project with infrastructure returns.

Open-Access

The open-access ownership model comes when a local government builds a fiber network and makes it available to multiple ISPs. The ISPs market and sell broadband and other products to customers. This model operates financially by the fiber owner selling access to the ISPs in an arrangement that is often referred to as selling loops. The loop charges are the only source of revenue for the municipal network owner.

The open-access model thrives in Europe but has had a more difficult time succeeding in the U.S. Europe has seen success with open-access networks because a significant number of the large ISPs there are willing to operate on a network operated by somebody else. This came about due to the formation of the European Union. Before the European Union, each country on the continent had at least one monopoly telephone company and a monopoly cable TV company. The formation of the European Union resulted

in a change in the law that opened up existing state-run monopolies to competition. All of the state-owned telecoms and ISPs found themselves in competition with each other, and most of these businesses quickly adapted to the competitive environment. This contrasts drastically with the U.S. market, where there is no example of any large cable company competing with another and only limited competition between large telephone companies.

When a few cities in Europe considered the open-access operating model, they found more than a dozen major ISPs willing to consider the model (in this country that would be equivalent to getting Comcast, AT&T, Verizon, and CenturyLink to agree to use the new fiber network). There are now open-access networks in places like Amsterdam and Paris, as well as in hundreds of smaller towns and cities. The biggest networks have over a hundred ISPs competing for customers—many of the ISPs with niche businesses that pursue a specific small customer niche. Due to that level of competition, the European fiber networks get practically every customer in their market since even the incumbent providers generally jump to the new fiber network.

That hasn't happened in the U.S. There is only one example of a big telco operating on somebody else's network, and it's in nearby Springfield, Missouri, where CenturyLink is in the process of using a network built by the City. However, it's hard to know where that venture will go since the Missouri operations are part of the sale of assets from CenturyLink to Apollo Asset Management. We don't know of any other examples where one of the largest telcos or cable companies has agreed to operate as a competitor on somebody else's network to serve residential customers. The large ISPs in the U.S. often lease fiber outside of their footprint to serve large business customers but have never competed for smaller businesses or residents in each other's monopoly footprints.

This means that open-access networks in the U.S. must rely on small ISPs. These small ISPs are generally local and mostly undercapitalized. The small ISPs have all of the problems inherent to small businesses. They often don't have the money or expertise to market well. They often have cash flow issues that put restraints on their growth. In addition, many of them don't last beyond the career of their founder, which is typical of small businesses in general.

Open-access network operators have struggled in this country due to the nature of the small ISPs on their network. Consider the example in Chelan County, Washington, which was reduced at one point to having only one local ISP that was selling to residential customers. The network originally had almost a dozen ISPs, but over the years, the ISPs either folded or were purchased by the remaining ISP.

A similar thing happened in Provo, Utah, before the City sold the network to Google Fiber. The network had originally attracted eight ISPs, but over time this was reduced to only two. It's hard to make an argument that a network with so few choices is open-access - because the whole purpose behind open-access is to provide customer choice.

<u>Examples of Open-Access Networks</u>. Following is a list of some of the other municipal open-access networks in the country.

- The Public Utility Districts (PUDs) in Washington State. These are countywide municipal electric companies. The PUDs are restricted to offering open-access due to legislation passed a number of years ago. There are numerous different open-access models being tried at various PUDs, with the

largest networks in Chelan County PUD, Grant County PUD, Douglas County PUD, and Pend-Oreille PUD.

- Utah has a similar law that applies to municipalities. This led to the creation of an open-access fiber business in Provo and another network called Utopia that serves a number of small towns. The Provo network was losing a lot of money, and the City decided to sell the network to Google Fiber for $1. Utopia is still operating a wholesale business but had significant financial problems during the first decade. However, after several rounds of refinancing, the Utopia network is growing vigorously and adding new towns to the consortium.
- A similar law was passed in Virginia after Bristol Virginia Utilities (BVU) built a retail fiber network. The legislation grandfathered BVU as a retail provider but only allowed other cities to operate open-access networks. So far, the wholesale model has been adopted by a few cities, the largest being Roanoke, which offers open-access on a limited basis to only parts of the city.
- Tacoma, Washington, chose an open-access model where the City was the retail provider of cable TV, but connections to the network for telephone and broadband were sold wholesale to ISPs. That was a losing venture, and the City is now leasing the network to an ISP.
- Ashland, Oregon, operates an open-access network, but the City also operates as a retail ISP on the network and competes against a few local ISPs that sell on the network.
- There are a number of municipalities that have built fiber rings that are promoted as "open-access" to carriers. For the most part, these networks only serve carriers or business customers, and most of the industry refers to this as a wholesale model rather than open-access.
- Other communities have tried to build open-access networks but then were unable to find any ISP partners. For example, Longmont, Colorado, tried to launch an open-access network but was unable to find ISP partners and decided to offer retail services directly to residents.

Advantages

Customer Choice. The most appealing aspect of an open-access network for a community is that it offers a variety of choices to customers over the same fiber network. The hope is always that having greater competition will lead to lower prices and better customer service.

Disadvantages

Retail/Wholesale Revenue Gap. There is a big difference in the revenue stream for a network owner between collecting a retail revenue stream from customers versus collecting only open-access fees charged to ISPs. For example, the average retail revenues on a fiber network serving residential customers might be over $100 per customer per month. The average revenues on an open-access network are likely far smaller, at perhaps $30 - $40 per customer per month.

There are some cost savings for the network owner in an open-access environment. The network owner doesn't serve end-user customers and doesn't have to sell, bill customers, or provide customer service. But it's still extremely difficult for the network owner to be profitable with open-access. The network owner still has to cover the full cost of debt on the network. The network owner still has to maintain the fiber network and provide the core electronics. In most scenarios, the network owner is responsible for continuing to install fiber drops and customer electronics.

Not Many Quality ISPs. Most open-access networks in the U.S. have had trouble finding and retaining ISPs on the network. Some examples are discussed above. The ISPs willing to operate in this environment are generally small and undercapitalized. Open-access forces these ISPs to compete against other small competitors, which holds down prices and puts pressure on ISP earnings.

Leads to Cherry-Picking. The open-access model, by definition, leads to cherry-picking by the ISPs. When ISPs are charged to use the network, they tend to concentrate on selling only to customers that bring the highest margin – and tend to not sell low-priced products with low margins. The only way to get broadband to everybody in an open-access network is for the network owner to lower its fees – and that makes it impossible to pay for the network. CCG has never seen an open-access network that has a customer penetration rate as high as would be expected if the same community had a municipal retail provider. Cherry-picking means fewer customers on the network and a smaller revenue stream for the network owner. Municipalities often build networks with the goal of getting broadband to the neediest citizens in the community, and open-access makes it a challenge to do so.

No Control over Sales Performance. The network owner in an open-access network has no control over the customer sales process. That means they only do as well as the ISPs on the network. In CCG's experience, many of the small ISPs operating on open-access networks tend to not have the resources for major marketing efforts or else only want to serve a niche market and don't try to mass market. A retail ISP that owned the same fiber network would try to sell to everybody – but that never happens on an open-access network.

Stranded Investments. One interesting phenomenon that especially affects open-access networks is stranded investments at customer premises. A retail ISP typically strives to keep customers on a network once it has made the initial capital investment to connect a customer. However, in an open-access network, the ISPs don't make this same effort. Over time, an open-access network owner will see a growing inventory of homes and businesses with a fiber drop and customer electronics that are no longer used - and which are not contributing to the bottom line.

Public-Private Partnership (PPP)

There are a wide variety of public-private partnerships that can be created between a government entity and an ISP. There are many ways that revenues, profits, and risks can be shared between partners. The following discussion examines the most common forms of PPPs.

PPPs initially arose internationally as a way to finance infrastructure needs that local, regional, or national governments could not pay for upfront or finance from taxes, bonds, or other methods of raising government money. Over the last fifty years, governments collectively in the U.S. have been unable to fund the needed level of infrastructure - and PPPs were often formed to help finance the infrastructure deficit.

There are three major ways that a fiber PPP can be structured depending upon who pays for the network. A fiber network could be mostly funded by the government, mostly funded by a commercial entity, or funded jointly by both.

PPP Funded Mostly by a Government. This scenario means that a government takes all of the financial risks of building a network and then hands the operations to somebody else. This is the arrangement that is in place in the Google Fiber partnership with Huntsville, Alabama. Reports are that Google Fiber is responsible for the costs inside the customer premise and the City for the rest. There are similar partnerships between Ting and Charlottesville, VA, and Westminster, MD. CenturyLink has reached a similar arrangement with Springfield, MO.

PPP Funded Mostly by the Commercial Provider. There are many examples where a commercial provider has built a fiber network with some upfront assistance from a community. In most cases, the parties don't think of these arrangements as a partnership.

For example, ISPs often ask for some concessions when building a fiber network. The first few markets for Google Fiber are reported to have this arrangement. It's widely believed that Kansas City granted major concessions to Google Fiber to get them to build fiber there. The City might have provided concessions like free rights-of-way, expedited permitting, use of city land for placing facilities, etc.

Another common form of this kind of partnership is happening this year as local governments are providing grants to ISPs using the American Rescue Plan Act funding. The municipalities rarely get an ownership share in the business for these kinds of contributions.

For this kind of arrangement to be considered a traditional PPP, a municipal entity would have to get something in return for the concessions they make to an ISP. This could be almost anything that is perceived to be of value. It might be free or reduced telecom prices provided to government buildings or fibers connecting government locations together. It could also be the ISP agreeing to help a city meet some social goal, such as building to poorer parts of the city that a commercial ISP might otherwise not have considered. In some rare cases, this might mean that the local government takes an ownership share in the business.

PPP Funded Jointly. When a municipality and an ISP both contribute significant cash or hard assets to a venture, it's clearly a PPP. Following are a few examples of the different ways such partnerships can be structured.

- Zayo partnered with Anoka County, Minnesota to build a middle-mile fiber network throughout the county. This is a suburban county just north of the twin cities. Both entities made a significant cash contribution to the project, plus the two parties together pursued and received a grant to help pay for the network. The county received access to a 10-gigabit network connecting all of its facilities, and Zayo received connections to all of the major business districts. Zayo owns the network, but each party has affordable access to the whole network as needed. Each party is also allowed to build outward from any point on the jointly built network at their own cost.
- Nashville, Tennessee, partnered with a commercial ISP to build fiber to city buildings as well as to commercial districts. Both parties made capital contributions. The City eventually sold its interest in the network but still retains fiber to most city buildings.
- There are dozens of small cities where a city built an initial fiber network to connect to schools, water systems, etc., and now allows commercial providers to build fiber spurs

from the city-owned ring. The financial arrangements for this vary widely. Sometimes the two parties just swap access to various locations on each other's network, and in other cases, each pays to lease access on the other's network. However, both parties share some parts of the network, portions of which each has funded.

- Several of the Public Utility Districts (PUDs) in Washington built fiber into business and residential neighborhoods and then allow ISPs to build fiber loops and electronics to connect to the core network.
- Google Fiber recently announced a partnership with West Des Moines, Iowa, in a network that can best be described as open-access conduit. The City is building empty conduits along every street and will also extend the conduit to each home and business. The network will be available to any ISP, and Google Fiber is the first announced network tenant. Google will pay to pull fiber through the conduit, and the company says it plans to serve the whole city. The City recently made a similar arrangement with Mediacom. In this partnership, the City has tackled the most expensive part of the network, but ISPs still have to make a sizable investment to pull fiber to reach customers.
- There are hundreds of examples of government entities that have built fiber routes jointly with a commercial partner. This is referred to in the industry as fiber sharing, and generally, each contributor to the fiber route gets some specific number of fibers for their contribution. For example, this is a common practice with school system fiber networks.

There are several kinds of contributions that a government can make to somebody else's fiber network. This could include cash, real estate, excused fees, or sweat equity. Governments can allow a commercial provider to use parcels of land or give them an existing building. Excused fees might mean not charging for something that would normally be due, such as permitting fees or property taxes. The government could excuse payments for poles, conduits, existing fiber, or towers. It could mean the commercial provider might not need to pay taxes or fees for some period of time, as is often done in many economic development projects. Sweat equity is assigning a value to the time contributed by a city. For example, we've seen a city assign extra employees for free for tasks like the permitting process during a major fiber construction project.

There are almost unlimited ways to model and form a public-private partnership. The underlying requirement is that the business must be profitable for the private commercial partner. Commercial providers expect a healthy rate of return on any investment they make in the business. Most commercial companies won't invest in a business that doesn't return at least a 20% to 30% return on their investment.

Following are the advantages of public-private partnerships.

<u>Advantages</u>

<u>Smaller Government Investment</u>. Funding from a commercial ISP lowers the amount of borrowing needed by a local government.

<u>Help in Financing</u>. City access to bond funding often makes it a lot easier for a commercial ISP to raise the rest of the needed investment.

<u>Disadvantages</u>

Matching Goals and Expectations. One of the primary reasons why there are not a lot of telecom public-private partnerships is that it's often difficult to reconcile the differing goals of the two sides. The commercial partner is generally going to be focused on the bottom line and returns, while the community part of the business often has goals like community betterment and lower rates. One of the biggest sticking points in creating PPPs is that cities want fiber built past every home, which ISPs prefer to build to only selected neighborhoods. It's often difficult to put together a structure that can satisfy all the different goals.

Expensive Money. Since commercial partners generally want to make at least a 20% return on equity, this can be expensive funding.

Tax-Free Funding Issues. It's difficult to obtain tax-free bond funding to support a PPP. Tax-free bonds generally can't be used for a project that benefits a commercial entity.

Process Driven by Commercial Partner. Our experience is that the commercial partner drives the structure of the business as a likely precondition for investing. This means that a local government will not have a lot of say in the details of how to operate the business.

Length of Partnership. Many commercial investors have a business plan that contemplates eventually selling the business to realize the cash value. This may be difficult to reconcile with the long-term desires and goals of a community-based fiber optics project.

Governance Issues. It's a challenge to develop a governance structure that can accommodate the government decision-making process. Governments generally go through a defined deliberative process, including holding open meetings to make any significant decisions. This does not mesh well with the decision-making process and the expected timeline for a commercial partner. A commercial partner might make decisions in days, while the government process can't be any faster than weeks.

Public-Public Partnerships

There are a few examples around the country of ISPs formed by multiple local governments working together. One example is Southwest Broadband (SMBS) in Minnesota, which was formed jointly by seven small rural communities.

SMBS followed the typical models for public-public partnerships. The towns all formed a joint venture where each member town is a partial owner of the business. States have different mechanisms for communities to band together, and this is a common model for numerous kinds of regional public ventures like water systems, transportation systems, etc.

Another successful public-public partnership is MINET, which was jointly formed and operated by the cities of Monmouth and Independence, Oregon. The municipal ISP has gained over an 80% market share in the two cities.

Advantages

Easier Financing. Many public-public partnerships have been created when the member cities alone did not have enough borrowing power to finance a project. Combining the bonding capacity of multiple communities can make a project feasible.

Economy of Scale. In the case of SMBS, none of the communities were large enough to have created a successful standalone ISP. It took all of the communities together to justify hiring the manager and staff needed to be successful in the business.

Disadvantages

Like Any Other ISP. The only downsides to this kind of arrangement are the typical risks that come from operating an ISP, in that the business has no guarantee of success.

Cooperatives

Cooperatives are owned by the customers of the business. Somebody that buys broadband from a broadband cooperative is given a share of ownership in the business. Around the country, there are a huge number of telephone cooperatives and electric cooperatives that operate broadband networks and power networks. There are no barriers to starting new broadband cooperatives, although it's a fairly rare occurrence. Once formed, a cooperative broadband ISP looks like any other standalone ISP. The new cooperative must find a way to fund the business and must hire the needed staff to operate the business. Most cooperatives are for-profit and must pay income taxes, although there are ways in some states to remain tax-free as long as a cooperative follows narrowly defined rules.

The only new broadband cooperative we know about is RS Fiber in Minnesota. This is a cooperative formed by a coalition of two counties, seven cities, and numerous rural townships.

Advantages

More Funding Flexibility. A cooperative has more financing options than a municipal ISP. A cooperative can raise money from traditional lenders like banks. There are also several boutique banks – CoBank and the RTFC - that are owned by cooperatives and mostly lend to cooperatives. Cooperatives often solicit some funds from cooperative members. Cooperatives can also borrow money at attractive interest rates from other existing cooperatives.

Good For Customers. Since a cooperative is owned by customers, the businesses can be highly focused on taking care of members. This typically means great customer service and often means lower rates than nearby ISPs.

Disadvantages

Harder Start-up. Most new commercial ISPs are started by existing ISPs, meaning that there is a commercial entity that can contribute start-up capital and perhaps provide financing assistance. However, a new cooperative is starting from scratch in terms of start-up capital and funding. RS

Fiber cobbled together financing from half a dozen sources since no lender was willing to trust a new start-up business with a loan large enough to fund the whole business.

Non-Profits

It is also for an ISP to be funded and owned by a non-profit corporation. There are a handful of urban non-profit ISPs that are bringing broadband to places like public housing. The only larger non-profit we know of is in the city of Dallas, Oregon. The fiber network was funded by a non-profit and hired MINET (mentioned above) to operate the business.

There have been large non-profits in the past that started ISPs or have thought about starting ISPs. The largest one we know is the Fastenal Foundation, which started a non-profit ISP in eastern Minnesota. The non-profit's motivation was to bring broadband to small cities that were suffering from poor broadband. The ISP became financially successful, and Fastenal sold the business to a commercial ISP.

Advantages

Tax-Free. The main advantage of a non-profit owner is that the business is not subject to taxes in the same manner that municipalities are tax-free.

Disadvantages

Like Any Other ISP. The only downsides to this kind of arrangement are the typical risks that come from operating an ISP, in that the business has no guarantee of success. Non-profits have the same issues with borrowing money as any commercial ISP. A new cooperative will have a challenge borrowing money due to being a new company – lenders like companies with a track record.

B. Financial Assumptions

Incremental Analysis

It's important to note that all of the projections were made on an incremental basis. This means that the studies only consider new revenues, new expenses, and new expected capital costs. This is the most common way that businesses of all sorts look at potential new ventures since the incremental analysis answers the question of whether any new business line will be able to generate enough revenue to cover the costs.

It's important to understand what an incremental analysis shows and does not show. An incremental analysis is basically a cash flow analysis. It looks at the money spent to launch and operate a new venture and compares those costs to the revenues that might be generated from the venture.

An incremental analysis is not the same as a prediction of what the accounting books of a new venture might look like. For example, if one of the existing ISPs in the area was to undertake one of these business plans, they would allocate some of their existing overhead costs to the new venture. The classic textbook example of this is that some of the existing costs of the general manager of the ISP would be allocated to

the venture in the accounting books. However, the cost of the salary of the existing general manager is not considered in an incremental analysis since that salary is already being paid by the existing business. If these studies were to show an allocation of the general manager, then they would not be properly showing the net impact of entering the new market.

Timing

Timing is critical to any business plan. The faster that a business can start generating revenues, the sooner it can cover costs. These studies are somewhat conservative in the predictions of the speed of the roll-out of the business venture. That means that if an ISP could get customers faster than predicted by the projections that they can have better results than we've shown.

Following are the major milestones as predicted by these forecasts:

- Financing. All the forecasts assume that funding is available in January 2023. This is illustrative only and could be changed to any other future date.
- Construction. Fiber construction is assumed to last for two years to build the whole rural area. Because of supply chain issues, which might take a little longer.
- First Customer. We've assumed that the first customer could be added to the network ten months after the date of funding. In Minnesota, this is going to be influenced by the construction season that only is easily feasible from May until October. To get the first customer this quickly would mean launching the business by building a few nodes the first year along with fiber to the neighborhoods nearest to the nodes. If the approach to construction is to first build the fiber backbone between nodes, then customers would not be added in the first year.

Pricing Strategy

We assumed that the products would be as simple as possible. For example, our analysis includes only three broadband speed tiers for residential or business customers.

There are a number of different pricing strategies used around the country by ISPs selling broadband. Following is a discussion of some of the more common models and a discussion of the pros and cons of the various approaches to pricing.

- Competition. When building broadband into a market that already has existing competition, it's important to consider the prices of competitors as well as predicting how they might react to competition. In rural areas with little or no existing broadband, this is usually not a factor.
- Market Rates. This asks the important question of what people are willing to pay for broadband. We see ISPs that set prices low based upon the assumption that nobody will change providers with prices near existing market rates. However, CCG has many clients that charge market rates for broadband and get similar penetration rates to ISPs with lower rates.
- General Pricing Philosophy. ISPs often come to the market with predetermined notions of how prices ought to work. A pricing philosophy is often based upon the overall goals for the business and the way that an ISP thinks about business. For example, some ISPs have a goal of maximizing cash flow or of maximizing profits (not the same thing). Other ISPs are more community-oriented and want to bring fast broadband to as many households as possible. These basic philosophies are often the driving force behind a pricing strategy.

For example, some ISPs believe in simplicity and only offer a few products. Other ISPs stress bundles and set prices accordingly. Some ISPs think that the way to sell a lot of services is by having low prices. Other ISPs think it's better to have higher prices and fewer customers. Some ISPs think it's important for the community to have a low-priced product for low-income households. Some ISPs charge the same prices to residents and businesses—others charge businesses a lot more.

Those various philosophies result in a couple of different pricing strategies that we manifested into market rates. A few key examples include:

- One Broadband Product. There are a few fiber ISPs that offer only one broadband product, most typically a gigabit.
- Low Basic Price. Some ISPs set a low price for the basic product. This is done more often by municipal ISPs, but there are small commercial ISPs with the same philosophy. As an example, an ISP might set the price of the basic broadband product at something like 50 Mbps for $40.

  CCG Consulting has access to the prices and the resulting customer counts from nearly 200 ISPs and what we have learned is that most customers will buy the basic broadband product if the speed is okay. A basic product set at slow speed like 5 Mbps likely won't sell, but in today's market, a product with a decent speed like 50 Mbps or greater will be perceived as acceptable to most households.

  It's debatable if setting low rates captures more of a market – but it's obvious that low rates leave a lot of margin on the table. In setting rates for this study, we began by considering existing market rates. These are "permanent" rates, and we don't consider special advertising rates that last for a year before reverting to full price. ISPs often make the mistake of setting their permanent rates to compete with competitors' special rates.

Following are the basic product residential rates in the market today:

- CenturyLink offers lower rates to new customers that eventually reach prices that start at $47 for 7 Mbps and $72 for 40 Mbps. The fee for the modem varies from $1.95 to $6.95.
- Frontier charges $44.95 for 6/1 Mbps, $54.95 for 12/1 Mbps, and $59.95 for 18/1.5 Mbps. For all products, a modem is $10.
- Arvig prices start at $47 for 5/1 Mbps and climb to $80 for 100/20 Mbps.
- Nuvera Communication's prices start at $50 for up to 30 Mbps and go to $90 for up to 100 Mbps.
- Mediacom offers a 60 Mbps broadband product with data caps – it's $49.99 with a 200 GB cap or $69.99 with a 400 GB cap. Most new customers are offered the standard starting product of $79.99 for 100/10 Mbps and a 1-terabyte data cap. The modem is $10.
- Windomnet prices range from $52 for a symmetrical 12 Mbps connection to $87 for a symmetrical 60 Mbps connection.
- Southwest Broadband charges range from $64.95 for 100/100 Mbps to $109.95 for 1 Gbps on its fiber network. The router is $10.
- Woodstock Communication charges prices for fiber starting at $39.95 for 25 Mbps to $99.95 for 250 Mbps. Prices for fixed wireless start at $49.95 for 10 Mbps to $79.95 for up to 50 Mbps.
- MVTV Wireless has speeds between 6 Mbps and 50 Mbps and charges $39.95 to $79.95, respectively.

- Lismore Wireless charges $47.95 for 10/2.5 Mbps and $77.95 for 50/10 Mbps for its fixed wireless broadband.
- Rise Broadband charges $42 for 5 Mbps up to $57 for up to 50 Mbps speeds on its fixed wireless networks. Every Rise Broadband plan comes with a 250 Gigabyte data cap and charges an additional $5 per 10 GB of data.
- Federated Broadband rates for fixed wireless start at $50 for 6/2 Mbps to $90 for 40/3 Mbps.
- LTD Broadband charges $50 for 6 Mbps up to $110 for 35 Mbps on its fixed wireless network.
- T-Mobile's new fixed cellular plan costs $60 per month for customers that use autopay. Speeds are whatever is delivered, and usage is unlimited. Prices are higher for the 4G hotpots.
- Verizon's new fixed cellular plan costs $55 per month for customers that buy Verizon cellular plans or $75 for non-subscribers. Speeds are whatever is delivered, and usage is unlimited. Prices are higher for the 4G hotpots.

A new ISP with a fiber network will be able to offer significantly faster download speeds than all of the ISPs other than cable companies. Fiber would bring significantly faster upload speeds than every other technology. In our experience, ISPs don't have a big problem selling a superior product. A customer with a slow DSL product is usually willing to pay a little more for broadband that is twenty times faster.

In the models we used $60 as the starting price for broadband. This is consistent with prices charged by others on fiber and is less than Mediacom. The $60 price is in the middle of the range of prices for fixed wireless but is far faster.

The forecasts assume some rate increases over time. Rates must be increased to keep up with expense inflation. The model is conservative and assumes that rates increase by 5% every fifth year, which works out to a little less than 1% per year. The big cable company have been raising rates by 3% to 5% every year.

- Price Steps or Tiers. Most ISPs price using tiers (like the above examples for incumbents). Probably the key attribute to tier pricing is the price differential between tiers. Consider three different pricing structures that begin with a $60 broadband product:

	Rate 1	Penetration	Rate 2	Penetration	Rate 3	Penetration
100 Mbps	$ 60.00	85%	$60.00	60%	$60.00	50%
250 Mbps	$ 90.00	10%	$75.00	30%	$70.00	35%
Gigabit	$120.00	5%	$90.00	10%	$80.00	15%
For 1,000 Customers:						
Revenue	$66,000		$67,500		$66,500	

The difference in the steps or tiers is that "Rate 1" prices are set at $30 steps between products, "Rate 2" is at $15, and "Rate 3" is at $10. The impact of smaller tiers is that it's easier to upsell a customer to faster products. The above penetration rates are typical for some CCG clients using the different price tiers. Customers might voluntarily choose a fast product when the step between tiers is small, and they are more likely in the future to upgrade anytime they feel their speed is

bogging down or inadequate. Conversely, when the steps are too large, customers buy and then stick with the lowest-priced tier rather than increase the monthly bill too much.

We have seen that having too many price tiers confuses customers. The above examples have tiers with three prices. We know of ISPs with seven to ten price tiers, and in looking at their penetration rates, we see that this confuses customers. We have seen the most effective rate structures having no more than four tiers, which can be explained to customers on a fiber network as fast, faster, and fastest, and gigabit.

- Setting Business Rates. Philosophies vary widely on business rates. The incumbent telephone companies and cable companies generally charge a lot more to businesses than to residential customers. At one time, the philosophy behind this was that businesses consume more resources and cost more to serve than residential customers. While that might still be true for medium and large businesses, ISPs will tell you that the average home today uses considerably more bandwidth than the average small retail store. The exception might be a coffee shop supporting a public hotspot or a business that deals in large files like photographers or engineers.

  We know a few ISPs that charge the same rates to businesses and residences, although that is rare. Most ISPs follow the incumbent pricing practices and charge more for businesses.

  One thing that a first-time ISP learns quickly is that incumbents don't have standard rates for businesses, but rather they negotiate with them. It's not unusual to find two similar small businesses in the same neighborhood paying drastically different rates for the same products. This creates a challenge for ISPs. Some ISPs set standard business rates that apply to all businesses, while others set rates on a custom basis compared to what a business is currently paying.

  The other thing that a new ISP learns quickly is that most businesses care more about reliability than price. They want their broadband and telephones to always work during business hours. They don't want to pay more than they can afford, but they are not afraid to pay for a quality connection. While a new fiber provider might see good appreciation for a fiber-based ISP saving them money, the chances are that they decided to change ISPs due to outages they have had in the past with their current provider – if they perceive fiber to be a more stable technology.

- Rate Bundles. The large cable companies are well-known for having bundles of products where they provide a discount to customers buying more than one product. Generally, customers have no idea which products the discount applies to. No more than 15% of the small ISPs that CCG works with provide a similar bundling discount. Most smaller ISPs set prices at rates at a competitive level and don't discount them further.

  We caution that we've seen ISPs that built a business plan and forecasts upon list prices and then found themselves in financial stress when a marketing person at the company decided they could sell more by offering discounts that weren't in the business plan. Interestingly, Verizon announced in 2020 that it is doing away with bundled rates for new customers. It will take a few years for customers with older plans to migrate to unbundled rates. Verizon describes the new rate structure as more open and honest and says that this is what customers want.

- Introductory Rates. The big telcos and cable companies are also well-known for advertising low introductory rates that increase dramatically after a term contract of 1 to 3 years. Most of the rates you'll see from these companies on the web or in advertising are introductory rates, and the real rates of these companies are generally buried in the small print if shown anywhere.

  Customers dislike the introductory rate process because they invariably get socked with an unexpected rate increase when rates jump back to list prices. The time of big introductory discounts might be starting to end. AT&T decided in 2019 to stop renegotiating customers with low introductory rates and moved customers to list rates. This cost AT&T nearly two million customers on DirecTV, but the company said they would rather have fewer customers that are profitable than keep customers that don't contribute to the bottom line of the company. A few medium-sized cable companies have made this same change.

  Most small ISPs do not offer introductory rates. They've found that introductory rates are a lot of work since it requires getting customers to sign a contract. More importantly, introductory rates teach customers that an ISP is willing to negotiate rates.

- Low-Income Pricing. This is covered in more detail Section I.A of this report. Most ISPs do not offer a low-priced product for low-income households. An increasing number of ISPs are instead participating in the federal programs that provide a discount to qualified low-income customers.

Rates Used in This Assessment

Telephone Rates

The studies assume a single residential telephone product – a telephone line with unlimited long-distance for $20.00. The product includes a full package of features like voice mail, caller ID, etc. These rates don't include taxes on the telephone service, such as the tax that supports 911.

The unlimited long-distance will be welcome in households that have poor cellular coverage since the telephone companies charge long-distance rates for calling outside of the county. The unlimited calling plans today often include Canada, Mexico, and even some other international locations.

The rate for a business line is $30, with the same features and unlimited-long distance. The studies assume three telephone products for businesses:

Cable TV Products

We did not include cable TV in the feasibility assessment. Millions of households nationwide have been dropping traditional cable every year and are instead using streaming video services.

Broadband Products

The three speeds below are arbitrary, and an ISP might use these prices but a different set of speeds. We have used a 3-tier pricing structure with a $15 price step between tiers. The broadband products are all assumed to have symmetrical download and upload speeds.

	Price	Percentage
Residential Fiber Broadband		
100 Mbps	$ 60.00	60%
250 Mbps	$ 75.00	30%
Gigabit	$ 90.00	10%
Business Fiber Broadband		
100 Mbps	$ 80.00	55%
25- Mbps	$105.00	30%
Gigabit	$120.00	15%

Most ISPs charge more to businesses for broadband, and the studies assume a $20 additive to business rates.

The financial models assume that the broadband products don't have data caps and provide unlimited broadband usage to customers. If there were data caps, then customers that exceeded those caps would be charged more than the basic prices.

Managed WiFi

This is a relatively new product that's been around for a few years. ISPs have found that the biggest quality problems with home broadband are due to obsolete or poorly placed WiFi routers in the home. A poor WiFi router translates to a poor broadband experience.

Many ISPs are now offering managed WiFi. This product places carrier-class WiFi routers in the home that are placed and operated by the ISP. High-quality routers and the placement of multiple routers for larger homes usually mean better broadband coverage throughout a home. ISPs often assist customers when adding a new device to the wireless network. The managed WiFi routers provide a secondary benefit to an ISP because they provide a network monitoring location inside the home, meaning that the ISP is more easily able to pinpoint problems.

The studies assume a monthly rate for managed WiFi of $5.00 for residences and $10.00 for businesses. It's further assumed that 70% of residents would buy this product and 60% of businesses.

Large Broadband Products

There are entities in Cottonwood County that buy larger bandwidth products. The studies are conservative and do not predict a new ISP winning this business. In the county, the fast broadband products would likely be sold to cellular towers, schools, and a handful of large businesses. Over time, a new fiber provider would likely win some of this business, but we didn't want to overinflate the financial outlook of a new ISP by overinflating these revenues.

Cell towers are an interesting challenge. In some parts of the country, we have clients with rural fiber networks that get almost every cellular tower as a customer. But we have other similarly situated clients that get none of this business. The cellular carriers like to buy large volumes of connections from a single regional provider, and they often already have a long-term contract for an area much larger than the county.

The new opportunity for cell towers will be for small cell sites. These are smaller cellular transmitters that are placed on utility poles or light poles and that bring improved cellular service into neighborhoods.

Network Capital Costs

The telecom industry uses the term capital costs to describe is the industry term for the cost of assets required to operate the business. The capital expenditures predicted in these models reflect the results of the engineering analysis described in Section II of this report.

Below is a summary of the specific capital assets needed for each base scenario. Capital for broadband networks includes several broad categories of equipment, including fiber cable, fiber drops, electronics for FTTP, huts and buildings, and customer devices like cable settop boxes and WiFi modems. In addition to capital needed for the network, there are operational capital costs for assets like furniture, computers, vehicles, tools, inventory, and capitalized software.

The Supply Chain Issue. We struggled with setting capital costs due to the current pressure in the industry from supply chain issues. The pandemic has wreaked havoc with the supply chain for telecom assets.

The biggest current concern in the supply chain is fiber cables. 2021 was the biggest year we ever saw for building fiber. The future looks to be even busier when looking out at the massive amounts of fiber that might be built as the result of the ARPA grants, aggressive state grant programs, and the possibility of a massive federal infrastructure program. Additionally, the big telcos have announced aggressive plans to finally build fiber.

As an example, AT&T said that the supply chain resulted in the company only achieving 2.5 million of the 3 million planned new passings in 2021. AT&T didn't name the vendor that was the primary reason for the slowdown, but it's likely that it's either Corning or CommScope.

This news must be sounding loud alarms in boardrooms everywhere in the industry because if AT&T has supply chain issues, then everybody else is likely to have worse ones. It's hard to imagine that every manufacturer in the industry isn't giving AT&T the highest priority in its queue. If AT&T can't buy everything they want, then how will smaller telcos meet fiber expansion goals? How will new fiber overbuilders like cities using ARPA funds be able to break into an overloaded supply chain?

Supply chain issues are arising for a variety of reasons, all of which might come together to create a perfect storm for the industry. One reason for shortages is manufacturing capacity. For example, Corning, which makes fiber cables, saw revenues jump by 21% in 2021 compared to a year earlier.

Factories that are already working at capacity can't flip a switch to produce 20% more product. Demand is going to grow a lot more. The consulting firm RVA LLC predicted in 2021 that the industry has plans to build fiber to pass 61 million homes between 2021 and 2025 – that's far more fiber than has ever been built.

Supply chain issues are also suffering from the lack of raw materials needed to manufacture key components. This is one of the key issues behind the chip shortage and the shortage of electronics cases that are made from resin. Much of the global supply chain has not recovered from the impacts of the pandemic and this issue is far from behind us.

There are also more subtle changes behind the scenes. For example, many manufacturers have quietly looked for sources other than China during the pandemic. Many companies have come to realize that their own success was tied too closely to supply chains that were wholly within specific regions of China. Switching supply sources to other countries is not something that happens overnight, and many of these new relationships are still growing and maturing.

Our goal is to be realistic but still be a little conservative in our estimates. For the past decade, the prices for components in the industry have been stable, and we've been able to make estimates that get within 5% of the cost of building a network. Right now, we are as lost as everybody else in the industry in that we don't have a crystal ball that tells us where prices might peak from the supply chain problems.

We started our analysis by using the most current component costs we know about. Some of these costs are already 20% or higher than costs from a year ago. We decided for purposes of the assessment to increase material costs by 20% over today's prices. Hopefully, that will mean a conservative and achievable capital budget.

Below is a summary of the cost of the needed assets to support the two options we studied. These investments are at the end of the fourth year of operations – the time when the ISP is projected to reach full market penetration. The estimates below represent the assumption that a new fiber ISP would eventually gain a 60% market share. Since there is an incremental cost to add a customer to a fiber network, the investments would be higher if the penetration rate is higher.

	Study Area
Fiber	$22,733,802
Drops	$ 2,298,079
Electronics	$ 1,308,926
Huts	$ 470,700
Operational Assets	$ 130,273
Total	$26,761,370
Passings	2,138
Cost per Passing	$12,572

We knew when we saw the cost per passing that anybody building fiber in the rural areas is going to need some grant funding to make this work. We normally see grant funding required for projects that have a

cost per passing of around $3,000 or higher. We note that rural fiber projects almost always require grant funding.

Customer Costs

Residential Fiber Electronics Costs: The model assumes that the average electronics for an ONT costs $719, which includes the cost of the labor for installation. In the projections, it was assumed that the installation would be done by external contractors. It might be less expensive to do installations using company personnel or local contractors who can install at a lower cost. We've also assumed that most businesses use the same ONT electronics used to connect to homes. Only larger businesses would require a larger ONT with more data ports.

Fiber Drops: Fiber drops are the fiber that connects from the street to the customer premises. We have included conservatively high costs for fiber drops. The assumption has been made that with the volume of drops needed plus the anticipated speed of network deployment, the drops during the first five years of the project would be installed by external contractors. It would be possible to build drops for less using ISP staff, but the huge volume of installations during the first five years are likely larger than what company personnel could handle.

The engineering analysis looked at the average drop length throughout the study area – being the average distance in various parts of the county from the road to reach homes and businesses. We've estimated the average cost of drops for the study area to be $1,631, which is higher than what we normally see and reflects some of the long distances that rural homes and farms are located from the closest highway.

Customer Penetration Rates

One of the most important variables in the assessment is the customer penetration rate or the percentage of the homes and businesses in Cottonwood County that will buy broadband service.

The analysis looks at customer penetration rates in several different ways. The base scenario begins with what we call expected rates. We used an expected penetration rate of 60% to begin our analysis. We think this is a conservatively low penetration rate based on the experience of other rural fiber overbuilders. The only way to get a better estimate of the penetration rates would be through a statistically valid survey or a canvass – which means trying to ask all of the rural customers if they would subscribe to fiber.

Expense Assumptions

As a reminder, unless otherwise noted, all scenarios are created from the perspective of a commercial ISP offering the services. We know the county is not interested in being an ISP and the majority of scenarios assume that an ISP owns and operates the network.

Expenses are the recurring costs of operating the business once it's built. We strive when building financial projections to have conservatively high expense estimates. It's often less costly for an existing service provider to add a new market than what is shown in these projections.

As mentioned earlier, expenses are estimated on an incremental basis, meaning that the models only

consider new expenses that would be needed to open the new market for an existing ISP. In an incremental analysis, it's assumed, for example, that the existing ISP is already paying for positions like an accountant, etc., and the incremental models only hire employees needed to open a new market and add additional customers.

The primary expense assumptions are as follows:

Employees: Labor is generally one of the largest expenses of operating a broadband network. The models assume that an ISP will need to hire additional staff to take care of the new customers. We have assumed salaries at market rates with an annual 2.5% inflation increase for all positions. We've assumed that the benefit loading is 38% of the basic annual salary. That would cover payroll taxes and other taxes like workers' compensation, as well as employee benefits.

At a minimum, expanding an ISP to cover the county would require the following types of new employees:

Customer Service Representative. Takes new orders, answers customer questions about billing, services, etc. We've assumed that an ISP serving the whole study area would need one additional customer service representative.

Install/Repair Technician. These technicians provide maintenance and repair calls. The technicians would maintain both network electronics and facilities as well as customers. We've assumed that an ISP serving the whole study area would add two technicians. This is due to the long drive times to reach customers in all corners of the county

We assumed that construction contractors would build the fiber network. We've also assumed that customer installations will be outsourced during the construction process and for the first few years thereafter. However, once the bulk of customers has been added, the forecasts assume that future installations will be done by company technicians.

Start-Up Costs: To be conservative, we've assumed $60,000 in start-up costs. There are one-time expenses associated with launching a new business or new market, and rather than list them all, we have included them as start-up costs. The start-up costs would be higher for a newly formed ISP.

Sales and Marketing Expenses: Every scenario will require a significantly high customer penetration rate to be successful. We used the assumption that there would be a marketing effort to sign customers. There have been rural ISPs that have been able to sign up customers using community volunteers, so it's possible that the marketing costs could be lower than assumed in the models. The advertising budget for the first three years of operations is $184,000.

Maintenance Expenses: There are a number of routine maintenance expenses that the new business would incur on an incremental basis. These include:

- Vehicle expenses to maintain the vehicles required for the field technicians.
- Computer expenses to support the computers used by employees.

- Tools and equipment expenses.
- Power expenses to provide power to the network.
- General maintenance and repair of the outside plant network and the electronics to repair damaged or nonfunctional electronics.
- Internet Backbone. Since this is an incremental analysis, we have shown only incremental increases in the cost of Internet bandwidth. If this business were served by a new ISP, then the cost of bandwidth would be higher to also cover the cost of transport to reach the Internet.

Software Maintenance: ISPs typically maintain a complex software system called BSS/OSS (billing and operational support systems). This software provides a wide range of functions: order taking, provisioning new customers, tracking of customer equipment, tracking of inventory, creation of customer bills, and the tracking of customer payments (or nonpayment). Since most such software is billed to providers on a per-customer basis, we have assumed an expense for this maintenance.

Billing: Billing costs are shown as the incremental cost used to bill customers. We assumed that there would be some mix of mailing paper bills, charging bills to credit cards, and charging bills directly as debits to bank accounts.

Taxes: The model assumes that if a commercial ISP operates the business that there will be state and federal income taxes. These taxes would not apply if this were operated as a municipal business or as a non-profit.

We have assumed no property taxes on assets, but it's possible that some amount of this might apply. There are a few places in the country that charge property taxes on fiber networks, but most of the country doesn't.

The forecasts do not include any taxes that are assessed to customers. For example, this business would be expected to charge and collect various sales and telephone taxes. These kinds of fees are normally added to the customer bill, and thus customers pay these taxes. The models don't show these taxes, and the assumption is that the taxes would be collected and sent to the tax authorities on the customers' behalf. They are not shown as revenue or expense of the forecasts but rather are assumed to be a passthrough.

Overhead Expenses: The forecasts include various overhead expenses. Again, since this is an incremental model, it does not include allocated expenses such as an allocation of the general manager's salary. But there are incremental costs attributable directly to the new business. This would include things like legal expenses, accounting audit expenses, consulting expenses, business insurance, and other similar expenses that are related to entering a new market.

Depreciation and Amortization Expense: The forecasts include both depreciation and amortization expense. These are the expenses recognized by writing off assets over their expected accounting lives. For example, the depreciation rate for a vehicle is 20% per year (is written off over five years). The cost of a new vehicle is then depreciated monthly to write off the asset over the five years or sixty months. All hard assets are depreciated except land. Depreciation rates are

set according to the expected life of the assets—something that is usually determined to comply with IRS rules and accounting standard practices. Soft assets like software are instead amortized, using the same process as depreciation.

C. Financial Results

The primary purpose of creating the financial forecasts is to determine if it might be profitable for an ISP to profitably operate in each scenario. We have found that ISPs want to understand the amount of capital spending that is required. ISPs are also interested in financial projection, particularly in any work that has been done to quantify the possibility of raising grant funding.

We always try to be conservative in creating financial forecasts. By conservative, we mean that an actual business plan ought to perform a little better than we are projecting.

Our model assumes a regular replacement of electronics. However, it is possible that upgrades will be needed less often than we have shown. Further, our assumption is that the cost of electronics at the time of each upgrade would cost as much as the equipment that is being retired. The experience of the electronics industry is that electronics get cheaper and more efficient over time, so the cost of upgrades is probably going to be less than is shown in the model. The vendors in the industry have also gotten better at having phased upgrades that allow for keeping older equipment in place and not having to replace everything at once, making upgrades less expensive than we have projected.

There are steps that the new business could take to improve upon these projections.

- Preselling. We've seen ISPs that can achieve earlier revenues than shown in this model through preselling to customers. This gives them the opportunity to begin connecting the network to the homes of presold customers while the network is being built. This would allow customers to be turned on in "nodes" or neighborhood-by-neighborhood as construction to specific neighborhoods are completed – at a faster pace than is shown in these projections.
- Adding Customers Sooner. These models assume that most customers will be gained by the end of the sixth year. There is a significant cash boost from selling faster and adding customers sooner.
- More Concentrated Build Schedule. It's always possible to build faster than shown in these forecasts if the ISP can execute on a faster construction schedule. The amount of network that can be constructed can be increased by adding more construction crews.

It is never easy to summarize the results of complicated business plans to make them understandable to the nonfinancial layperson. The following summary shows a few key results of each scenario that we think best allow a comparison of the numbers between scenarios. Note that a table of all the financial results is included in Exhibit II, which makes it easier to compare different scenarios.

Fiber to the Rural Areas

As a reminder, the full study area is all of the rural places that we determined to be unserved or underserved.

Base Study

	No Grant	Breakeven Grant
Asset Costs	$26.9 M	$26.9 M
Grant	$ 0.00 M	$ 21.0 M
Equity	$ 4.5 M	$ 1.0 M
Bank Debt / Bond	$ 25.7 M	$ 5.7 M
Total Financing	$ 30.3 M	$ 27.7 M
Penetration Rate	60%	60%
Cash after 5 Years	($ 2.74 M)	$ 0.57 M
Cash after 10 Years	($11.08 M)	$ 0.52 M
Cash after 15 Years	($19.62 M)	$ 0.28 M
Cash after 20 Years	($28.00 M)	$ 0.20 M

This shows that building fiber in the whole study area is not feasible without substantial grant funding. In this case, the breakeven grant of $21 million represents a little over 78% of the total cost of the network. This is related to the high cost of assets per passing, which was shown earlier at $12,572.

Breakeven is defined as a scenario where the project never runs out of cash – so the breakeven grant amount shows the lowest amount of grant funding needed for the project to always be cash positive. It's worth noting that no commercial ISP would tackle this project if they didn't expect to perform better than breakeven. That probably means that an ISP would expect more than a $21 million grant before considering the project.

It's worth noting that this scenario assumes that 15% of the funding provided by the ISP is in the form of equity. Banks generally want an ISP to inject equity so that the ISP has some "skin in the game". However, we've seen banks not require equity when a substantial amount of grant funding is paying for the network.

Customer Penetration Rate

The most significant variable affecting the success of a fiber project is almost invariably the customer penetration rate – the percentage of customers in a market that buy service. The base scenario studies above assumed a 60% penetration rate. The numbers below show two additional scenarios – lowering the penetration rate to 50% and raising it to 70%.

	50%		60%		70%	
	Base	Breakeven	Base	Breakeven	Base	Breakeven
Asset Costs	$ 26.3 M	$ 26.3 M	$ 26.9 M	$ 26.9 M	$ 27.5 M	$ 27.5 M
Grant	$ 0.0 M	$ 22.8 M	$ 0.0 M	$ 21.0 M	$ 0.0 M	$ 19.2 M
Equity	$ 4.5 M	$ 0.7 M	$ 4.5 M	$ 1.0 M	$ 4.6 M	$ 1.4 M
Bank Debt	$ 25.4 M	$ 3.7 M	$ 25.7 M	$ 5.7 M	$ 26.1 M	$ 7.8 M
Total Financing	$ 29.8 M	$ 27.2 M	$ 30.3 M	$ 27.7 M	$ 30.7 M	$ 28.4 M

Penetration Rate	50%	50%	60%	60%	70%	70%
Cash after 5 Years	($ 3.01 M)	$ 0.65 M	($ 2.74 M)	$ 0.57 M	($ 3.46 M)	$ 0.56 M
Cash after 10 Years	($12.00 M)	$ 0.62 M	($11.08 M)	$ 0.52 M	($10.14 M)	$ 0.46 M
Cash after 15 Years	($21.23 M)	$ 0.36 M	($19.62 M)	$ 0.28 M	($18.00 M)	$ 0.20 M
Cash after 20 Years	($30.36 M)	$ 0.21 M	($28.00 M)	$ 0.20 M	($25.64 M)	$ 0.16 M

The above results show the following:

- The asset line shows how the needed capital varies with the changing number of customers at various penetration rates.
- The penetration rate has a significant impact on the amount of needed grants. The breakeven grant needed at 50% penetration rate is $22.8 million, and this drops to $19.2 million at a 70% penetration rate.
- The percentage of grants required is concerning because most federal grants do not award grants greater than 75% of the costs of the assets. The means than an ISP seeking a grant in the county for the remaining unserved areas will likely want some grant matching from the State or the County.

Other Scenarios

We also looked at a few alternate business structures. These scenarios were examined at the base 60% penetration rate. The results would also vary with greater of fewer customers.

ISP Leases the Network

This is an example of a public-private partnership. In this scenario, the County would build the network and then lease it to an ISP. The ISP would operate the business and would be able to earn any extra profits for doing so. There are a few examples of this scenario, such as the arrangement between Google Fiber and the City of Huntsville, Alabama.

This scenario turns out to be difficult to make work in rural areas. The local government borrows the money, and even if lease payments are set to be equal to debt payments, there is not enough cash flow to offset capital upgrades and replacement. And that is assuming that a local government could find an ISP willing to guarantee debt payments.

The following looks at the scenario where the grant is set to equal to the breakeven grant calculated above.

	At Breakeven Grant	
	County	ISP
Asset Costs	$ 26.8 M	$ 0.1 M
Grant	$ 21.0 M	$ 0.0 M
Equity	$ 0.0 M	$ 0.2 M
Bank Debt	$ 6.3 M	$ 1.0 M
Total Financing	$ 27.3 M	$ 1.2 M

Penetration Rate	60%	60%
Cash after 5 Years	$ 0.17 M	$ 0.33 M
Cash after 10 Years	($ 0.70 M)	$ 0.68 M
Cash after 15 Years	($ 1.62 M)	$ 1.12 M
Cash after 20 Years	($ 2.39 M)	$ 1.97 M

This scenario doesn't look attractive for the County. The issue for the County is that there is no way for it to pay for the needed electronics upgrades over time, which contributes to the County's losses. This scenario makes money over time for the ISP, but the returns are low and slow in coming.

Open-Access

The open-access scenario turned out to be a loser for the County. In the open access scenario, the County would pay for all of the network, including customer electronics. The network would be leased to ISPs at a rate between $35 and $55 dollars per customer per month, depending upon the broadband product. The ISP would sell to customers and would incur some small capital costs for things like WiFi routers inside customer homes.

	At Breakeven Grant	
	County	ISPs
Asset Costs	$ 26.9 M	$ 0.1 M
Grant	$ 21.0M	$ 0.0 M
Equity	$ 0.0 M	$ 0.1 M
Bank Debt	$ 6.7 M	$ 0.8 M
Total Financing	$ 27.7 M	$ 0.9 M
Penetration Rate	60%	60%
Cash after 5 Years	($ 0.34 M)	$ 0.18 M
Cash after 10 Years	($ 1.69 M)	$ 0.29 M
Cash after 15 Years	($ 3.11 M)	$ 0.56 M
Cash after 20 Years	($ 4.33 M)	$ 1.03 M

As the numbers above show, this scenario loses significant money for the County while the ISPs are slightly profitable. These losses are fairly easy to understand:

- The County would be making nearly the identical capital investment as in the retail scenarios.
- The County would still need to employ a small staff of technicians to care for the fiber network and the electronics. This adds to the cost of operating the business.
- The County would collect the smaller open access loop fees instead of the much larger retail revenues. Looked at simply, the County still must cover the debt with half the revenue stream.
- The results for the ISPs would be the same regardless of the financial performance of the local government network owner.

Sensitivity Analysis

We looked at the impact of changing the other various key assumptions – which we refer to as a sensitivity analysis.

Changing Broadband Prices

We looked at a scenario that changed broadband prices. Increasing broadband prices by $5 per month (changing the base rate from $60 to $65) increased cash flow over 20 years by $1.49 million. This means that a $1 change in broadband prices changes 20-year cash flow by approximately $298,000. This is a significant sensitivity. Decreasing rates by $5 had a similar impact and lowered cash over 20 years by over $1.49 million. This provides evidence that an ISP should be careful in lowering rates. For example, if a marketing plan suggests cutting rates to gain customers, the long-term impact of lower rates could be devastating for cash generation.

Changing Financing Terms

We looked at the impact of changing the various financing parameters.

Interest Rate. We looked at a scenario that lowered the interest rate by 100 basis points, or 1% (such as changing the interest rate from 5% to 4%). This increased cash flow by more than $730,000 over twenty years. The impact of increasing the interest rate was similar, where increasing the rate by 100 basis points lowered cash flow by $780,000.

This provides a warning that anybody planning a new fiber network during a time of financial uncertainty must keep a close eye on interest rates and be ready pause financing if interest rates move too high. We've been lucky for the last decade that interest rates have held steady for years at a time, but over history, it's more normal for interest rates to fluctuate. As we write this report, there are strong rumors of additional interest rate increases.

Loan Term. The base scenario assumed a 20-year loan term, which is the length of the loan. We looked at the impact of increasing the loan term from 20 years to 25 years. This increased cash over 20 years by $1.1 million.

We also looked at decreasing the loan term from 20 years to 15 years. This scenario doesn't work – the shorter loan terms mean higher loan payments, and the 15-year term doesn't look feasible. The business doesn't generate enough cash to be able to cover the higher debt payments.

In both cases, the change in long-term cash flow is due to the changes in annual debt payment required for loans of various lengths. This provides a great incentive to consider the longest loan maturity that can be achieved. Longer loans mean lower annual debt payments (just like with a home mortgage). Most loans can be repaid earlier or refinanced, but the longer the loan term, the smaller the annual required debt payments and the lower the pressure on cash.

The Additive Nature of the Variables

It's worth noting that the impacts of the various variables can be added together. As an example of this, we looked at a scenario where the ISP was able to improve on multiple of the assumptions used in the above financial results. We looked at a scenario where the ISP was able to count on obtaining a 70% market penetration, was able to finance the project over 25 years, and decided to charge $5 more than the prices used in our analysis. This had a significant impact on the needed grant funding and lowered the breakeven grant from $21 million in the base case to $16.5 million.

This example acts as a reminder that some of the key variables are under the control of the ISP.

What Conclusions Can We Draw from the Financial Results?

Building Fiber in Rural Cottonwood County Will Require Significant Grant Funding

We expected when we started the assessment that grant funding would be required to help fund broadband in the rural parts of the county. This was expected due to the low housing density in rural areas. Our analysis allowed us to quantify the amount of grants needed. It turns out that the amount of grant required varies significantly depending upon the expected customer penetration rate. The following tables represent the breakeven grant scenarios for a commercial ISP.

	Penetration Rate	Assets Needed	Grant Needed	Grant Percent of Assets
Full Study Area	50%	$26.3 M	$22.8 M	87%
	55%	$26.6 M	$21.8 M	82%
	60%	$26.9 M	$21.0 M	78%
	65%	$27.2 M	$20.1 M	74%
	70%	$27.5 M	$19.2 M	70%

There are several observations to make about the need for grant funding:

- The full study area requires substantial grant funding for the project. This is due to the high cost per passing in the rural areas. Even with a 70% penetration rate, a grant that covers 70% of the asset costs is needed to breakeven.
- There are federal grants that might be able to fund up to 75% of the assets in the rural areas. These tables show that the needed grants are above that level unless the network achieves a 65% penetration rate. The project will likely need a mixture of State or County matching to be feasible.
- We note that there are provisions where the upcoming BEAD grants can fund more than 75% of a project, but there are penalties for asking for more than a 75% grant that is probably going to make it challenging to get the higher grant funding.
- The above table should lead any ISP interested in serving the county to conduct a statistically valid survey of any area they plan to serve. The tables show that the customer penetration rate is critical to being profitable. Any ISP will want to understand the level of interest in buying broadband from a new fiber ISP.
- Note that all of the grant amounts shown in the tables above represent the breakeven scenario. No commercial ISP would tackle a project that is only expected to break even if the ISP must invest

equity. An ISP would seek a larger amount of grant funding to be able to reach its desired level of profitability.

Other Business Structures Don't look Possible

Due to the large amount of grant funding required, it doesn't look feasible to contemplate other scenarios like open-access or public-private partnerships. There isn't enough profits generated over time to enable both the County and an ISP to be made whole.

The Forecasts are Sensitive to Changes in Other Key Variables

As the above table shows, the customer penetration rate seems to be the most important variable that affects financial performance. However, each scenario is also sensitive to changes in broadband rates, the interest rate on debt, and the term of borrowing. Any ISP thinking of tackling this project must be aware of how changes in these variables can change the expected results of the business plan.

The Importance of the Breakeven Calculations - and the Important of Expected Returns

The tables of results above highlight that a lot of grant funding is required for an ISP to break even in the rural parts of the county. Breakeven, in this case, refers to the ISP always maintaining positive cash after the initial financing.

We want to caution that breakeven is not the same thing as being profitable. Each ISP will have a different definition of profitability. Commercial ISPs typically expect a higher profit or return than municipal ISPs – and there is a wide range of ways that commercial ISP calculate profitability. If you talk to a dozen ISPs and you might find a dozen different methods for defining profitability.

Most commercial ISPs measure success by using some return goal, although some smaller ISPs only care about the amount of free cash spun off by a business at the end of the year. Every return calculation includes both a numerator and denominator, and commercial ISPs don't use the same numerators or denominators. As an example, one ISP may expect a certain return on equity, with the numerator being based upon the operating margin, while another ISP may expect a return on equity based upon free cash flow. Those are two hugely different numbers for asset-heavy businesses because free cash flow includes the cost of paying for annual capital upgrades. Other ISPs use a metric of return on assets. Other ISPs measure success based on the internal rate of return (IRR), which converts future expected earnings into today's dollars.

This can get really complicated, and so anytime an ISP talks to a municipality about a desire to make a return it's vital to see the formula they are using to calculate that return. A return of 20% on equity expected by one ISP might turn out to be lower than an expected IRR of 6% for another ISP.

Municipalities may also expect a return. For example, many municipal electric utilities are required by law to make a return in order to build up a rainy-day fund to pay for catastrophic weather events. Some cities expect all utilities to contribute to the city coffers and would expect a fiber business to make a return. The calculations above consider that the amount of grants needed to breakeven uses the simplest definition of cash flow breakeven – the business never runs out of money. A business that breaks even on cash flow

over twenty years will actually have lost money if there was equity invested in the business – because the business would not have earned back the initial investment.

The expected return can be a huge deal for commercial ISPs and is one reason that a lot of ISPs won't build rural networks even if they get a lot of grant funding. As can be seen by the above earnings discussion, it's difficult enough to get a rural business to the point of breakeven, let alone make a commercially acceptable return. This is one of the primary reasons why the ISPs that tend to partner with communities for rural fiber businesses tend to be entities that have relatively low earnings goals.

D. Funding for Broadband Networks

For a large percentage of broadband projects, the biggest challenge is finding funding. This section of the report looks at the various ways that other communities have been able to fund broadband networks. If a community wants fiber badly enough, there probably is a way to pay for it.

The County is not likely to consider being an ISP but since some of the options we considered include public-private partnership, the following discussion covers both commercial bank financing and bond financing.

There are a number of different financing options to consider. Below we look at the following:

- Private Financing (loans)
- Public Financing (bonds)
- Grants
  - Federal Programs
  - State Programs
- Loan Guarantees
- Customer Financing
- Public-Private Partnerships

<u>Private Financing Options</u>

A commercial ISP will normally rely on traditional private financing, meaning loans. Some of the largest, publicly traded ISPs often raise money through corporate bonds. Following are some key challenges that ISPs must navigate to get bank financing:

> <u>Equity</u>: Most forms of private financing require some equity. Equity means that the borrower brings some sort of cash or cash equivalent to the business as part of the financing package. The amount of equity required will vary according to the perceived risk of the venture by the lender. The higher the risk, the more equity is required.
>
> Equity can take a number of different forms:
>
> - <u>Cash</u>: Cash is the preferred kind of equity, and lenders like to see cash infused into a new business – cash that can't be taken pulled out of the business and that doesn't earn interest.
> - <u>Preferred Equity</u>: A stock corporation (like an LLC or C Corp) can raise equity by selling some form of preferred stock that acts as equity. A buyer of preferred equity usually earns some guaranteed interest rate on the equity investment, but the payments are not usually

guaranteed like they are for bank loans. If the business gets into a cash crunch, it must pay bank loans and other forms of debt before paying preferred equity interest.

- Assets: It's possible to contribute assets as equity. For example, a new fiber venture might be seeded by having one of the partners contribute an existing fiber route or another valuable asset to the business. In such a case, the contributed asset often must be assigned a market value, often appraised by an independent appraiser.

Bank Loan Basics: The banking industry generally does not like to finance long-term infrastructure projects. This is one of the primary reasons why the country has had such an infrastructure deficit. Until about the 1960s, banks would fund things like power plants, electric and water systems, telephone networks, and other long-term revenue-generating assets. But various changes in banking laws require banks to maintain larger cash reserves, which makes them less willing to make long-term loans. Banks have also increased their expectations over time to want to earn higher interest rates. Many attribute this to the fact that giant publicly traded banks have captured most of the banking market. Banks don't like long-term loans since the interest rates get locked in for many years, possibly depriving the banks from earning more on their own equity.

Most banks prefer not to make loans with a term much longer than 12–15 years, and a broadband project might not generate enough cash in that time period to repay the loans.

Banks are also averse to start-ups and prefer to make loans to existing businesses that already have a proven revenue stream. It's extremely hard for a first-time borrower to be able to borrow the kind of money needed to build a broadband network.

Collateral. The biggest issue that borrowers have in getting a bank loan is the requirement for collateral, which is the assets a borrower pledges to a bank if the project fails. Banks like hard collateral like buildings, vehicles, shares of stock, and things they know they can readily sell for a reasonable price. Banks don't like broadband networks as collateral because even a little bit of web searching shows them that failed fiber networks are sometimes sold for pennies on the dollar. Fiber networks have little intrinsic value – all of the value of an ISP comes from the paying customers on a network.

It's important to understand the implications of collateral. Communities often ask an ISP operating nearby to build fiber in their town. What they generally fail to realize is that the ISP might have to pledge the entire business as collateral in order to secure the loan – meaning that if the new venture fails, the ISP could lose the whole existing business.

Return on Bank Equity. Banks don't only consider the interest rate when making loans. A bank concentrates on its return on equity and will consider a combination of factors like interest rates, upfront and monthly loan fees, the likelihood that a borrower will pay a loan off early or default on a loan, etc. A bank will look at a dozen financial parameters before making an offer of interest rate and term – based on meeting the bank's targeted return on bank equity. There is a misperception that interest rates are negotiable, but the same project offered to multiple banks is likely to get a nearly identical financing package offered by all banks.

Federal Loans

Rural Utility Service (RUS): This is a part of the Department of Agriculture and is the only federal agency that makes direct loans for broadband projects. The Rural Broadband Access Loan and Loan Guarantee Program (Broadband Program) furnishes loans and loan guarantees to provide funds for the costs of construction, improvement, or acquisition of facilities and equipment needed to provide broadband in eligible rural areas. These loans can't be used for any town with a population of over 20,000. The RUS acts much like a bank and follows similar lending practices. I like to describe the RUS as a bank from the 1950s because its lending rules were set by Congress to loan money for rural electrification and have never been modernized.

RUS makes broadband loans and loan guarantees to:

- Finance the construction, improvement, and acquisition of facilities required to provide broadband, including facilities required for providing other services over the same facilities.
- Finance the cost of leasing facilities that are required to provide broadband if the lease qualifies as a capital lease under Generally Acceptable Accounting Procedures (GAAP). The financing of such a lease will be limited to the first three years of the loan amortization period.
- Finance the acquisition of facilities, portions of an existing system, and/or another company by an eligible entity, where acquisition is used in the applicant's business plan for furnishing or improving broadband. The acquisition costs cannot exceed 50 percent of the broadband loan amount, and the purchase must provide the applicant with a controlling majority interest in the equity acquired.
- Finance pre-loan expenses, i.e., any expenses associated with the preparation of a loan application, such as obtaining market surveys, accountant/consultant costs for preparing the application, and supporting information. The pre-loan expenses cannot exceed 5% of the broadband loan, excluding any amount requested to refinance outstanding telecommunication loans. Pre-loan expenses may be reimbursed only if they are incurred prior to the date on which notification of a complete application is issued.

RUS is allowed to make loans to a wide range of entities. Borrowers can be either non-profit or for-profit and can be one of the following: corporation, limited liability company (LLC), cooperative or mutual organization, Indian tribe or tribal organization as defined in 25 U.S.C. 450b, or state or local government, including any agency, subdivision, or instrumentality thereof. Individuals or partnerships are not eligible entities.

To be eligible to receive a loan under this program, the entity must:

- Submit a loan application. We note that the loan application requires a lot of work, including such things as pre-engineering, surveys, mapping, financial business plan models, environmental impact studies, and other things, which make the application expensive to prepare externally.
- Agree to complete the build-out of the broadband system described in the loan application within three years from the date the borrower is notified that loan funds are available.
- Demonstrate an ability to furnish, improve, or extend broadband in rural areas.
- Demonstrate an equity position equal to at least 10% of the amount of the loan requested in the application; and

- Provide additional security if it is necessary to ensure financial feasibility as determined by the administrator. (For anyone other than large borrowers, this generally means pledging the whole existing business as collateral).

In practical terms, RUS loans are administered as follows:

- The rules say that a project needs at least 10% equity, but this is often expanded to be anywhere from 20% to 40% at the discretion of the RUS. In effect, the RUS acts as a bank, and it will require enough equity so that the projected revenues can adequately cover debt payments.
- The loan terms are generally in the range of 12 years, but the RUS can choose to extend to 20 years for fiber projects. This is much shorter than the terms available on bond financing, meaning the annual payment would be higher under a RUS loan than with a bond.
- It is exceedingly hard to get a project funded for a start-up business. The RUS typically wants the whole company of the borrower pledged as collateral. Thus, the bigger and the more successful the existing company, the easier to meet the RUS loan requirements.
- Their collateral requirements are overreaching in other ways that make them hard to work with for municipal projects. For example, if the project is going to share fiber with some existing network, such as one built by a school system, they would want that asset as collateral. Many borrowers find the RUS collateral demands to be impossible to meet.

This makes the RUS a very unlikely funding source for a municipal venture or for any start-up venture. The RUS rarely loans to municipalities and even more rarely to start-up ventures. The RUS has a major bias for lending to ISPs that are already RUS borrowers.

The other big drawback of these loans is that they take a long time to process. It's normal for a loan application to be at least six months, and we've seen a backlog at the agency push that out to 18 months. Very few borrowers are willing to wait that long unless they are certain they will be funded. Because of the timing and the collateral rules, it's extremely challenging to coordinate RUS loans with other forms of financing.

However, the RUS loan fund is often large, and there have been many times over the last decade when the balance to be lent sat at more than $1 billion. Congress generally adds additional funds to the RUS pot each year. The RUS also has some discretion, and it has the power to include some portion of a loan as a grant that doesn't have to be repaid. This is something that can't be counted on, but we know of projects where the borrower only had to pay back 80% of what they borrowed. The RUS interest rate tends to be lower than bank rates during periods when bank interest rates move higher. In recent years, RUS loan rates were not much cheaper than commercial loans, but that seems to be changing with increasing bank interest rates.

Servicing an RUS loan requires significant paperwork for drawing down funds along with significant annual reporting requirements.

Other Bank Loans

There are two specialty banks that specialize in making broadband loans that should be mentioned. The first is CoBank. This is a boutique bank that is owned collectively by a bunch of telephone cooperatives.

CoBank historically made loans to cooperatives, but over the years has branched out to the other parts of the industry.

CoBank is cautious and only takes on loans for projects that look to have a high chance for success. This means it rarely loans to a start-up but prefers existing ISPs with a long history and a strong balance sheet. CoBank loans are generally at market interest rates, similar to bank rates. CoBank also wants significant collateral. Finally, CoBank loans are rarely for more than 15 years and often for shorter terms.

The other industry bank is RTFC, which is a bank owned by electric cooperatives. RTFC rarely lends to anyone other than a cooperative but could be the source of funding if a local government is partnering with a cooperative. Borrowers must typically join the cooperative as a condition of borrowing.

Loan Guarantees

Another way to help finance broadband projects is through federal loan guarantees. A loan guarantee is just what it sounds like. Some state or federal agency will provide a loan guarantee, which is very much like getting a co-signer on a personal loan. These programs guarantee to make the payments in the case of a default and thus greatly lower the risk for a lending bank. In return for the lower risk, the banks are required to offer a significantly lower interest rate.

These guarantees are not free. There is an application process to get a loan guarantee in much the same manner as applying for a bank loan or a grant, meaning lots of paperwork. The agency making the guarantee will generally want a fee equal to several interest "points" upfront. To some extent, this process works like insurance, and the agency keeps these fees to cover some of the cost of defaults. If they issue enough loan guarantees, then the up-front fees can cover eventual losses if the default rates are low. These points are a payment to the agency for issuing the guarantee and are not refundable.

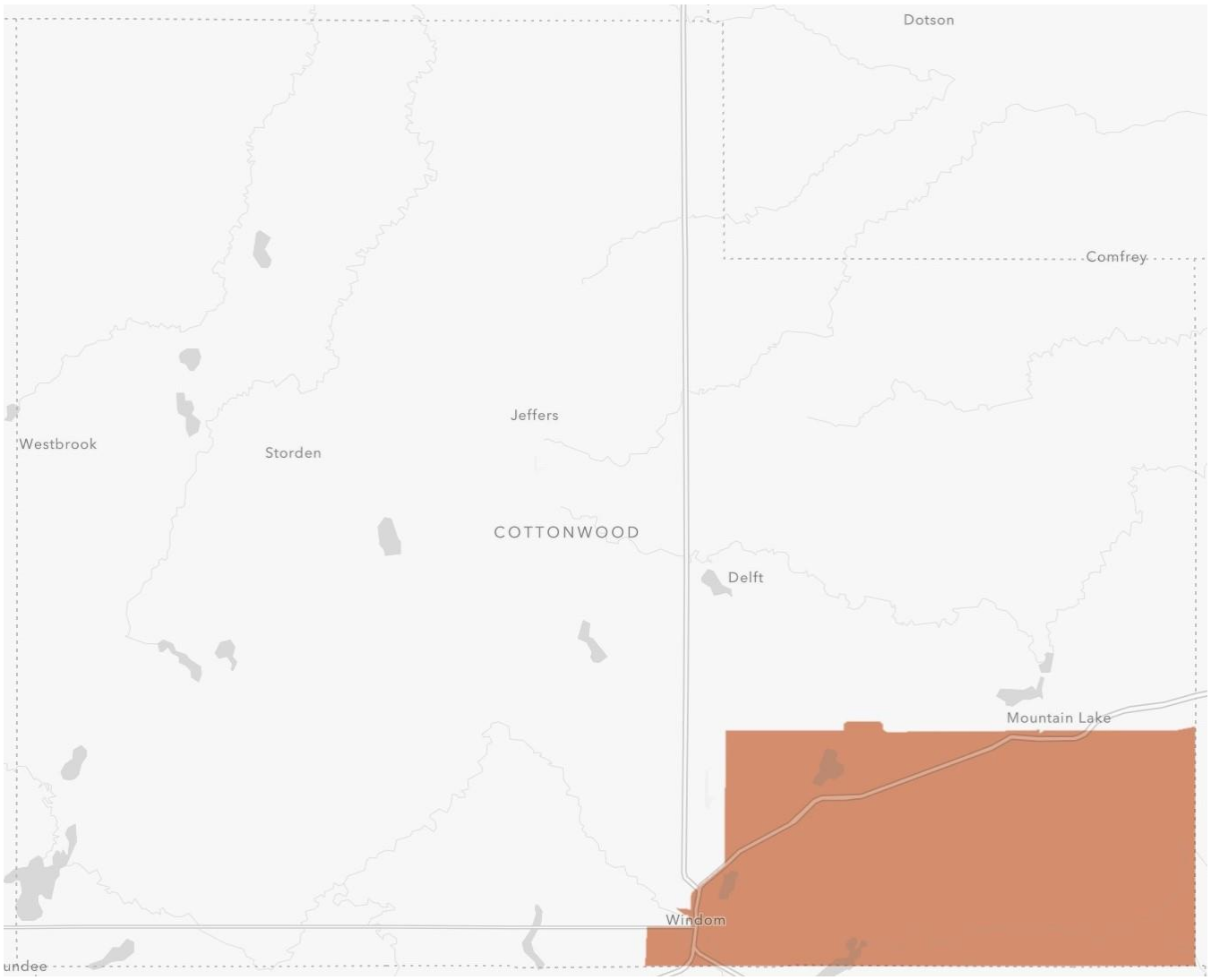
There are several federal agencies that might be willing to make loan guarantees for telecom projects. The following agencies are worth considering:

> **HUD 108 Program**: The Department of Housing and Urban Development has a loan and loan guarantee program that is allotted for economic development. There is both federal money under this program as well as money from this program given to the state to administer. While these loans and loan guarantees generally are housing-related, the agency has made loan guarantees for other economic development projects that can be shown to benefit low- or moderate-income households. If enough of a fiber project can be said to benefit low-income residents, then these loans can theoretically be used for a fiber project.
>
> **Small Business Administration 504 Loan Program**: This program by the SBA provides loans or loan guarantees to small start-up businesses. These loans or loan guarantees must be made in conjunction with a bank, with the bank providing some loan funds directly and with the SBA loaning or guaranteeing up to 50% of the total loan.
>
> **USDA Business and Industry Guaranteed Loans (B&I)**: The Department of Agriculture provides loan guarantees through the B&I program to assist rural communities with projects that spur economic development. Such a project must, among other things, provide employment and

improve the economic or environmental climate in a rural area. These loan guarantees are available to start-up businesses. The program can guarantee up to 60% of a loan over $10 million or greater percentages of smaller loans.

Opportunity Zones. Congress created a new investment opportunity as part of the 2017 Tax Cuts and Jobs Act. The Act created Opportunity Zones in which investors can get special capital gains treatment and other tax breaks for investing in qualified infrastructure within an opportunity zone. Each state governor designated specific opportunity zones. There is a sizable Opportunity Zone in southeastern Cottonwood County, shown on the map below.

Qualified investments made inside an Opportunity Zone can get special tax treatment. The first benefit is that capital gains tax can be deferred from past investments if the gains are reinvested inside of an opportunity zone. For example, if an investor had a capital gain from the sale of a property, they could invest those gains in an Opportunity Zone project and defer the original capital gains taxes until as long as 2047. Investors have until 2026 to make such investments.



An investor also gets capital gains tax forgiveness on new investments made inside an opportunity zone if that investment is held for at least ten years. Most of the opportunity zones include sizable areas of low-income residents, and a qualified investment must meet a test of benefitting that community in some significant way. A fiber network that will bring broadband to all the homes in an opportunity zone would meet that test since there are many demonstrable benefits of fiber.

The other benefit of using opportunity zone financing is that the interest rates can be favorable. Interest might be set far below market rates, or some principal might be forgiven if there is enough benefit accruing to the lender.

Any ISP building a network in Cottonwood County should consider getting at least part of their funding from one of the many Opportunity Zone funds that have been created to invest in qualified investments. This portion of the financing portfolio would likely have a lower interest rate and might not have to pay back the full cost of the investment.

New Market Tax Credit. The New Markets Tax Credit (NMTC) Program was established in 2000 as part of the Community Tax Relief Act of 2000. The goal of the program was to spur revitalization efforts of low-income and impoverished communities across the United States and Territories. Most of rural America qualifies for new market tax credit financing. New market tax credits are normally used to fund only a small portion of a project.

The NMTC Program works by giving big tax credits to investors that are willing to invest in infrastructure projects in qualifying communities. The tax credits are so lucrative that often the other terms for accepting the funding are modest. The tax credit equals 39% of the investment paid out—5% in each of the first three years, then 6% in the next four years, for a total of 39%.

The Community Development Financial Institutions (CDFI) Fund and the Department of the Treasury administer the program. Treasury allots credits each year in a complicated way, with the simplest explanation being that there are entities around the country each year that are awarded tax credits, and these entities work as brokers to allot the credits to specific projects. The credits are often purchased by large banks or other firms that invest in infrastructure.

Generally, in practice, these funds act like a mix of loans and credits to the recipient. For instance, a community that received these funds might have to pay some modest amount of interest during the seven years of the tax credit and then have a balloon payment for the principal. However, often some or even all of the principal can be excused, making this look almost like a grant.

Public Financing Options

If the County was going to invest in any infrastructure as part of a partnership, it's likely that funds would come from municipal bonds. The two primary mechanisms used for public financing are revenue bonds and general obligation bonds. There are some major benefits of using bond financing. First, the term of the bond can match the expected life of the assets, and it is not unusual to find bonds for fiber projects that stretch to 25 or 30 years. It's also possible to finance a project completely with bonds, meaning that no cash or equity is needed.

Bonds often, but not always, have lower interest rates than commercial debt. The interest rate is dependent upon several factors, including the creditworthiness (bond rating) of the borrower as well as the perceived

risk of the project. In recent years when commercial interest rates were low, the rates for municipal bonds were similar to bank loans. But there have been times when bond rates are higher than bank rates.

It's generally easier to sell bonds than to raise commercial money from banks. Sometimes bonds require a referendum, but once bonds are approved there is generally a ready market for selling the bonds.

The traditional source of public money used to finance telecom projects is through the issuance of tax-exempt municipal bonds, meaning the buyers of the bonds don't have to pay federal and/or state income taxes on the revenue from the bonds.

Revenue Bonds: Most of the municipal fiber networks that have been built have been financed through revenue bonds. Revenue bonds are typically backed primarily by the revenues of the fiber business. With a pure revenue bond, a local government will not have to repay the bonds if the project fails. With that said, having a bond default is a financial black eye that might make it hard for a community to finance other future projects. So, to some degree, most governments feel obligated to pay back failed revenue bonds since there is a big penalty in terms of credit rating for not doing so.

It has gotten harder to finance broadband projects with pure revenue bonds due to some failures on the part of other municipal networks. Among these are Monticello, MN; Crawfordsville, IN; and Alameda, CA. These kinds of failures have made investors leery about buying bonds that are only backed by the business. This reluctance has made financing with revenue bonds more expensive.

The cost of a bond issue cannot be judged only by the interest paid. The other financing costs of bonds can outweigh the impact of the interest rate on the bottom line. Because of market reluctance to buy revenue bonds, they often have higher interest rates than general obligation bonds, but they also can incur the following costs:

Debt Service Reserve Fund (DSRF): Many revenue bonds require borrowing additional funds to be kept in escrow as a hedge against missing future payments. The DSRF is often set to equal a year's worth of principal and interest payments. This money is put into escrow and is not available to operate the business.

Capitalized Interest: Bonds begin accruing interest from the day the money is borrowed. Since fiber businesses take a number of years to generate enough cash to make bond payments, the bondholders require capitalized interest that is used to make the interest payments for up to the first five years of the project. Basically, the project must borrow the amounts needed to make debt payments which can add a significant amount to the size of the bond issue.

Bond Insurance: Bond insurance is an up-front fee paid to an insurance company that will then pay one year of bond payments to bondholders in case of a default. We've seen bonds issued that have required both a debt service reserve fund and bond insurance.

In recent years, the interest rates on municipal bonds have been lower than the interest rate on commercial loans. But that has not always historically been the case. The difference between bond interest rates and commercial interest rates both change over time; that difference is referred to in the industry as the "spread." Sometimes the spread favors bonds, and at other times it favors commercial borrowing. Interest rates are also not the same for all kinds of bonds. For instance, the interest rate for revenue bonds can be considerably higher than general obligation bonds due to the perceived higher risk.

General Obligation Bonds (GO Bonds): If revenue bonds aren't an option, then the next typical alternative is general obligation bonds. General obligation bonds are backed by the tax revenues of the entity issuing the bonds. This backing can be in the form of various government revenues such as sales taxes, property taxes, or the general coffers of a government doing the borrowing.

What these pledges mean is that if the broadband project fails and can't make the bond payments, then the pledge revenue source, such as property or sales tax, would have to be used to make the bond payments.

Many states require a referendum to approve general obligation bonds. Most states have a few exceptions for things like economic development bonds that don't require a referendum. Local governments sometimes hold a referendum anyway just to make sure the public supports the initiative being financed.

There are other financing mechanisms that have been used by other municipalities to fund revenue-generating projects. These include:

Variable Rate Demand Obligations (VRDOs): A VRDO is a bond where the principal is paid in a lump sum at maturity. The borrower often has the right to repay the bonds in whole or in part at any time (upon an agreed-upon notice). VRDOs are effective in circumstances when the borrower wants to match the repayment of the bonds to a revenue stream that varies year to year or a revenue stream that can vary from initial estimates and changes over time. In the case of the new telecommunications system, this type of financing provides the flexibility to make bond payments that match the actual revenues received. If revenues are slower than anticipated, principal payments do not need to be made. If revenues come in faster than anticipated, repayment of the bonds can be accelerated without penalty. We can recall having only ever seen this used once for a municipal telecom system by the city of Alameda, California. This kind of financing is common for other kinds of municipal needs.

VRDOs are most commonly structured using 7-day floating interest rates. Interest rates are reset each week, and this adds a lot of risk to this type of financing. Unlike fixed-rate bonds, the borrower doesn't know what the interest rate will be on the VRDOs over the life of the issue. Interest rates on VRDOs are on the short end of the yield curve and have historically been lower than interest rates on fixed-rate bonds. There is typically a maximum rate that the VRDOs cannot exceed. But in a market where there is a significant increase in overall interest rates, this kind of financing could end up being significantly more expensive.

Capital Appreciation (Zero Coupon) Bonds (CABs): CABs are bonds that are issued at a deep discount, and which do not bear any stated interest rate. Like a Series E savings bond, CABs are bought at a price that implies a stated return calculated on a basis of the bond being payable at par at maturity. With no stated interest rate, there is no interest paid until maturity, at which time all the compounded accreted interest is paid. With no interest payments required in the beginning years of the bonds, this would enhance the cash flow in the beginning years of the business.

CABs have several drawbacks over other types of available financing. The interest rates on CABs are typically higher than both fixed-rate bonds and VRDOs. Investors prefer not to have a prepayment option on CABs, which limits the flexibility of the government to call the bonds early if revenue collections are better than anticipated or if a restructuring of the debt is needed. We've not ever heard of this being used for telecom—although there is no reason why it could not be used.

Comparing Bond and Bank Financing

There are also a few benefits for commercial financing.

- Generally, the amount that must be borrowed from commercial financing is lower, sometimes significantly lower. This is due to several issues associated with bond financing. Bond financing often contains the following extra costs that are not included with commercial loans:
    - Surety: Bonds often require a pledge of surety to protect against a default of the bonds. The two most common kinds of surety are the use of a debt service reserve fund and bond insurance. A debt service reserve fund (DSRF) borrows some amount of money, perhaps the equivalent of one year of bond payments, and puts it into escrow for the term of the bond. The money sits as insurance to be used if the project has trouble making bond payments. Bond insurance works the same way, and a borrower will pre-pay an insurance policy at the beginning of the bond that will cover some defined number of payments in case of a default.
    - Capitalized Interest: Bonds typically borrow the interest payments to cover bond payments for some period of time, up to 5 years.
- Construction Loans: Another reason that commercial financing usually results in smaller debt is through construction financing. A commercial loan will forward the cash needed each month as construction is done, and interest is not paid on funds until those funds have been drawn from the bank. Bonds generally borrow all of the money on day one and begin accruing interest expense on the full amount borrowed on day one. Construction loans also mean that a borrower will only draw funds that are needed, while bond financing is often padded with a construction contingency in case the project costs more than expected.
- Deferred Payment: Commercial financing often will be structured so that there are no payments due for the first year or two. This contrasts with bonds that borrow the money required to make these payments. Fiber projects, by definition, require several years to generate revenue, and deferring payments significantly reduces the size of the borrowing.
- Retirement of Debt: It's generally easy to retire commercial debt, which might be done to pay a project off early or to refinance the debt. This contrasts with bonds that often require that the original borrowing be held for a fixed number of years before it can be retired or refinanced.

Grants

It's hard to imagine the construction of fiber networks in rural areas without some grant support. We've only included grant opportunities below that we think might be used in the County.

Federal Broadband Grants: There are several permanent federal broadband grant programs that might benefit this project.

ARPA State and Local Fiscal Recovery Funds (SLFRF)

This is the $350 billion of funding that went directly to states, counties, cities, towns, and townships. The purpose of this funding is to provide state and local governments with the necessary resources to:

- Fight the pandemic and support families and businesses struggling with its public health and economic impacts,
- Maintain vital public services, even amid declines in revenue, and
- Build a strong, resilient, and equitable recovery by making investments that support long-term growth and opportunity.

While the funds can be used for a number of different types of programs, they must address one of the following four categories:

- Replace lost public sector revenue
- Support the COVID-19 public health and economic response
- Provide premium pay for eligible workers performing essential work
- Invest in water, sewer, and broadband infrastructure.

The final rules eliminate any consideration of existing broadband speeds. The final rules allow broadband to be constructed to reach households and businesses with an identified need for additional broadband infrastructure investment. There still must be a justification that the project addresses a problem highlighted by the pandemic. But rather than relying on speed as the justification, localities can consider broadband reliability, affordability, or access to a connection that meets or exceeds symmetrical 100 Mbps. Localities can document this need using any available data, including local speed tests, federal or state data, interviews with residents and businesses in the affected areas, and just about any other way that proves there is an existing broadband need.

In addition to broadband infrastructure, the funds can be used to expand internet access and digital literacy. The final rules provided the following examples of ways the funding can be used:

- Affordability programs such as subsidies that address the cost of internet service
- Digital literacy programs
- Programs that provide devices and equipment to access the internet, such as tablets, computers, or routers.
- Services that expand internet access without constructing new networks, such as the expansion of public WiFi networks or free WiFi in public housing communities.
- Programs that support the adoption of internet service where service is available

For infrastructure spending, the rules require recipients to address affordability while building new broadband networks saying, "a project cannot be considered a necessary investment in broadband infrastructure if it is not affordable to the population the project would serve." Treasury outlines two ways recipients should address affordability:

- Lack of affordable broadband can be used to define areas eligible for investment with SLFRF funds.
- If a project provides internet service to households, the ISP must participate in the Affordable Connectivity Program.

ARPA Capital Project Fund Grants

The American Recovery Plan Act allocated the $10 billion Capital Projects Fund[26] directly to states for broadband.

States will administer the grants and make awards to specific projects. Each state will need a grant program that follows the federal rules for this money. Since these new rules are different than the rules governing many existing state grant programs, the states will have to quickly adjust to follow these rules for at least this money. In some states, this might require the legislature to change current grant rules.

Communities and states can define the eligible grant areas. These grants do not use FCC mapping in determining eligibility. A grant area must only be shown to not have reliable 100/20 Mbps broadband in order to be eligible – that is a very loose test. Treasury provides amazing leeway in defining eligible areas, and almost any reasonable form of proof of poor broadband can suffice to prove an area is eligible. Of course, states will have some say in defining eligible areas, and I foresee a huge tug-of-war over this issue between state grant offices and communities.

Grant projects must be able to provide symmetrical gigabit speeds. There is going to cause confusion all over the industry as different grant programs have different speed requirements. This might also require legislative changes in some states.

A project must meet all of the following requirements: A project must be spent on infrastructure that will enable work, education, or health monitoring. Projects must address a critical need that results from or was made obvious during the pandemic. Projects must address a critical community need.

Treasury wants a priority for last-mile infrastructure. States can request middle-mile projects, but Treasury must approve. Some money will be allowed for devices, but the state must retain ownership of devices. Money can go for improvements to government facilities that meet all of the eligibility rules.

[26] The full rules are at: https://home.treasury.gov/system/files/136/Capital-Projects-Fund-Guidance-States-Territories-and-Freely-Associated-States.pdf

Treasury allows states to fund projects 100%, with no matching. But states might require matching to spread the grant benefits to more projects.

Project costs back to March 3, 2021, can be funded under some circumstances. This might cover costs like a feasibility or engineering study.

The rules do not mandate paying Davis-Bacon wages, but it encourages projects to pay a living wage.

Projects must be completed by 2026, although Treasury has the ability to grant extensions.

ReConnect Grants

In the 2017 Farm Bill, Congress created a grant program called ReConnect[27]. The program awarded $200 million in grants, $200 million in loans, and $200 million in a combination of grants and loans in 2019. Congress reauthorized an additional $600 million to be awarded in 2020. There was an earlier round in 2022 for $1.2 billion that has recently started to announce awards. The USDA just announced another round that starts in early September 2022, and the expectation is another round in 2023. The rumors are that these rounds could be for as much as an additional $2 billion. Following is a highlight of the rules for the latest ReConnect grants.

- Speeds. This is the first federal grant program that will consider any area not served today by 100/20 Mbps broadband as grant-eligible. But note that there is a big grant scoring penalty for serving areas with existing speeds greater than 25/3 Mbps. This means the grant allows serving areas with existing speeds greater than 25/3 but penalizes an applicant for doing so. The grants do not automatically adhere to the FCC mapping data, but an applicant needs to be prepared to demonstrate why an area is eligible. Challenging the FCC mapping requires an opinion from an engineer who has examined technology in the field or a rigorous online survey that demonstrates slow speeds.
- Eligible Entities. Almost anybody is eligible, but a big preference is given to tribes and to "local governments, non-profits, and cooperatives as applicants and additional points to those applications (including for projects involving public-private partnerships where the local government, non-profit, or cooperative is the applicant)."
- Must be Rural. Grant-serving areas must be rural and remote. There is a ReConnect mapping tool[28] that will tell you if an area is eligible. To be eligible for funding, the grant area must be "15 minutes or more from an urban area of 2,500-9,999 people; 30 minutes or more from an urban area of 10,000-24,999 people; 45 minutes or more from an urban area of 25,000-49,999 people; or 60 minutes or more from an urban area of 50,000 or more people." Additionally, there is a density test.
- Pandemic Matters. Applicants must demonstrate how the grant area was hit particularly hard by the pandemic.

[27] https://www.usda.gov/reconnect

[28] https://ruraldevelopment.maps.arcgis.com/apps/webappviewer/index.html?id=1e82a64056fc46e4a28361c5e9447246

- Economic Need. The grants favor bringing broadband to Socially Vulnerable Communities. On first reading, this looks like it's going to take some effort to meet this test.
- Prefers Open-access. Retail rates must be affordable and non-discriminatory. There are grant points awarded to those willing to offer "wholesale rates," which is another way of describing open-access.
- Strong Labor Standards. While the grant doesn't require Davis-Bacon prevailing wages, there are grant points awarded for agreeing to pay the prevailing wages or higher.
- Net Neutrality. Applicants must be willing to adhere to net neutrality.
- Can be Used in RDOF Areas. The funding can be used by an RDOF winner to supplement that award.

HUD Community Development Block Grants (CDBG)

Grants under this program can be used to build fiber or wireless networks in areas lacking broadband access. Any grant application must meet all three of the following objectives:

- The project must benefit low- or moderate-income neighborhoods
- The project must eliminate "slums / blight."
- The project must demonstrate urgent need.

The last criterion is fairly easy to demonstrate in any community without adequate broadband. The big hurdle for many grant applicants is the second objective of eliminating blight. We've seen an argument made that improving broadband improves incomes, which ultimately improves impoverished communities. For example, luring tenants to closed storefronts with good broadband meets this test.

The CDBG grants have wide latitude in considering grant applications and can be used in the following ways that benefit broadband:

- The acquisition, construction, reconstruction, rehabilitation, or installation of public facilities and improvements (which include fiber or wireless infrastructure improvements).
- The acquisition, construction, reconstruction, rehabilitation, or installation of distribution lines and facilities of privately-owned utilities, which includes the placing underground of new or existing distribution facilities and lines.
- Digital literacy classes as a public service.
- Economic development – grants/loans to for-profit businesses, particularly businesses that focus on broadband/Internet access and technology.

It's worth noting that the CDBG program also makes block grants to states which then administer state grants. These state grants must still follow the same federal guidelines for eligibility as listed above.

It's hard to use this money to support a widespread network that serves different neighborhoods, but it can be useful to supplement other grants by using this money for low-income areas.

Broadband Equity, Access, and Deployment Program (BEAD) Grants

This is the official name of the $42.5 billion grant program approved by Congress in November 2021. This grant program was established by the Infrastructure Investment and Jobs Act. Congress established the following high-level requirements for this grant program. Detailed rules were defined by a Notice of Funding Opportunity.

- Every State Has a Separate Timeline. The money will go from NTIA to the states, and the states will administer the grants. However, the grants must meet all of the NTIA rules. There is a detailed process for states to get access to the funding. For example, States must reach out to stakeholders in all portions of the state. States must allow for a challenge process to give an opportunity to challenge the maps used to define grant eligibility. After the NTIA approves a state's plan, the state will have to develop and announce the specific grant program and timing.
- The Grant Application is Complicated. This is probably the most intensive set of grant application rules ever for broadband grants.
- Large Amount of Funding. States will get at least $100 million each, with the rest distributed based on the number of unserved households in each state, the overall population, and the percentage of low-income residents. The average state will get $850 million, so this is by far the largest broadband grant program ever. It's estimated that Minnesota will receive $550 million for this grant program.
- Definition of Broadband. Grants must adhere to two key definitions of broadband. Unserved are places with broadband speeds under 25/3 Mbps. Underserved are areas with speeds between 25/3 and 100/20 Mbps. Grants must first go to unserved areas before being used for underserved areas. Funding for anchor institutions is only allowed after serving underserved areas.
- Deployed Speeds Must be at Least 100/100 Mbps. Anything built with the network must deliver speeds of at least 100/100 Mbps – but there are waivers to build infrastructure that meets 100/20 Mbps.
- 5-Year Grant Program. States have five years to disperse the funds. We don't know what that means. It could mean a series of grant funding rounds over a few years, or it could mean one giant grant process at the beginning, with payments stretched out over time. Each state is likely to have a different solution.
- Other Uses of the Grants. Grants don't have to all go for broadband to unserved and underserved areas. Grants can be made to connect eligible community anchor institutions. States can use the money for data collection, broadband mapping, and planning. Funding can go to serve qualifying multi-family apartments with WiFi or low-cost broadband.
- Eligible to All. BEAD doesn't give priority to any class of grant recipients. The grants can't exclude cooperatives, non-profit organizations, public-private partnerships, private companies, public or private utilities, public utility districts, or local governments from eligibility.
- Several Grant Priorities. States must give priority to grants that are deployed in counties with persistent poverty. Projects that will deliver more than the minimum speeds will be given priority. Projects that are shovel-ready will be given priority. Projects that pledge to pay Davis-Bacon wages will get priority.
- Challenge Process. Incumbent ISPs can challenge the validity of a grant area. Interestingly, the NTIA can override states in these challenges.

- Grants up to 75%. Grant applications must provide at least a 25% matching for the cost of the project. Matching may include CAREs funding and ARPA funding. Matching can also come from state grants. The NTIA rules suggest that grant applicants willing to take less than 75% will have an advantage.
- Requires Two 9's Reliability. Deployed technology must only meet two 9's reliability – meaning that it can be out for two days per year and still be considered adequate.
- Construction Must Complete in Four Years. A grant recipient must cover every home in a coverage area within four years of receiving the grant.
- Low-Price Option. Grant recipients must provide at least one low-cost broadband option for eligible households. The NTIA is expressly forbidden to regulate rates in any manner.
- No Middle-Mile. Interestingly, any fiber built along highways must include access points at "regular and short intervals." This money is not intended for middle-mile fiber.
- Public Awareness Campaign. Grant recipients must carry out public awareness programs in grant areas extolling the benefits of better broadband.
- Plenty of Paperwork. Grant recipients must file semiannual reports tracking the effectiveness of the grant funding.

Broadband Adoption Grants

The Infrastructure Investment and Jobs Act (IIJA) created two new grant programs to address digital equity and inclusion. This section of the IIJA recognizes that providing broadband access alone will not close the digital divide. There are millions of homes that lack computers and the digital skills needed to use broadband. The grant programs take two different approaches to try to close the digital divide.

The State Digital Equity Capacity Grant Program will give money to States to then distribute through grants. The stated goal of this grant program is to promote the achievement of digital equity, support digital inclusion activities, and build capacity for efforts by States relating to the adoption of broadband. I haven't heard an acronym for this grant program – it's likely that each state will come up with a name for the state program.

The Act allocates $1.5 billion to the States for this program – that's $300 million per year from 2022 through 2026. Before getting any funding, each state must submit a plan to the NTIA on how it plans on using the funding. States will have to name the entity that will operate the program, and interestingly, it doesn't have to be a branch of government. States could assign the role to non-profits or others.

The amount of funding that will go to each state is formulaic. Each State will automatically get $100 million. The remaining funding will be allocated to states based on the relative percentage of unserved and underserved locations in each state compared to the rest of the country. This allocation will rely on the new FCC broadband maps. The NTIA has already said that it's not going to use the new maps that will be coming in November 2022 but will wait until after the mapping challenge process.

The second new grant program is called the Digital Equity Competitive Grant Program. These are grants that will be administered by the NTIA and awarded directly to grant recipients. The budget

for this grant program is $1.25 billion, with $250 million per year to be awarded from 2022 until 2026.

These grants can be awarded to a wide range of entities, including government entities, Indian Tribes, non-profit foundations and corporations, community anchor institutions, education agencies, entities that engage in workforce development, or a partnership between any of the above entities.

This will be a competitive grant program, with the rules to be developed by the NTIA. While the broadband infrastructure grant in the Act includes a long list of proscribed rules, Congress is largely letting the NTIA determine how to structure this grant program.

The two grant programs create an interesting choice for entities involved in digital inclusion. They can go after funding through the state or compete nationwide for grants. I doubt that anybody can make that decision until we see the specific grant rules coming out of each program.

Smart Grid Grants

There is a lot of grant funding that will be awarded through the federal Department of Energy (DOE) related to smart grid infrastructure. This funding comes from the same Infrastructure, Investment, and Jobs Act that created the BEAD grants.

These grants will be awarded from the DOE to states, and the states will then award grants. The grants will stress electric grid resiliency. One of the best ways to gain resiliency and smart grid technologies is by deploying fiber to provide 2-way communication with network electronics and devices. Any fiber that is built for smart grid purposes could also double to bring last-mile broadband.

The specific details of these grants have not been released.

State Grant Programs[29]

Minnesota Border-to-Border Grants: This grant program has been awarding grants since 2014. The funding each year comes from the budget process in the legislature. The grants are administered through DEED (Department of Employment and Economic Development).

The most recent round of Border-to-Border funding was for $95 million, by far the most money ever made available for the grant program. There was a tiny portion of the county included in a Border-to-Border grant filed by Hansen Communications to serve Comfrey, Minnesota. The grant dips slightly into the county. Grant winners are not likely going to be announced until near the end of this year.

[29] https://www.Minnesotacommerce.gov/wp-content/uploads/2021/12/Broadband-Accelleration-Grant-Year-2-Program-Guidelines_FINAL.pdf

There will likely be additional rounds of Border-to-Border grants, but likely not of the same dollar magnitude.

There are a few key rules for Border-to-Border grants:

- The State has created its own broadband map that is then used to determine grant eligibility. In many cases, the state grant eliminates many of the problems of overstated speeds that is included in the FCC maps. DEED requires ISPs to report actual coverage areas (instead of Census block), and DEED tries to reflect actual broadband speeds rather than marketing speeds.
- The grants can only be awarded to serve areas that are defined as unserved or underserved. The grant defines unserved as areas that have no landline broadband alternative available that can deliver speeds of 25/3 Mbps. Underserved areas are those that don't have broadband speeds of at least 100/100 Mbps.
- The largest grant award is $5 million, although the majority of the grants awarded in previous years were for less than this.
- The grants can only be given to the entity that is going to own and operate the network – that generally means the money is given to an ISP and not to a local government.
- The entity getting the grant has to be an operating entity already in business. The grants won't fund a start-up company. Because of this, almost every grant award so far has gone to telephone companies, cooperatives, and cable companies.
- The grant funding must be used within two years of the award.
- Anybody applying for a grant must show proof of having the financing required for the matching part of the grant.
- The grants will provide up to 50% of the cost of a project. But projects that ask for less than 50% have an easier time getting funded.
- Not all assets are eligible for the grants. Generally, only the direct assets that will provide 100 Mbps broadband are eligible. For example, the grants will cover fiber technology but won't pay for most wireless technology.
- While it's not an official rule, we've seen in past years that the awards are spread around the state as much as possible.

The DEED office is going to play a bigger role going into the future. This office will be awarding Minnesota's share of the $42.5 billion BRAD grants.

Customer Financing

If a public-private partnership is unable to fully fund a project, we've seen citizens step up and agree to fund some portion of a broadband project. When you consider the high cost of building rural fiber, getting some assistance directly from potential customers is sometimes the only solution for raising all of the needed funding.

Property (or Other Kind of Tax) Revenues. It is possible to obtain some or all of the cost of a broadband network through a pledge of future tax revenues. That pledge can then support a bond. This is different than most bonds for a broadband network, where the network would be secured by revenues of the broadband venture. But a pledge of some other kind of tax revenue is one of the easiest ways to get a bond. There are some real examples of this kind of financing:

- Lyndon Township, Michigan: This is a township of about 1,000 homes that voted to raise property taxes to fund a fiber network. The township then partnered with a local broadband cooperative to provide services. The project is a win/win for citizens. Property taxes increased about $25 per month per household. The township provides inexpensive access to the network to the cooperative, which is offering attractive customer rates. This area had no broadband before the project.
- UTOPIA, Utah: UTOPIA is a consortium of a number of small towns in Utah that banded together to get fiber. Many of the member towns have pledged property tax revenues to fund part of the cost of the network.
- Cook County, Minnesota: Cook County funded about half of its fiber network using a federal grant awarded from the Stimulus funding program in 2008. The county held a referendum and used a sales tax increase to finance bonds to pay for the remaining matching funds needed to build the project.

Direct Customer Contributions: It's also possible to fund some project costs through direct contributions from potential customers. This has never been done on a large scale because it would be exceedingly difficult to get a lot of residents to agree to write a check to fund a network. But there are some examples to consider:

- Contribution to Aid in Construction: Most utilities have a program where they will agree to extend their network to customers if those customers agree to pay the cost of the connection. We are aware of numerous cases where small pockets of rural homes raised the needed money to get connected to a nearby broadband network.
- Ammon, Idaho: This is the only municipal attempt at funding a network in this way. The City of Ammon will connect customers to a fiber network if they contribute $3,500 up-front to cover the cost of construction.

Public-Private Partnerships

If the County gets involved in helping to fund broadband, it will likely be through some kind of public-private partnership (PPP). There is no one model for a PPP, and such an arrangement can be structured in many ways, which was addressed earlier in this report. The main benefit of a PPP is that the commercial operator of a project benefits by getting some bond financing from the municipal partner. This allows the business to blend the benefits of bond and commercial financing and is one of the ways that makes it easier to get through the first few years of the project.

The general benefits of bond financing are what makes public money attractive to a commercial partner - lower interest rates, long repayment terms, and small or no payments for the first few years. But the downside is that there are more overall financing costs, and in the long run, a bond makes a project cost more in terms of cash. The safety of a bond in the first few years can be attractive.

Combining Public and Private Financing. There are benefits to combining the two kinds of financing:

- Banks will often consider the financing that comes from bonds as the equivalent of equity, meaning that the commercial partner will not require as much, or even no, cash equity from the commercial ISP.

- In terms of the amount borrowed, the two methods work well together if commercial construction loans are used to cover the construction and bond financing is used for the longer-term financing costs.
- Combining the two methods can work to produce a payment term that is longer than a traditional commercial loan.
- Combining the two methods also usually means lower debt payments during the first few critical years while the network is being built.
- Both municipalities and commercial telcos have a natural borrowing limit—meaning that there is always some upward limit on the amount of money they can borrow. Combining both kinds of financing can mean that neither partner hits their debt ceiling. Just as an aside, the debt ceiling is often the main impediment to funding a project 100% with bonds. Fiber projects are generally large projects, and the required funds can easily exceed the ability of a local government to fund it 100%.

Following are a few examples of this type of PPP:

- RS Fiber Cooperative: RS Fiber is a new broadband cooperative that was formed in Renville and Sibley counties. The project was funded from various sources, including a loan for 25% of the project supplied by a bond backed by the cities and counties involved in the project. The Cooperative raised the other money with a combination of bank loans and grants.
- Swift County, MN: The county government contributed a significant percentage of the cost needed to construct a broadband network in the county. The bond proceeds were loaned to Federated Telephone Cooperative and are expected to be paid back over time.

ARPA Funding Partnership. We are seeing a lot of partnerships where counties, cities, and townships are contributing some ARPA funding to ISP partners to help bring broadband. Some folks don't think of this as a partnership and consider this the equivalent of making a local grant to an ISP. But generally, the local governments that make this kind of contribution can also convince the ISP to provide some services, such as free broadband for government offices or some other form of benefit to the local government.

IV. OTHER ISSUES

A. How to Find a Partner

One of the operating options explored in this report involved exploring broadband partnerships - how might the County best explore finding a partner.

The Best Characteristics for an ISP Partner

Experience. Finding partner ISPs with a history of being a successful retail ISP is one of the most important characteristics to look for. We know of several investor-driven ISPs that want to invest and operate broadband networks that have never built or operated a network. This isn't to say that such a group can't be a good partner, but it's a higher risk to work with an ISP that doesn't already have customers and that hasn't worked in a partnership before.

There are a few stories in the industry of public/private partnerships that went awry because of the lack of experience by the ISP partner. In the following two examples, the ISP management team was made up of folks with industry experience but who had never worked together as an ISP team before.

- The first example is Utopia in Utah. This is a collaboration of small towns that are working together through the Utopia organization to create an economy of scale for the business. State law in Utah doesn't allow municipalities to be an ISP, so Utopia works as an open-access network where the cities build the network, and various ISPs compete for customers.

  Utopia started by hiring an external management team that had not worked in the open-access environment before. Several things went wrong – the networks were late in getting constructed and came in over budget. The ISPs did not sell as aggressively as the business plan had supposed. Utopia ran out of cash before construction was complete and almost folded, but the business was eventually saved through several rounds of refinancing and is now large enough to be financially stable. It took almost a decade of the business being in financial duress to get to that point. More importantly, it took a new management team that grasped the best way to operate an open-access network.

- Another example is Lake County, Minnesota. This is one of the northernmost counties in the state and quite remote. There are 11,000 residents in 2,100 square miles. The County decided to borrow money to build a county-wide fiber network. They hired an outside firm to construct the network and run the ISP. The management team did a terrible job of managing the project. The project went far over budget and ran out of money with a backlog of almost 1,000 customers that couldn't be connected to the network.

  The project was funded through a combination of a $10 million federal grant and a low-interest rate government loan for $56 million. The County borrowed over $7 million in bonds and also made direct loans to the new business. The project roll-out went disastrously, and the project ran out of money before getting many customers connected. The project went underwater financially and didn't make enough money to cover debt payments. In 2019, the County sold the network to an ISP for $8.4 million. The federal government had to write off about $40 million in debt, and

the County must continue to make payments on the original bonds plus repay the internal loans made to the project.

Experience Working with Municipalities. Priority should be given to work ISPs that have worked with local governments before. CCG has witnessed a number of public-private partnerships with the recurring theme that the two parties get frustrated with each other over time. This is due to two factors – frustration with the government decision-making process and a difference in goals and expectations.

Commercial ISPs become quickly frustrated with the municipal decision-making process. Most local governments have a specified legal process that must be followed to make certain kinds of decisions. This might mean listing a topic for a public meeting, waiting for a period of time, and allowing public comment on the issue. Commercial ISPs are used to making decisions quickly and don't like the drawn-out processes that government requires. Government entities get frustrated as well since their commercial partners push them to make decisions too quickly.

A more fundamental issue arises in public-private partnerships over time due to a fundamental difference in goals. The issue commonly arises when the two parties didn't thoroughly discuss their long-term goals before a partnership begins. Commercial ISPs are usually most focused on cash flow and profit margins. If an ISP has invested equity in a broadband network, it becomes unhappy if the business doesn't meet the expected earnings goals. Governments often have a different set of goals – serving every household, offering low-priced broadband to low-income houses, or providing subsidized broadband to non-profits and anchor institutions. In many cases, these kinds of fundamental differences can't be overcome and eventually ends up in the dissolution of the partnership.

The difference between the government and a commercial ISP often surfaces when there is a discussion of rates. Local governments often push back against rate increases – particularly in election years. Governments generally push ISP partners to provide low rates and often want an ISP to provide subsidized rates for low-income households and even free service to groups like non-profits.

These kinds of issues are less likely to be a huge problem if the ISP has worked successfully with other municipalities before. A government entity that is working with an ISP that has not partnered in this manner before should have an in-depth discussion upfront about expectations. It's a lot easier if the two parties decide upfront that they aren't compatible instead of getting a divorce after the partnership has been launched.

Financial Strength. Municipal entities often have a hard time judging the financial strength of a partner. Unfortunately, most public/private partnerships are not made with large, well-financed ISPs. The more typical partnerships are with telephone companies, electric cooperatives, or fiber overbuilders. It's typical for commercial ISPs of this type to overstate their financial security – and they may even believe what they say in doing so. But there are a few fundamental things about ISPs that a city should understand:

- Almost every ISP has a natural borrowing limit. There is only so much debt that bankers and other lenders will allow them to carry. By definition, when an ISP nears that lending limit it means that bankers think the company is pushing its financial limitations. Any ISP that has borrowed to its limit can't afford to make financial mistakes, and that means the partnership and all its other ventures need to perform as expected. It's not unusual to see a budding partnership be dependent upon obtaining financing, and it's not uncommon for the ISP to not get the hoped-for funding.

- The biggest issue with ISPs and borrowing is collateral. Banks don't look at fiber networks as good collateral for loans because there is very little value from repossessing a fiber network. This means the only good collateral that most ISPs have is the value of their existing company. Even surprisingly large ISPs might have to pledge their entire company in order to borrow a sizable amount of money to build an expensive network. It's often necessary for owners of ISPs to make personal guarantees on loans, meaning that both their business and their personal assets are on the line with a new fiber project. ISPs are unlikely to disclose to a government partner the details of how they raise money – among other reasons, they fear public disclosure laws and don't want their personal financial position discoverable as a public record.

Capacity to Grow. One of the hardest things to judge is the ability of an ISP to grow quickly. A traditional ISP like a telephone company may have a lot of customers – but they acquired them slowly over decades. ISPs often get stressed to the breaking point when they try to grow too quickly. It's not unusual for an ISP to somehow assume that existing middle and upper management can handle a growth scenario while still handling the existing responsibilities they've always had.

Just because a company is a great ISP doesn't mean that the company is capable of growing quickly. Unfortunately, there is no way to judge this unless the ISP has already been growing prior to the creation of the partnership.

Fair Recognition of Value. One of the important attributes of a good partnership is the full and fair recognition of the value that each party brings to the partnership. Municipalities should be wary of a partner that overvalues what they bring to and undervalues what you bring. A government can create value for a public/private partnership in a number of ways:

- Funding. Any amounts paid towards funding a broadband network are valuable. Governments often don't know how to set a value for cash contributions – something that commercial partners routinely figure out. It's been my experience that ISPs don't value government funding as much as they do other funding sources. I think this is because government funding doesn't come with the same stringent strings and responsibilities. A local government is not likely (or even able) to require things that a bank might require, such as collateral or a lien on a partner's assets. If an ISP gets into financial trouble, the first entity they will try not to pay is a government partner. This can be dealt with in creating a partnership agreement, but to some degree, which requires a government to think like a bank.
- Anchor Tenant. Government entities often make good anchor tenants – which means guaranteeing to buy services with a long-term contract. It's not untypical for a government entity to be one of the largest broadband and telecom customers on a network.
- Other Assets. Governments often have other assets that can benefit a partnership. This could be land for placing equipment; It could be a building to create a central office or a storefront. It might mean towers, empty conduits, or spare existing fiber that can be used to defray the cost of constructing a broadband solution. The value of such assets should be set according to what the partnership would pay to get the same thing from a third party.
- Easier Construction Processes. Local governments often take a significant role during the construction process. They might have to approve permits for rights-of-way. They might be the entity that locates existing utilities. They might require inspection of construction work sites during and after construction. They might require things like traffic management during construction. Before tackling a major fiber construction project with a partner, a government might review these

various requirements to see if they can be streamlined to make it easier to build fiber. Note in doing so that this likely means making any relaxed rules available to any other entity that wants to build fiber.

- Contributed Labor. A government can contribute labor. Using the last example above, a government could agree to conduct permits, locating, or some other service for free as a way to contribute to launching a partnership project.
- Tax Abatements. Tax abatements have always been a tool for economic development. Governments often have it within their power to excuse certain taxes to entities that bring something of economic value to the community. For example, it's common to forego property taxes to lure a business to locate in the community. There are numerous taxes and fees that might impact a new broadband network, such as property taxes, sales taxes, or right-of-way fees that a government might be willing to waive to help a new network get established.

The bottom line is that a government can bring significant value to a partner, and that contribution should be valued fairly. Even when a government brings tangible value, such as contributing funding, it's not unusual for an ISP to undervalue that contribution. It's even more prevalent for an ISP to not assign a realistic value to the more intangible contributions.

How do You Find Potential Partners?

We've seen almost every partnership we know of come about through one of the following processes:

- Request for Information (RFI). It's typical for communities that want broadband to issue an RFI aimed specifically at soliciting potential ISP partners. An RFI typically describes the situation in the community, typically describes whatever work has already been accomplished (such as this feasibility study) and describes the role the municipality wants to take in a partnership.

  The RFI then asks ISPs to describe themselves and their capabilities. The RFI probably won't go so far as to request a specific solution but rather asks the ISPs to discuss how they might tackle broadband issues in the community.

  And RFI is generally the first step in determining which ISPs might be interested in partnering. After the RFI, the process typically moves to one of the two processes described below.

- Request for Proposal (RFP). An RFP is typically a lot more in-depth. In addition to asking ISPs to introduce themselves, an RFP might ask for specific proposed solutions. It might go deeper in detail and ask about the financial strength of the ISP partner and ask how they operate in other markets.

- Direct Negotiation. It's routine for governments to interact directly with potential ISP partners rather than go through an RFI or RFP. This might involve a local government reaching out to ISPs in the area, or it might be in response to an ISP making an unsolicited proposal to a local government to bring broadband.

Comparing the Three Options.

It's worth considering these processes from the perspective of an ISP. ISPs are leery of public records laws. They are often highly reluctant to provide financial information, customer lists, or other information that they feel is confidential. They don't trust that local governments will fight to keep such information confidential. ISPs are even leerier about spelling out specific details of their business plan and how they approach a broadband market – they don't want that information to be available to their competitors.

Many ISPs are not willing or able to respond to an RFI or an RFP that asks for lengthy written responses to a long list of questions. Vendors that sell equipment and services are used to the idea of making proposals and usually have a pile of pre-prepared canned responses to the typical questions they are asked by a prospective customer. However, an ISP may never have been asked to make a proposal in writing in the specific and detailed way that might be needed to respond to an RFI or an RFP. There are ISPs that refuse to participate in an RFI or RFP for this and related issues. We know there are ISPs that eliminate cities from consideration if they insist on going through the formal RFP process – such cities are willing to engage in discussions but not in a written dialogue that creates a publicly discoverable audit trail.

ISPs prefer direct discussions where nothing is put into writing during the negotiation stage. That's the same process that ISPs typically use when they partner with other ISPs – they sit and talk out the pros and cons and mutually decide if there is a potential for a partnership. As often as not, such discussions end up with the realization that a partnership is not a good idea, and the parties amicably go their separate ways with nothing that was discussed put into writing.

Here is the process that we have found to be effective:

> For most local governments, the best first step is to invite known ISPs for a high-level discussion about whether any kind of partnership makes sense. This process might involve several meetings where an ISP might come back with ideas, followed by a meeting where the local government reacts.
>
> The RFI process is a better approach if there are no local ISPs to consider. For example, we worked with a geographically isolated community where there was no local ISP candidate within fifty miles. An RFI made sense since the community didn't have a wish list of local ISPs to consider. An RFI also might make sense for larger communities. In this case, we define larger to mean that the cost of the project is large – perhaps more than $25 million. We've known communities that found an ISP partner through an RFI that they would never have otherwise found.
>
> An RFI should ask for basic information only. That might include asking an ISP to provide its history, talking about the products it normally sells, and talking about the management team. While cities might have a hundred questions for a prospective partner, the ISP is going to be a lot happier if the details of their business are not put into writing at the early stage of meeting and negotiating.

Establishing Compatible Goals

At some point during the early stages of the process, it's vital for both sides to thoroughly discuss their goals for the project. Misalignment of goals is the number one issue that plagues public-private

partnerships eventually. Both parties need to fully hear, understand, and be fully comfortable with the goals of the other partner.

Goals generally can be stated simply and don't have to be complicated. Goals for a municipality might be things such as serving the entire community, not needing to subsidize the project, keeping rates low, and so forth. Goals for an ISP might be to generate a specific target of cash flows or profits. It wouldn't be unusual for an ISP partner to eventually want the option to buy the business. But an ISP might have the opposite intention and be hoping to flip and profit from the business in a few years.

It's important for a municipality to fully understand an ISP's goals. This is one situation where a municipality might want to discuss these goals with a consultant or somebody with broad industry experience. It's not unusual for two partners to be using different jargon when discussing financial issues, and it's vital to fully comprehend what an ISP is telling you about their goals.

An alignment of goals is probably a make-or-break issue for a potential partnership. Many of the differences that a municipality and an ISP might have can be negotiated, but you can't negotiate a difference in philosophy. If an ISP has a goal that a municipality can't live with, such as selling out in 10 years – then our advice is to not pursue the partnership. When an ISP tells you a goal of that nature, they mean it.

How to Rank Potential Partners

There are hundreds of questions that a local government might ask an ISP that might range from big important questions like, "Can you bring funding to this project?" to questions with less impact, such as, "What's your process of disconnecting customers who don't pay?"

We advise prospective partners (government or otherwise) to place their questions into three categories, 1) make-or-break questions, 2) questions that might disqualify a potential partner, and 3) all other questions.

Every community will have its own list of make-or-break questions based on its own priorities and expectations. Make-or-break questions might be things like 1) "How much funding can you bring to the project?" or 2) "Are you willing to serve everybody in the community?"

Questions that might disqualify a potential partner might be similar questions, again based on the specific priority and goals of a given community. Keep in mind that some of the items in this category might be subject to negotiation – something that should be asked.

The first two categories of questions are the important ones that should be used to qualify and rank potential partners. Other less critical questions are important but probably shouldn't be addressed until it looks like both sides are serious about moving forward. You choose a partner based upon the most important aspects of the relationship – the other facts can be filled in when a partnership is on the table.

There are several techniques that are used to rank potential partners. Most rankings are done by compiling the rankings by a team of reviewers. The most important questions might get weighted somehow to have the biggest impact on the composite answer. A ranking process generally is aimed at creating a numerical

value that reflects the composite opinion of those doing the ranking. Numerical rankings should not be so rigid that this is the only way to rank partners – but it's an important step.

Defining the Roles of Each Partner

It's vital to define the specific roles and responsibilities of each partner. Ideally, this should be done before formalizing the partnership arrangement.

CCG has often used a technique that seems to work ideally in defining a partnership. It starts with a list of all the tasks needed for launching and operating the upcoming broadband business. The level of detail usually becomes readily apparent. For example, if it's clear that the ISP is going to have 100% of the interactions with customers, then having a task called "Interface with customers" would be sufficient rather than listing all of the various ways that somebody might interface with customers.

The items on the list would include financial and other contributions as discussed earlier, issues having to do with the construction of the new network, issues having to do with governance, and issues having to do with operating the business.

The responsibility for each task must be assigned. The choices for each task are 1) the task is the responsibility of the government, 2) the task is the responsibility of the ISP, 3) the task is a joint responsibility of both parties (in which case that needs to be fully described), or 4) the task is the responsibility of some third party (like an outsourced vendor). This kind of checklist can quickly show if the two parties are aligned and agree on the responsibilities or if there are tasks where the two sides have different views.

Making this checklist serves two purposes. It's a great tool for getting both parties to acknowledge the specific roles of each partner. It also then serves as a great template for developing a contract between the partners.

Maintaining Local Control

One of the biggest challenges faced by municipalities in partnerships with ISPs is the question of maintaining some local control to ensure long-term responsiveness to local needs.

One of the best ways to tackle this question is for the municipality to make a list of aspects of the businesses where they would hope for some local control. It's likely that a list will include major aspects of operating the business, such as setting rates, installation intervals, business hours, priorities of repairing customers after an outage, etc. A good thought experiment is for the local government to change hats and look at these same issues from the perspective of the ISP that wants to operate a profitable business. This exercise often highlights that there are some tasks where ISPs must have control.

One of the stories we tell about politics and local control concerns Bristol Virginia Utilities, which was one of the first cities to enter the broadband business. The business was operated by the electric utility, which was a branch of the local government, but which had a full standalone operating authority as a utility. The bonds were fully backed by the electric utility, but since the City had to approve any bond issue, the City reserved the right to set and approve rates. A few years after launching the business, and

during an election year, the City Council voted to slash all the rates by 15%. The utility warned them this would put the business underwater, and as was warned, the utility was unable to meet a bond payment due six months later. The City got the message and raised the rates to a higher level than the original rates to correct the shortfall. The City also changed its ordinances so that no future city council could change rates.

There are numerous other examples of negative ways that local governments have meddled in a new broadband business. Politicians might make promises to constituents on behalf of the ISP. Politicians often press the ISP to give special rates to friends or to forgive bad debts for a constituent. It's not unusual for politicians to go further and interfere in things like personnel decisions. It's important to have clearly defined boundaries and lines so that an ISP can say no to meddling.

ISPs are highly wary of ceding any control to a government entity. ISPs know that a partnership with a municipality is always tentative and can change drastically after an election. There are plenty of examples of a council or board that changed from pro-broadband utility to anti-broadband after an election. Political changes can put a huge strain on the business relationship even if there are no control issues. ISPs know that the municipality they partner with today may not be the same in the future.

This is not to say that a municipality shouldn't have any control over the business. One of the more obvious aspects of maintaining control depends upon who funds the network. A municipality is going to get little or no say in how to operate a network that includes significant funding from a commercial ISP. If an ISP brings money to a project, they generally will not take the risk of letting a municipality tell them how to operate the business.

But even funding doesn't always determine control. Many ISPs will only partner if they can make all the business decisions – even if the government funds the network. This is why you must ask all of the questions before creating a partnership.

The only surefire way for a municipality to have control is to fund and operate the network. It's going to be difficult to find an ISP partner that will want a city to influence business decisions once the business is operating. This is a case where a little authority is a bad thing. If a municipality has any authority to control the business, then eventually, somebody at the municipality will push the limits.

B. Community Engagement Plan

This section of the report will discuss a community engagement strategy. This strategy will cover three different aspects of community engagement:

- Bringing the public and elected officials into the process. If the community is going to tackle the various aspects of the broadband gaps and the digital divide, then it will be important to engage the public to support the effort.
- Finding the resources to accomplish broadband goals. Almost any broadband solution is going to need some local effort to accomplish the needed tasks.
- Ongoing Deployment Efforts. Finally, the report will look at any possible ongoing deployment efforts.

Consumer Education

One important aspect during both phases of community engagement is to provide useful information to help the public better understand broadband issues. We've seen communities tackle public education in some of the following ways.

- Publish This Feasibility Report. While not many people will wade the whole way through a report of this size, it's been written for anyone in the community to read.
- Hold Public Meetings. Public meetings can be held to explain the results of this study, or meetings could be more generic and be aimed at explaining broadband issues. It's important to have elected officials at public meetings so they can directly hear the kinds of issues that households and businesses have with existing broadband. It's vital to advertise heavily to drive attendance at meetings. CCG has been to a community meeting with only one attendee and to others that were standing room only in a large room.
- Broadband Web Site / Social Media. Many communities create a broadband web page or accomplish the same thing using social media. Such a page can be used to educate as well as inform. For example, a common educational feature is to have a lengthy section with responses to "Frequently Asked Questions." Such a website can also inform the public about upcoming events or other things the government wants to advertise.[30]
- Gather a List of Broadband Proponents. One important resource is to create a database of local broadband proponents – citizens who say they support broadband. Having a list of emails, home addresses, and phone numbers will be useful when it's time to gather support for public actions.
- Broadband Newsletter. Communities often create a newsletter dedicated to broadband. A good newsletter should be aimed at educating the public on topics related to broadband and at keeping the public informed on the progress of the effort to get better broadband.
- Outreach Meetings. One of the most successful ways to reach the public is what CCG calls organization outreach. This means sending a spokesperson to meetings of the local organizations to talk about broadband issues and answer questions. This could be all types of local groups – PTAs, church groups, service organizations, youth groups, etc. Most organizations will allow time for a short presentation. It's vital to have a prepared presentation to get across whatever message you want the public to know. These outreach meetings are best done by those who are strong broadband proponents or who have specific knowledge about broadband.

Engaging with Public Officials

The process of bringing public officials into the process is something that is generally unique to every community and is something that most communities already know how to do since local governments tackle numerous other topics that are as complicated as broadband. Some of the steps we see communities take with elected officials are:

- Basic Education. This involves the same kinds of steps used to inform the general public. That might include a presentation of the results of this study and making this report available.
- More In-depth Workshop. Elected officials often conduct workshops where elected officials can hear more about and ask questions about topics. These typically are sessions where no votes are taken.

[30] An example of an effective community broadband website can be found at https://falmouthnet.org/. This is a community that is still in the process of trying to fund and build a fiber network.

- Engagement on Specific Tasks. Many communities get active engagement from elected officials in the process of investigating broadband. For example, it's not unusual for a few elected officials to participate in a broadband task force or committee.

Staffing for Community Engagement

Both phases of community engagement require some level of staffing to be successful. Both phases require a focused and persistent effort, so it's important to identify the staffing needed to be successful. We've seen many efforts to get community buy-in fizzle when nobody was dedicated to the community engagement tasks. We've seen the following ways that communities have staffed the effort.

- Dedicated Government Staff. The most expensive option, but one of the most effective, is to dedicate government staff to concentrate on broadband community engagement. That requires a commitment by elected officials to fund the effort. This would typically not be a permanent position but rather somebody dedicated to the effort for some fixed time. This is also not a 9-to-5 job since interfacing with residents and organizations often means evening meetings.

  A county in Minnesota found a broadband solution because the mayor of one of the smallest towns in the county told his economic development director that getting broadband was his top priority. This economic development leader spearheaded the first phase of the process – educating the public on the issue of broadband. This particular area had towns with okay broadband from a cable company and rural areas with little or no broadband. The economic development director met with everybody imaginable in the area, including other city governments, county governments, state representatives, and every civic and social group imaginable. After two years of tireless work by this one staff person, the communities in parts of two counties agreed on a broadband solution. This would never have happened without this one dedicated staff position.

  It's worth noting that this is a function that could be funded through the ARPA funds received by communities. Planning for implementing a broadband solution is a legitimate use of those funds. There are also other federal and state broadband adoption grants that could be used for the same purpose.

- Volunteers. Volunteers are also an important part of this effort. Every community seems to have some people who really hate the state of the existing broadband and who are willing to volunteer time to hunt for a solution. In the example given above, the economic development director assembled a group of active volunteers to help with the effort to engage with and educate the public. These folks created email lists, went canvassing door-to-door talking about the need for broadband, and showed up at every government meeting to stress that they wanted a broadband solution. It's important that any volunteer effort have some structure and is working with a staff person can make sure such a group stays focused. If a community decides to engage volunteers, there should still be a commitment to providing some funding. In the case of the Minnesota effort, local governments funded the effort required to canvass and survey the communities. This included several rounds of mailing postcards asking homeowners to pledge support for broadband.

- Broadband Task Force. Another approach is to create a formal committee or task force to explore the issues around community broadband. These task forces are generally composed of both citizen

volunteers and a few elected officials. Such a group is going to be moist effective if tasked with solving specific projects. It's normal that such a group would report back regularly to the government about their progress. Such a group can collectively take on some of the needed community engagement tasks, and we've seen effective committees do this well. It's not unusual for a Broadband Task Force to solicit help from additional volunteers.

Such groups are usually given a budget but also restrained by needing to have expenditures pre-approved. We could write pages on the dos and don'ts of operating a successful citizen's advisory group. Most communities are familiar with the idea through having used similar groups for other community efforts. The main key to success is to make sure that the group has a specific agenda, a specified budget, and the specified authority to meet its goals. A task force can accomplish great things if they are properly directed to do so – but can stray if not given good direction.

Deployment Efforts

There are many areas where community engagement can turn into actionable results through the good use of full-time staff, a task force, or community volunteers. Following are some of the key tasks that might be accomplished through the community engagement process.

Setting Broadband Goals and Policies.

We have found that it is useful for any local government that wants to move forward with broadband to first establish clear goals for getting better broadband. Specific goals are needed, for example, before a community can decide if it's better to build broadband, look for a partner, or look for an ISP to bring a turnkey solution. Without specific community goals, it's going to be hard to analyze any offers made by potential partners. A well-thought-out set of goals provides the framework needed to provide a basis for making decisions about broadband.

We would add one word of caution in that a broadband task force is going to tend to be composed of those who are totally gung-ho on getting a fiber solution. It's important to bring other community opinions into the process of setting final goals. But getting this process started is something that can be asked of a task force or other kind of volunteer group.

Gather a List of Broadband Supporters. If there will be any organized citizen outreach, it will prove to be worthwhile to begin assembling a list of citizens who support getting better broadband. Many grants require a significant showing of public support, so gathering a list of supporters provides a way to quickly get letters of support needed for grants.

More importantly, gathering a list of supporters provides a way to start demonstrating to an ISP that there is a demand for better broadband. To give an example, the City of Bristol, Virginia was one of the first municipalities to build a fiber network. The City had no idea how many customers it might get, so a year prior to starting construction, the City put a sign-up logbook in the lobby of the utility and put a simple interest form on its website. The City didn't advertise these efforts other than employees telling customers about it. By the time construction started, the City had gathered interest from over 30% of households who were interested in buying fiber if the City built the network. It turns out that nearly every home on the list bought fiber when it was offered.

At the time, the City didn't have a name for this effort, but we'd now call this pre-marketing. We don't think you would have tackled this feasibility study with a strong sense that people want better broadband. Gathering non-binding commitments from households is one of the most powerful tools that can be tackled during the community outreach phase of the project. It's a lot easier to attract an ISP partner (or decide to tackle this yourself) if you have specific evidence that many homes are ready to buy better broadband.

Making It Easier to Build Fiber

Many communities have developed processes for working with existing utilities that can be a hindrance for somebody trying to build a widespread network. The processes that affect building a new fiber network include things like gaining access to rights-of-way, permitting, identifying existing buried facilities, construction rules, and post-construction inspection.

It's not unusual that some of these processes in place were developed over the years in response to the behavior of a cable company, a telephone company, the electric company, or others. Existing utilities rarely tackle major construction projects but instead make small incremental changes to infrastructure to respond to changing demographics. Rules that might be reasonable for the electric company might be a barrier to somebody wanting to build fiber everywhere. As an example, one of my clients went to build in a town and was told that it had to submit a separate permitting request for each pole in the network. This greatly slowed down the permitting process and the whole project. We can only imagine at some time in the past that somebody in the city had changed the process in response to getting a permit request for a lot of poles. Likely this change was implemented by staff at a lower level than the city council – but informal policies implemented by staff tend to become hard and fast rules over time.

Most communities have not seen a widespread utility construction project since the cable companies built in the 1970s. We strongly recommend that each local government review these policies for reasonableness before the start of any major broadband project. After all of the work to attract better broadband, the local governments should not have any impediments in place to enable the construction of a new network. We would caution that any changes in policy made to accommodate a large construction project will also apply to other utilities. Most communities that have done this review realize that processes over time have drifted from the ideal.

This is the kind of review that can be given to a few technical volunteers who might compare your processes to those in a few other communities that have built fiber. Ultimately, it's likely that a few ordinances might be needed to update the processes.

More Market Research

This is something that might be done by a partner ISP, but also possibly by the County if there is to be a public-private partnership.

> Market Surveys. There are a few factors that are vital to get an accurate and believable survey. The questions asked must be unbiased and can't lead respondents to answer in a given way. It's also important for a survey to be random if you want the results to represent the whole community. If

the goal of a survey is to predict broadband penetration rates, it's just as important to hear from those who don't want broadband as it is to hear from those who do.

There are two types of market surveys that can be done to help understand the public demand for better broadband.

The first is an online survey, where everybody in the rural area would be asked to go online and answer some basic questions. Online surveys are not statistically valid but are still valuable to find out how the public feels about broadband. Online surveys are best to understand public sentiment.

However, the most important thing that an ISP generally wants to understand is the potential market penetration rate – how many people might buy service on a new network. That can only be quantified with a statistically valid survey.

It's essential to have confidence in the survey results, and this speaks to the accuracy of the answers obtained in the survey. Most business and political surveys are designed to provide an accuracy of 95% plus or minus 5%. That accuracy would mean that if you were to ask the same questions to 100% of the people in the area that the results should not vary by more than 5% from what was obtained in the survey. That is a high level of accuracy, but other levels of accuracy are possible by varying the number of completed surveys.

Surveys have gotten a bad name due to political surveys. There are several reasons that a political survey can produce unreliable results. The primary reason is that respondents might not truthfully answer all of the questions for many different reasons. We don't see this kind of bias in broadband surveys because the topic doesn't seem to trigger emotional responses – folks generally tell us the truth about the topic.

The last factor to consider is a phenomenon called survey fatigue. If the survey asks too many questions or takes too long, then a lot of people will hang up in the middle of the survey. A good survey shouldn't take more than 10 minutes, and one taking 5 minutes would be ideal.

There are two ways to conduct a statistically valid survey of a whole community – either by knocking on doors or by telephone. The effort required to knock on doors is massive. The trick is to figure out a way to reach homes at random – it can be done, but it's hard to have the discipline for surveyors to stick to a random knocking pattern.

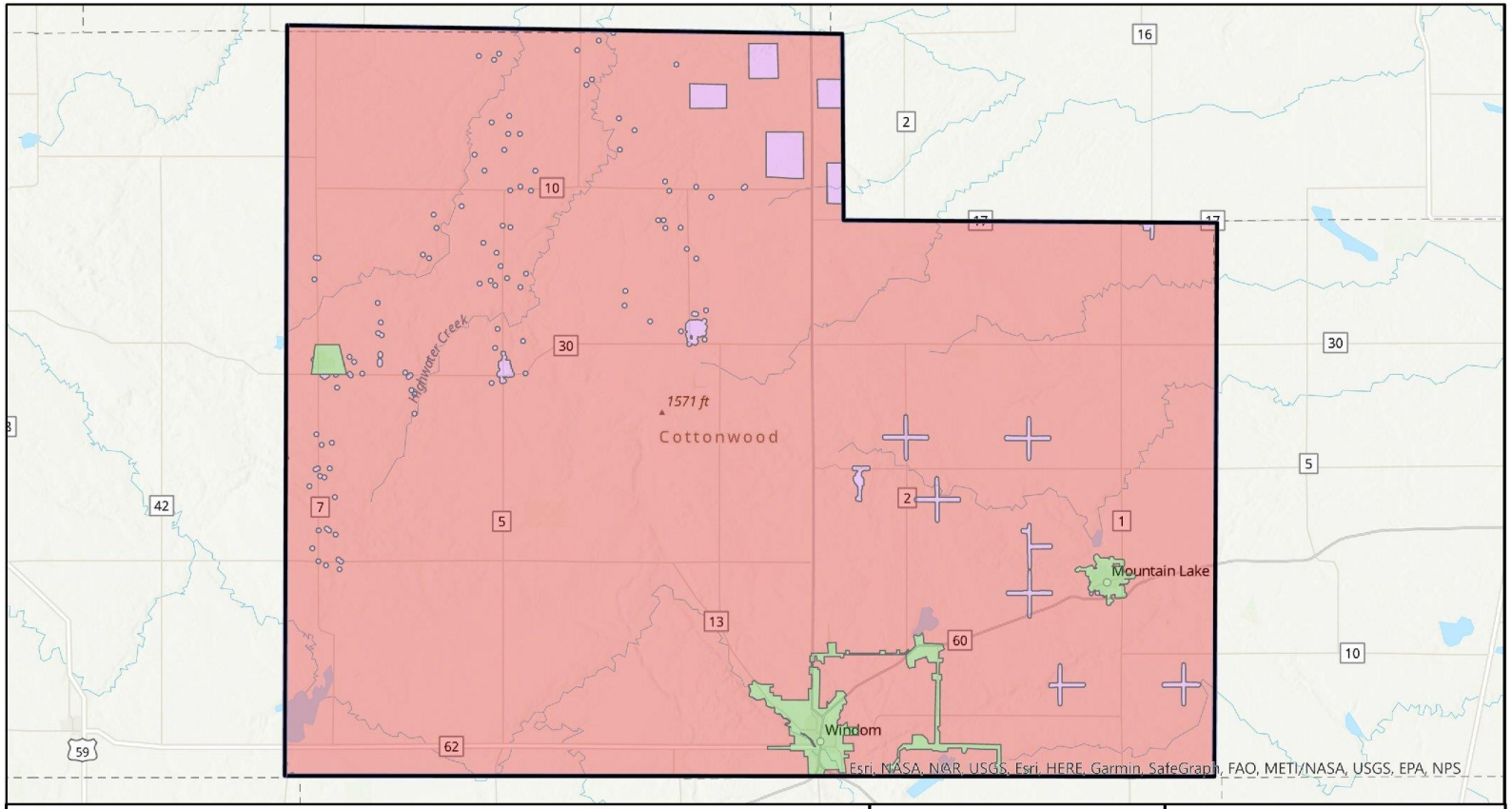
It's far easier to administer the survey by phone. It makes no sense these days to do a telephone survey using the white pages and calling just landlines. We know that the households keeping landlines are older and more conservative, and their responses on a survey won't represent all households in an area. The biggest challenge is finding a good list of telephone numbers. It's possible that such a list is available from tax bills or other government records.

<u>Canvass</u>. A canvass is similar to a survey but has the goal of reaching as many people as possible in the proposed service area. A canvass can be conducted in many ways through mailings, phone calls, or knocking on doors. We've seen communities engage groups like the PTA and service organizations to get people to participate in the canvass. We've worked with communities where

volunteers were able to reach out to almost everybody the planned broadband areas.

A canvass is even better than a survey if it's done well and gets to a large percentage of households. The primary reason for undertaking a canvass is to get residents and businesses to pledge to buy broadband if a network is built. Such pledges are typically non-binding but can provide good support when the community is looking for funding. A canvass is also an effective way to let the public know about the plans for bringing broadband.

EXHIBIT I: Engineering Maps



Cottonwood County Eligible Areas

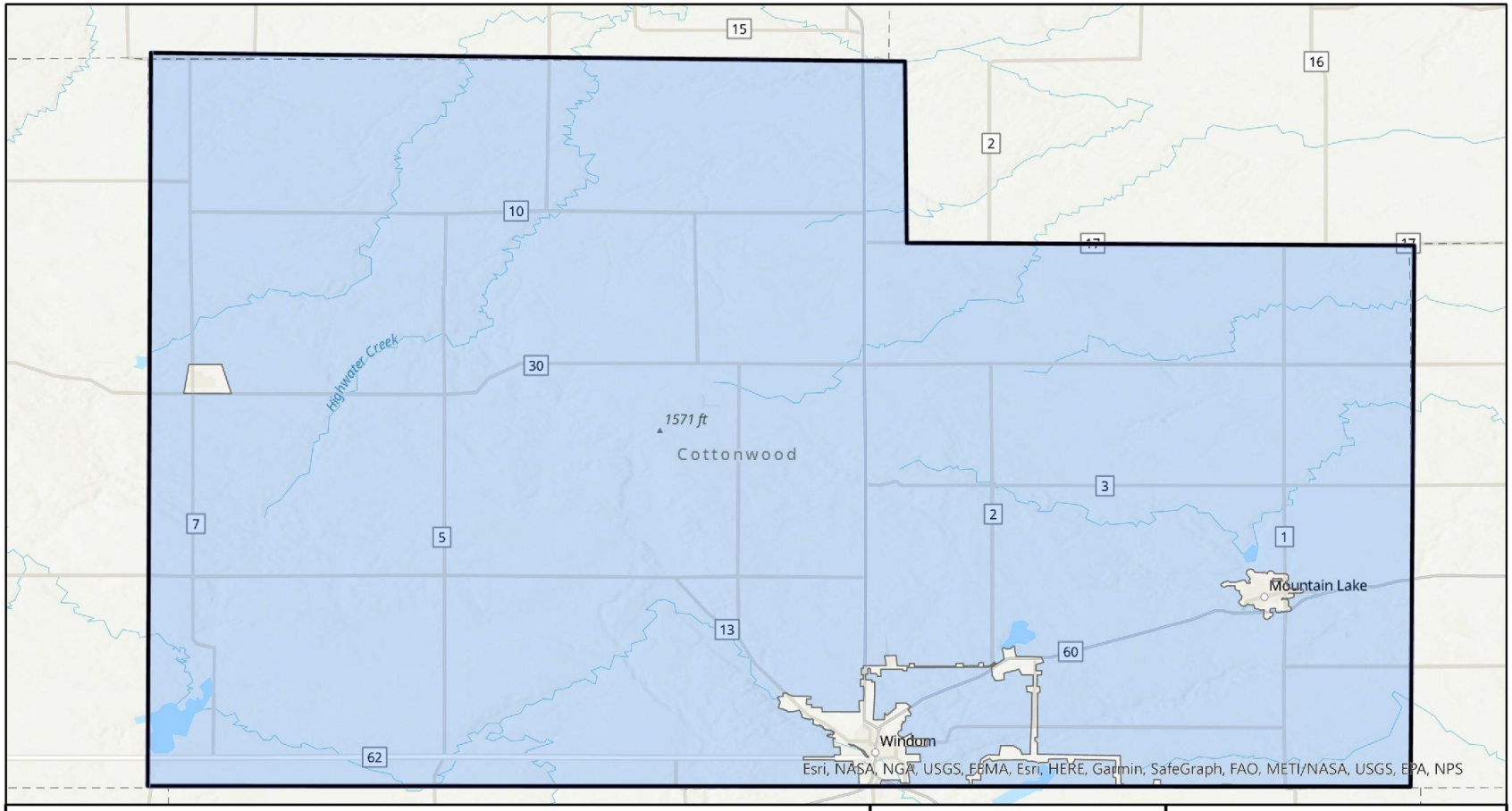
- County Border
- MN Underserved
- MN Unserved
- MN Served

Cottonwood County, MN

FINLEY ENGINEERING

1981 Engebretson Ave
Slayton, MN 56172
www.FinleyUSA.com

SHEET TYPE/NAME	
Project Name:	Cottonwood County Feasibility Study
User Name: j.torborg	
Staked By:	
Date: 9/16/2022	



Cottonwood County Study Area

County Border

Study Area

Cottonwood County, MN

FINLEY ENGINEERING

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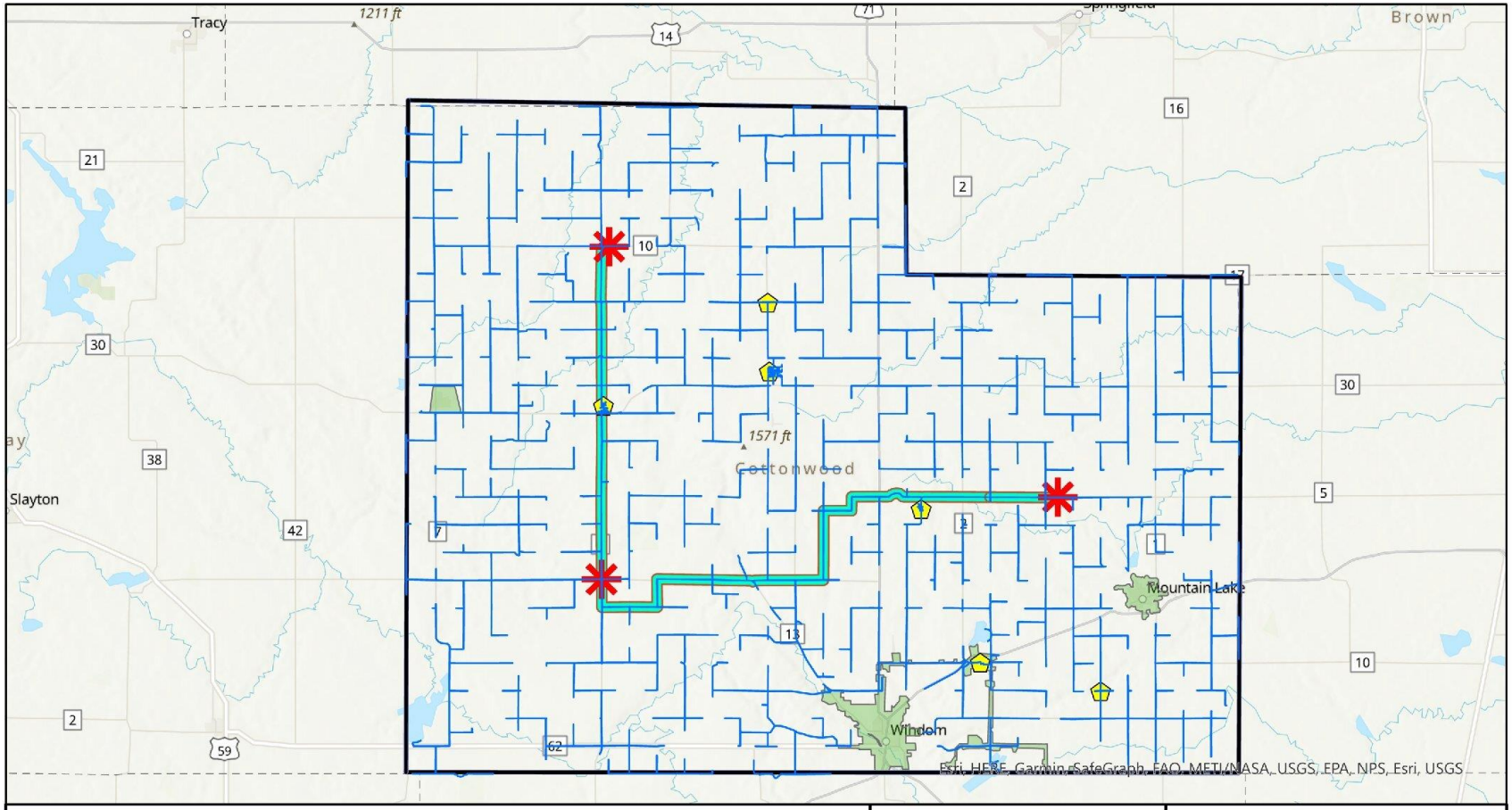
Slayton, MN 56172
www.FinleyUSA.com

Project Name:	Cottonwood County Feasibility Study
User Name: j.torborg	
Staked By:	
Date: 9/16/2022	



Cottonwood County Feasibility Study Design and Served Areas

- County Border
- Splitter Cabinets
- Backbone
- MN Served at least 100/20M
- Electronics Nodes
- Fiber Route

Cottonwood County, MN

FINLEY ENGINEERING

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Slayton, MN 56172
www.FinleyUSA.com

SHEET TYPE/NAME

Project Name:	Cottonwood County Feasibility Study
User Name: j.torborg	
Staked By:	
Date: 9/16/2022	

EXHIBIT II: Summary of Financial Results

		Year 4 Assets	Take Rate	Loan	Equity	Grant	Total Financing	Year 5 Cash	Year 10 Cash	Year 15 Cash	Year 20 Cash
1	**Base 60%**	$26.9 M	60%	$25.7 M	$4.5 M		$30.3 M	($ 2.74 M)	($11.08 M)	($19.62 M)	($28.00 M)
2	**60% Breakeven Grant**	$26.9 M	60%	$ 5.7 M	$1.0 M	$21.0 M	$27.7 M	$ 0.57 M	$ 0.52 M	$ 0.28 M	$ 0.20 M
3	**50% Penetration**	$26.3 M	50%	$25.4 M	$4.5 M		$29.8 M	($ 3.01 M)	($12.00 M)	($21.23 M)	($30.36 M)
4	**50% Breakeven Grant**	$26.3 M	50%	$ 3.7 M	$0.7 M	$22.8 M	$27.2 M	$ 0.65 M	$ 0.62 M	$ 0.36 M	$ 0.21 M
5	**55% Penetration**	$26.6 M	55%	$25.5 M	$4.5 M		$30.0 M	($ 2.88 M)	($11.54 M)	($20.41 M)	($29.16 M)
6	**55% Breakeven Grant**	$26.6 M	55%	$ 4.6 M	$0.8 M	$21.8 M	$27.2 M	$ 0.40 M	$ 0.41 M	$ 0.21 M	$ 0.14 M
7	**65% Penetration**	$27.2 M	65%	$25.9 M	$4.6 M		$30.5 M	($ 2.62 M)	($10.62 M)	($18.81 M)	($26.83 M)
8	**65% Breakeven Grant**	$27.2 M	65%	$ 6.8 M	$1.2 M	$20.1 M	$28.1 M	$ 0.57 M	$ 0.50 M	$ 0.24 M	$ 0.16 M
9	**70% Penetration**	$27.5 M	70%	$26.1 M	$4.6 M		$30.7 M	($ 3.46 M)	($10.14 M)	($18.00 M)	($25.64 M)
10	**70% Breakeven Grant**	$27.5 M	70%	$ 7.8 M	$1.4 M	$19.2 M	$28.4 M	$ 0.56 M	$ 0.46 M	$ 0.20 M	$ 0.16 M
	Based on Line 2										
11	**Higher Interest Rate**	$26.9 M	60%	$ 5.8 M	$1.0 M	$21.0 M	$27.8 M	$ 0.48 M	$ 0.20 M	($ 0.27 M)	($ 0.58 M)
12	**Lower Interest Rate**	$26.9 M	60%	$ 5.7 M	$1.0 M	$21.0 M	$27.7 M	$ 0.66 M	$ 0.83 M	$ 0.80 M	$ 0.93 M
13	**15-Year Term**	$26.9 M	60%	$ 5.9 M	$1.0 M	$21.0 M	$27.9 M	$ 0.33 M	($ 0.32 M)	($ 1.16 M)	$ 0.84 M
14	**25-Year Term**	$26.9 M	60%	$ 5.7 M	$1.0 M	$21.0 M	$27.7 M	$ 0.70 M	$ 0.98 M	$ 1.06 M	$ 1.30 M
15	**Higher Prices**	$26.9 M	60%	$ 5.7 M	$1.0 M	$21.0 M	$27.7 M	$ 0.74 M	$ 1.11 M	$ 1.30 M	$ 1.69 M
16	**Lower Prices**	$26.9 M	60%	$ 5.8 M	$1.0 M	$21.0 M	$27.8 M	$ 0.42 M	($ 0.06 M)	($ 0.75 M)	($ 1.29 M)
17	**Best Look 9+14+15**	$27.5 M	70%	$25.7 M	$4.5 M		$30.3 M	($ 1.71 M)	($ 7.43 M)	($13.30 M)	($18.93 M)
18	**Best Breakeven**	$27.5 M	70%	$10.2 M	$1.8 M	$16.5 M	$28.5 M	$ 0.55 M	$ 0.47 M	$ 0.24 M	$ 0.26 M
	Open-Access With Grant										
19	**County**	$26.9 M	60%	$ 6.7 M		$21.0 M	$27.7 M	($ 0.34 M)	($ 1.69 M)	($ 3.11 M)	($ 4.33 M)
20	**ISPs**	$ 0.1 M	60%	$0.8 M	$0.1 M		$ 0.9 M	$ 0.18 M	$ 0.29 M	$ 0.56 M	$ 1.03 M
	Lease Network with Grant										
21	**County**	$26.8 M	60%	$ 6.3 M		$21.0 M	$27.3 M	$ 0.17 M	($ 0.70 M)	($ 1.62 M)	($ 2.39 M)
22	**ISPs**	$ 0.1 M	60%	$ 1.0 M	$ 0.2 M		$ 1.2 M	$ 0.33 M	$ 0.68 M	$ 1.12 M	$ 1.97 M