Pope County, Minnesota

Broadband Feasibility Study

June 27, 2017

CCG CONSULTING

FINLEY ENGINEERING
INTEGRITY INTO EVERYTHING

Finley Engineering
CCG Consulting

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EXECUTIVE SUMMARY

Finley Engineering and CCG Consulting submit this report of our findings and recommendations for the feasibility of creating a broadband network in Pope County. The county finds itself in a situation where a substantial part of the county has or will soon have good broadband, including fiber, while other parts of the county have little or no broadband. The county is a textbook example of broadband haves and have-nots—with those without broadband living close to others that have it. This disparity will eventually harm those portions of the county without broadband and you can expect those areas to suffer lower housing prices and become places where families and business don't want to be located.

Our study area looked at the feasibility of bringing fiber to the parts of the county that are not expected to have fiber construction over the next few years. We looked at three different business plan scenarios for getting broadband to everyone: 1) building fiber everywhere, 2) a hybrid plan that has a mix of fiber and fixed-wireless broadband and that covers the whole study area, and 3) a hybrid plan that excludes Glenwood. Finley Engineering developed estimates of the cost of deploying each network option and CCG used these costs in the financial business plans to see if there is an economically viable model for providing broadband in the rural areas.

For each scenario we looked at a number of different options. For example, we looked at the difference of funding the project with municipal bonds or with commercial loans. We looked at different levels of customer penetration, including and calculated the breakeven scenario, which determined the number of customers needed for the business to always be able to cover costs and remain cash positive. We also looked at the impact of the most import variables in the forecasts including customer pricing, interest rates on debt and having the projects partially funded by grants.

It does not look to be economically feasible to immediately build fiber everywhere. There are not enough potential customer revenues to cover the cost of constructing, financing and operating a fiber network. This scenario looks to require as much as 70% of the funding coming from grants to be viable – something that is not likely. It does not look easy to finance all-fiber with debt.

The hybrid model looks promising. This scenario brings fiber to Glenwood, Villard, Sedan and to customers living close to the backbone fibers in the network, then builds wireless elsewhere. This scenario only requires a customer penetration rate of 43% to break even and it generates significant cash at higher penetration rates. We have been seeing rural penetration rates between 65% and 85% when building to areas that didn't previously have broadband – so this scenario looks relatively safe.

The county should still have a long-term goal to have fiber everywhere and the hybrid scenario looks to be the only solution that can get funded today and that can generate excess cash that can be used to eventually bring fiber to the rest of the county.

The county has already taken the first steps of presenting these study results to potential service providers. Hopefully one or more of them will be able to seek grant funding from Minnesota DEED in the upcoming grant cycle this fall. But if that doesn't happen then there are steps the county can take to be prepared to support a grant filing for next year.

FINDINGS

Following are the key findings of our investigation:

THE PROBLEM

Lack of Rural Broadband: As the county already knows, there is a glaring lack of broadband in the rural parts of the county today. The county shares one characteristic that we are starting to see all over the country in that some parts of your county have, or will soon have, fiber while others have practically no broadband options. That kind of contrast will have long-term negative impacts on housing values and quality of life in the areas without broadband.

BASIC FACTS ABOUT THE COUNTY

Potential Customers: We looked at several different sources of data for counting homes and businesses in the county. The primary source of information was county GIS data. We counted businesses in the service area by using a database provided by the state listing all of the registered businesses in the county. The passings (potential homes or businesses) used for each of the scenarios are as follows:

Fiber Everywhere	4,626
Hybrid 1 - Fiber/Wireless	4,626
Hybrid 2 - No Glenwood	3,658

Road Miles: To bring fiber to the whole study area would require building fiber along 765 miles of streets and roads. It is probable that a final fiber design might find ways to pare a few of those miles and still reach everybody, so our projected fiber investment is conservatively high.

THE POSSIBLE SOLUTIONS

The study looked at three possible engineering solutions to bring broadband to the parts of the county that don't have fiber today.

Build Fiber Everywhere: We first looked at building fiber everywhere within the study area. That means building fiber in Glenwood, Villard, Sedan, along the lake, and all of the unserved rural parts of the county.

Hybrid 1 – Fiber/Wireless Everywhere: This option builds fiber to Glenwood, Villard, and Sedan as well bringing fiber to homes and businesses located along the backbone fibers. All other customers are provided broadband using wireless point-to-multipoint radios. This scenario brings fiber to 1,358 passings with wireless to the rest.

Hybrid 2 – Excludes Glenwood: This option is the same as Hybrid 1 except that it excludes Glenwood. This scenario brings fiber to 429 passings with wireless to the rest.

ENGINEERING FINDINGS

Backbone Fiber Network: Finley Engineering recommends that all three options include a fiber ring. This will provide redundant capability to the electronics for either a fiber or wireless network. The backbone ring also can provide fiber connectivity to homes and businesses located near the chosen routes. The fiber ring would also provide the ability to more easily extend additional fiber in the future. The recommended backbone fiber in the analysis would be 67.6 miles long and built with 96 fibers to accommodate future growth. However, if fiber is built to extend from existing fiber at service providers in the County a ring might not be necessary. But the network costs would only be slightly lower by eliminating the ring.

Aerial vs Buried Fiber: The entire network was designed using buried fiber. The soil in the county allows for relatively easy burying of fiber and the cost to bury fiber in the rural parts of the county would not be any higher than to place the fiber onto existing poles. A buried network will last longer and have fewer maintenance issues.

Total Asset Costs: Following are the assets required to launch each of the three different scenarios. These assets assume the business would have a 60% customer penetration rate. These asset costs would increase or decrease along with higher or lower numbers of customers.

	Fiber Everywhere	Hybrid 1	Hybrid 2
Fiber & Drops	$25,323,020	$5,651,837	$3,500,217
Electronics	$ 3,023,004	$1,596,352	$1,340,184
Huts/Towers	$ 395,094	$1,172,029	$1,172,029
Operational Assets	$ 530,232	$ 530,233	$ 523,340
Total	$29,271,350	$8,950,451	$6,535,769

BUSINESS PLAN RESULTS

The county's hope for the project was to find solutions that can bring broadband to the county and that are financially sound, meaning that they generate enough cash to be solvent. The county also has a goal of eventually bringing fiber to everybody.

Penetration Rate: The penetration rate is the percentage of potential customers in the study area that buy service. We began the study process using an arbitrary penetration rate of 60%. We then determined the needed penetration rate to make each option financially sustainable, and called this the breakeven penetration rate.

Business Plan Results

There are detailed financial summaries of the various business plans in Section III.B of this report. Following is a high-level summary of the three scenarios studied:

> **Fiber Everywhere:** We could not find a financial scenario where building fiber to the study area was financially self-sustainable with a reasonable customer penetration rate. If financed with

revenue bonds this scenario would require a bond of $40.2 million. General obligation funding would be a little smaller at $36.7 million. Financing the project with commercial loans would require a combined debt and equity of $34.0 million.

<u>Hybrid 1 Fiber/Wireless</u>: This scenario builds fiber in Glenwood, Villard, Sedan, and for those passings close to backbone fibers. Everyone else in the study area is offered wireless broadband. This scenario will break even with commercial financing and with a 43% penetration rate – something that seems reasonably achievable.

This option would require a revenue bond of $12.4 million, a general obligation bond of $11.3 million or combined debt and equity for a commercial project of $9.8 million. This scenario, with commercial financing and a 60% customer penetration generates $12.1M of cash over 25 years. At a 70% penetration it generates $17.8 M – both amounts that could be used over time to replace radios with fiber.

<u>Hybrid 2 Fiber/Wireless</u>: This scenario excludes Glenwood and builds fiber to Villard, Sedan, and to those passings close to backbone fibers. Everyone else in the study area is offered wireless broadband. This scenario breaks even with a 49% customer penetration, again something that is reasonably achievable. By excluding Glenwood the needed investment is smaller and this scenario would require a revenue bond of $9.1 million, a general obligation bond of $8.3 million or combined debt and equity for commercial financing of $7.8 million. This scenario, with commercial financing and a 60% customer penetration generates $8.4M of cash over 25 years. At a 70% penetration it generates $13.1 M – both amounts that could be used over time to expand the fiber network.

CONCLUSIONS

- It does not look like there is a sustainable business plan for building fiber everywhere. There are not enough customers in the study area to justify the cost of the network that extends for 765 miles. This scenario has a higher cost than what we normally see for building fiber drops due to the average length of rural drops that we estimate at 750 feet.
- The hybrid fiber/wireless scenario is financially feasible. Due to the relatively low breakeven penetration rate of 43% this scenario can become cash positive quickly and generates significant cash over time.
- The hybrid fiber/wireless scenario that excludes Glenwood also looks financially viable, although it doesn't perform as well as the one that includes Glenwood. The scenario still has a breakeven penetration rate of 49% which ought to be achievable in this market.
- All of these scenarios include portions of the network that should be eligible for grant funding from Minnesota DEED. The financial performance improves for any scenarios that obtains some grant funding, although it looks like the all-fiber scenario would require as much as 70% grant funding to be viable.
- The most significant variable in these studies is customer pricing. We recommend that broadband products be sold at or above 'market rates,' meaning rates similar to what is being charged in other parts of the county today.

RECOMMENDED NEXT STEPS

If you decide to move forward, the following tasks are the most likely next tasks to tackle. In your case, since there is the opportunity for getting state grants later this year, you need to make the next steps happen rather quickly if the county is to benefit now from those grants.

1. **Find a partner**. The very first step is to look for an operating partner. That process is already underway. In order to file for a DEED grant this year it's likely that one of the nearby telephone companies would have to decide quickly about asking for a grant. Since the DEED grant process is funded newly each year there is no way to know if grants will be available in the future. The legislature approved $20 M in grant awards for the upcoming grant cycle.

2. **Consider a survey**. Our experience today is that there will be sufficient demand in the rural parts of the county to support the needed penetration rates. CCG works extensively with rural communities and in the last few years we have seen the penetration rates for bringing broadband to rural markets of 65% – 85%. Since Glenwood already has decent broadband it's unlikely that it will do as well as the rural areas. You might want to do a survey to find out the level of demand. If you do a survey, it's essential to do it in such a way as to get statistically valid responses that you and potential telco partners can believe.

3. **What if Nobody Applies for a Grant this Year?** It is already late into 2017 and this year the DEED grant applications are due by September 1. If nobody requests a grant this year the county could take steps to improve the chance of getting grants next year. This could take the form of an education campaign to inform the public about the benefits of faster broadband. The county could also help to organize marketing drives to get customers to pre-sign for broadband, if it's built.

4. **Consider the possibility of providing some county funding**. If you have trouble finding one or more partners to build all of the unserved and underserved parts of the county, then you should consider the possibility of pledging some financial support towards building a broadband network. This was done recently in nearby Swift County; the government there contributed a significant amount of bond funding to help finance the project. They expect the revenues of the projects to be able to cover the bond payments. There was something similar done a few years ago when Sibley and Renville counties contributed 25% of the cost of building a broadband network. In both cases it was that pledge of financial support from the county that enabled the borrowing of the remaining needed funds.

I. BACKGROUND RESEARCH

In this section of the report, CCG will look at the incumbent providers in the county, at the products and prices of existing service providers in the market, and at the impact of the Connect America Fund.

A. Incumbent Providers

The county has numerous incumbent cable and telephone companies service different parts of the county. Historic telephone service in the county was provided by a number of different incumbent providers. There are five independent telephone companies that serve some portion of the county. There is also service in the county provided by CenturyLink, which is one of the biggest telcos in the country and which purchased the companies that were once known as Qwest (and before that US West). There is also cable TV service in Glenwood provided by Charter (Spectrum).

Incumbent Telcos

A map showing the service areas of the incumbent telephone companies is included as Exhibit I.

CenturyLink is the third largest telephone company in the country with headquarters in Monroe, Louisiana. Several years ago the company purchased Qwest, which was formerly Mountain Bell and US West, and was part of the Bell Telephone system. The company provides service in Glenwood, Villard, and parts of the southern and central rural parts of the county. CenturyLink had annual revenues in 2016 of $17.5 billion.

As the incumbent provider, CenturyLink is considered the "provider of last resort" in its service areas. This means that CenturyLink is required to serve all residential and business customers for basic local services, and it must provide facilities to all customers. The rules that govern the way that CenturyLink serves customers in the county are embodied in their "General Customer Services Tariff," which is approved by the Minnesota Public Utilities Commission. This tariff contains all of the regulated products and prices, along with the terms and conditions under which CenturyLink will sell them to customers. The tariff sets forth rules for such customer service procedures as the manner and amount of customer deposits, the rules by which they will disconnect service for nonpayment, and the rules by which they will reconnect service. We'd like to note here that a recent trend is to get states to deregulate many services as competitive and take them out of the tariff; the Minnesota tariff has had many products removed in recent years.

As a telco, CenturyLink sells the full range of residential and business voice services. CenturyLink also sells data products. They sell traditional TDM voice services based upon multiples of T1s. They also sell high-speed DSL service. In rural markets, for the last decade CenturyLink has provided DSL speeds of between 1 and 15 Mbps. CenturyLink has been upping those speeds in some markets by installing new DSL equipment. For instance, in some parts of the Twin Cities CenturyLink now supports DSL products with speeds up to 25 Mbps. DSL speeds are advertised in terms of "up to" speeds and customers can get slower speeds than the speeds advertised. Some of the factors contributing to slower speeds include the distance the customer is from the CenturyLink central office, and the age and size of the copper wiring in a neighborhood. CenturyLink also builds fiber to some business customers and can sell a gigabit speed broadband.

In recent years CenturyLink has invested significant capital in improving data speeds in metropolitan areas. For example, in 2016 the company built fiber to pass 900,000 homes in major markets like Seattle, Phoenix, Denver and the Twin Cities. There is no expectation that they are ready to invest in fiber in smaller markets.

CenturyLink also offers cable TV where the broadband is fast enough. Under the Prism trademark they are delivering cable over bonded pairs of copper using DSL and IPTV technology. In most markets CenturyLink partners with DirecTV for a cable product. The CenturyLink technicians install the satellite service and CenturyLink bills for the DirecTV on the telco bill. They also give a bundling discount, making it cheaper to buy DirecTV through CenturyLink than buying it direct.

CenturyLink accepted money from the Connect America Fund (CAF II) to enhance the DSL in rural markets. However, according to the FCC website for the award of this money it's only going to benefit a few dozen homes in the far south end of the county. Those homes should be getting a DSL boost to at least 10 Mbps.

Federated Telephone Cooperative, part of Acira, has a small service area inside the county. There is a pocket of customers in the southwest corner of the county served by Federated out of a central office located in Hancock, MN. Federated is a cooperative, meaning it is customer owned. The company has built fiber-to-the-premise through its telephone service territory.

The company was awarded a Border-to-Border grant from DEED and is currently building fiber-to-the-premise to several communities and the surrounding rural areas of eastern Swift County, to the south of Pope County. In that project the Swift County government used bond money to make a significant loan to Federated to help finance the project. It's expected for those loans to be repaid from revenues of the project.

Hanson Communications. The telephone company in Starbuck operates under the name of Starbuck Telephone Company and is part of Hanson Communications. Hanson Communications owns telephone companies in Minnesota, South Dakota, Colorado, and Ohio. Altogether, Hanson Communications is the 55th largest incumbent telephone company in the country. Starbuck Telephone Company was one of the first telcos acquired by Hanson Communications, acquired in 1966. The company serves the town of Starbuck and the surrounding rural areas. The company plans to build fiber-to-the-premise in the Starbuck exchange within the next few years.

Runestone Telecom Association is a cooperative that is headquartered in Hoffman, MN and serves the communities of Barrett, Cyrus, Donnelly, Elbow Lake, Hoffman, Kensington, Lowry, Norcross, Tintah, and Wendell. The company has plans to build fiber-to-the-premise to much of their service area in the county over the next few years.

TDS Telecom is a midsized telephone company headquartered in Madison, WI. The company is the 7th largest incumbent telephone company in the country and has grown by acquiring numerous smaller telcos. In Pope County TDS purchased what used to be called Mid-State Telephone Company. The company has a significant presence in Minnesota with over 700,000 customers – the 3rd largest state for the company.

In larger towns and cities TDS has begun to build fiber to residences and offers speeds up to a gigabit. But in Pope County and in most smaller communities the company delivers broadband using DSL. In Pope County the company offers telephone service plus broadband over DSL. TDS plans to begin an upgrade to DSL in the Sedan, Terrance, and Brooten exchanges this year. Those upgrades are being funded in part by the ACAM program that is part of the federal Universal Service Fund. Those upgrades must cover 75% of homes in those service areas and be finished within ten years (2017 being the first year).

Cable TV Providers

Charter (Spectrum) Communications is the second largest cable TV company in the country with 25 million customers, just smaller than Comcast. The company reached that size through a 2016 acquisition of Time Warner Cable and Bright House Networks. The company is in the process of rebranding its triple-play products as 'Spectrum'.

In the study area considered by this report, Charter serves the city of Glenwood.

Charter was founded in 1993 and got its start as a cable company in 1995 when it acquired Cable South. Paul Allen, one of the founders of Microsoft, bought a controlling interest in the company in 1998. The company has continued to grow through acquisition, buying a dozen smaller cable systems over the next decade. The company went through a bankruptcy in 2009 and was able to walk away from $8 billion in debt, with the majority of the new shares going to Apollo Management. There have been continued rumors about the merger of the company with Verizon. Charter recently announced that they were partnering with Comcast to be able to provide cellular phone products in their service areas.

Dish Network is a large satellite provider and has customers in Pope County. The company has around 14 million customers nationwide and annual revenues of over $14 billion. The company has average customer revenues of over $80 per month. Dish Network can be bought as a standalone service and is also available as a bundle for CenturyLink customers.

Dish Network now also offers an Internet-based cable product branded as Sling TV. This service offers an abbreviated channel line-up and costs less than traditional cable products.

DirecTV is one of the largest cable providers in the US with more than 20 million customers. DirecTV merged with AT&T in 2015.

In Pope County, DirecTV is available as a standalone service and is also available as part of a service bundle with CenturyLink.

Other Broadband Providers

Gardonville Cooperative Telephone Association. This is a cooperative telephone company located in nearby Douglas County. They serve some customers in Pope County using point-to-multipoint wireless technology using unlicensed spectrum.

Satellite Data

There are a number of satellite providers available in the county. In each case, the availability depends upon the ability to have a clear line of sight from a satellite dish to the satellites. The top four providers in the country are Exede (which also markets under the name of Wildblue), HughesNet, DishNet, and StarBand. In general, there are several issues with using satellite broadband. First is latency, which means delay in the signal. 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 problems with any real-time applications such as streaming video, voice over IP, gaming, web sites that require real-time such as education courses and testing, or making connections to corporate WANs (for working at home). When the latency gets too high such services won't work at all. Any website or service that requires you to maintain a constant connection will perform poorly, if at all, with a satellite connection. The second biggest issue is the small data caps. These caps limit the amount of data a customer can download in a given month. All of the services require contracts of up to 2 years. Finally, the service can be expensive. Here is a short summary of the four providers:

Exede (Wildblue): Exede uses the newest satellite and uses technology that has meant a significant increase in download speeds. Exede touts speeds up to 17 Mbps download although customer reviews say the average speed is more like 12 Mbps. Still, that makes it the fastest satellite service. They also tout an upload speed of almost 5 Mbps.

Monthly plans range from $49.99 to $129.99 per month and vary by the size of the monthly data cap. There is also a $9.99 monthly fee for the modem as well as a $149.99 installation fee. The basic package comes with a monthly allowance of 10 gigabits of total download (same as the largest cellular plans). The premium service has a cap of 25 gigabits. This puts the price per gigabit at $5.50, about half the price of cellular data. Exede does allow unlimited download at night.

HughesNet: HughesNet is the oldest satellite provider. They have recently upgraded their satellites and now offer speeds advertised as 8 Mbps download and 0.4 Mbps upload. Their prices range from $49.99 to $129.99. The smallest package has a 10 gigabit download limit per month and the largest one is 20 gigabits. When including the $9.99 cost for the modem, the premium package equates to $7 per downloaded gigabit.

DishNet: DishNet is associated with Dish networks and can be bundled with their cable product. DishNet prices range from $49.99 to $79.99. They also charge $10 monthly for the modem. They have download speeds of 7 Mbps and upload at 0.8 Mbps. The monthly caps range from 10 gigabits per month on the smallest plan to 50 gigabits on the larger plan. For the largest plan, this works out to $1.80 per downloaded gigabit, making them the most affordable satellite provider.

StarBand: StarBand is a legacy satellite provider that works on older satellites. Their prices range from $59.99 to $119.99 with a $14.99 monthly charge for the modem. Their data caps range from 1 gigabit for the smallest plan up to 5 gigabits on the largest plan. That works out to a cost of $27 per downloaded gigabit for the largest plan, making them probably the most expensive broadband per gigabit in the country.

Future Satellite. There are several companies that are looking for the funding to build a newer satellite network using satellites placed in orbits much closer to the earth than the current satellites providing broadband. This would solve the latency issue discussed above.

The biggest company looking at this is Elon Musk. He already owns SpaceX, the company that is commercially launching satellites. Musk says it will require a $10 billion investment to build the satellite network.

The satellites would use frequencies between 10GHz and 30GHz, in the Ku and Ka bands. Musk says that SpaceX is designing every component from the satellites to earth gateways and customer receivers. There is a detailed filing with the FCC of his plans for the network at https://cdn.arstechnica.net/wp-content/uploads/2016/11/spacex-Technical-Attachment.pdf.

The specifications say that the network could produce gigabit links to customers, although that would require making simultaneous connections from several satellites to one single customer. And while each satellite has a lot of capacity, using them to provide gigabit links would chew up the available bandwidth in a hurry and would mean serving far fewer customers. It's more likely that the network will be used to provide speeds like 50 Mbps to 100 Mbps.

Those speeds could be revolutionary for rural America. The FCC and their CAF II program is currently spending $9 billion to bring faster DSL or cellular service to rural America with speeds that must be at least 10/1 Mbps. Musk says this whole venture will cost about $10 billion and could bring faster Internet not only to the US, but to the world. Still, at this point there is no way to guess if this will happen or if the satellites will operate as claimed.

Cellular Data

There are four primary cellular companies in the country—AT&T, Verizon, T-Mobile, and Sprint. Only Verizon and AT&T have wide coverage in rural counties like Pope, although there are exceptions.

We expect that some households in the county use their cellphone data plans for household broadband. There are several problems with this. First, customer speeds decrease with distance from a cellphone tower. Speeds for cellular data generally are not fast. There are two different cellular data standards in use: 3G and 4G. 3G data speeds are capped by the technology at 3.1 Mbps download and 0.5 Mbps upload. Most rural 4G networks operate at about 12 Mbps download and the upload varies by service provider. There are slightly faster 4G networks which have speeds up to about 25 Mbps download, which you might think of as 4.5G, but which are mostly available today in urban areas. For both of these standards, actual speeds in the field will vary by distance from the tower as well as by how busy a tower is, meaning actual speeds in rural areas tend to be fairly slow for most customers. Actual average 4G bandwidth in the country is just over 7 Mbps. But speeds in rural areas are largely determined by how far a customer is from a cell site.

While cellular data avoids the latency issue of satellite data, it is more expensive per downloaded gigabit than satellite data and for most customers will be slower.

B. Current Broadband and Other Prices

This section of the report examines the broadband prices available to customers today in the county. It used to be easy to analyze the prices of services. Just a few years ago you could go to the web and find the prices charged by any telco or cable provider, and except for the rare special, most customers in a given town paid about the same thing for service. This is no longer true. Most telco providers have removed their "standard" prices from the web and so there is no baseline cost you can compare. Further, companies have developed strategies to charge different rates to different customers.

We know from experience that prices will vary widely by customer. Over the years, customers have purchased various specials or other promotional pricing and might be charged differently than their neighbors. It seems almost counterintuitive, but the customers paying the most from most incumbents are those that have been with them the longest. This means that there is no longer anything that can be considered as a "standard" price in the market. Nevertheless, if you want to compete against these companies, you must understand that there will be a range of prices.

CenturyLink

CenturyLink is the incumbent telephone company in Glenwood, Villard, and surrounding rural areas. Historically the telephone rates they charged were filed under a tariff on file at the Minnesota Public Utilities Commission. A few years ago every one of their telephone customers in the county would have been billed exactly the same rate for the class of service they were using (residential and business rates are different). We would have been able to look at bills for Qwest at the time and would have seen the same rates for every resident. But CenturyLink now has bundling discounts and they also run specials, and so you will be able to find different telephone rates in town. Because telephone is so competitive, the tariffed rates are now generally viewed as the highest rate that CenturyLink can charge and there will be customers paying less than the tariff rate.

CenturyLink sells DSL for broadband and these rates have never been regulated. So the company has always been free to charge different rates to different customers for the same services.

CenturyLink does not directly offer cable TV, but they bundle DirecTV on the same bill.

Telephone Rates

Their basic 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 is allowed to charge whatever they want, within reason. The following rates were the last listing of the flat rate option, meaning a telephone line using these rates can make unlimited local calls. There used to be options available for customers who wanted to be able to make and pay for fewer local calls.

	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 a new FCC fee that is currently capped at $1 per month by the FCC, 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 were either sold a la carte or 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 features and they range in price from $2.95 to $8.50 per feature for residential service. These products are also now de-tariffed and CenturyLink can charge whatever it likes for these products.

CenturyLink DSL

CenturyLink sells high speed Internet 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. As discussed above, CenturyLink offers a lot of specials, with special rates available on their web site for new customers. But as typical with most big ISPs, a subscriber's rates will increase back to 'normal' rates at the end of a special promotion. Following are some of the rates charged for residential DSL. We say some of the rates because there are certainly going to be customers in the market on older specials that have different rates than these. Note that the quoted speeds offered by CenturyLink DSL are "best effort" speeds, meaning they are not guaranteed. In fact, rural customers typically get speeds significantly slower than the advertised speeds.

<u>Residential DSL</u>

CenturyLink currently advertises three special DSL products on their website. These are bundled prices that assume that the customer also buys a telephone line at the full regular price.

<u>Bundled Pricing (bundled with either telephone service or DirecTV)</u>

Fast	From 786k to 3 Mbps Download	$14.95 to $24.95 for a 1-year contract $39.95 Regular Pricing
Faster	From 7 Mbps to 12 Mbps	$29.95 for 1-year contract $39.95 Regular Pricing

Fastest Over 12 Mbps	$29.95 for 1-year contract $39.95 Regular Pricing

As you can see, all of the DSL has a regular price of $39.95 and the speed a customer can get is related to the specific DSL technology that is deployed in their area. In addition to the base price, CenturyLink charges $6.99 per month for a DSL modem. Customers can provide their own compatible modem to avoid the fee, but the web is full of cautionary tales of customers who were unable to get "compatible" modems to work for them.

Pure DSL

Pure DSL is CenturyLink's name for a DSL line that is not bundled with telephone or DirecTV. The CenturyLink website shows the following current prices for Pure DSL. A customer must sign a two-year contract to get the discounts. There is one price for the first year, a higher price for the second year, and after that the customer pays the list price:

	First 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 comes with the $6.99 CenturyLink DSL modem.

We don't expect that there is any DSL in the county faster than 12 Mbps. Generally the faster speeds are available only in the metropolitan markets.

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. Basically, CenturyLink will negotiate a price with a business customer based upon how many other products they purchase and also depending upon 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.

Federated Telephone Cooperative

The company mostly publishes only its bundled prices, which are as follows:

Simple Solution Basic cable and phone	$46.95
Basic Solution Expanded basic cable and phone	$77.95
Surfer Solution 20 Mbps broadband and phone	$71.95
10 Mbps broadband standalone	$59.95
Tech Solution 10 Mbps broadband and expanded basic TV	$109.95
Connected Solution 20 Mbps broadband, basic cable and phone	$97.95
Scholar Solution 20 Mbps broadband and phone	$126.95

Long Distance

Telephone in the bundles come with no long distance, which can be purchased at the following prices:

Per Minute	$0.10
60-minute bundle	$5.95
350-minute bundle	$26.95

Business Broadband	Monthly	3-Year Contract
5 Mbps	$109.95	$69.95
10 Mbps	$119.95	$79.95
15 Mbps	$139.95	$99.95
20 Mbps	$149.95	$109.95
30 Mbps	$169.95	$129.95
50 Mbps	$179.95	$139.95

Plus, there is an additional $40 discount for bundling with other products.

Runestone Telecom Association

Their prices obtained from their website are as follows:

<u>Telephone</u>

Basic Line	$18

(Same price for residences and businesses. They also charge a subscriber line charge of $6.50)

Features sold separately and not included in the basic line:

Caller ID	$4.00
Caller name and number	$6.00
Voice mail options	$3.95 to $8.95
Many other features	$1.00 each
Long Distance	$0.14 per minute

<u>Broadband (on fiber)</u>

7 Mbps	$56.95
15 Mbps	$61.95
30 Mbps	$66.95
50 Mbps	$74.95
100 Mbps	$105.95
300 Mbps	$130.95
1 Gbps	$154.95
Installation	$35.00
Managed WiFi	$3.95

Television

Basic	$25.95
Expanded Basic	$60.29
Digital Package with Music	$8.00
The Works	$101.14
HBO	$15.95
Cinemax	$7.95
Starz	$10.95

Hanson Communications

Product prices from their website:

Telephone

Basic Line	$18.00

(Same price for residences and businesses. They also charge a subscriber line charge of $6.50)

Per minute long distance	$4.95 per month plus 7 cents per minute
Unlimited long distance - Res	$14.95
Unlimited long distance – Bus	$25.00

Broadband (on DSL)

Same for res and bus	$43.95

TDS

The company does not publish its prices on its website. They are not required to do so and are like many telcos that only give out pricing over the phone to somebody who lives in their service area.

About all we know about their products and prices is that they advertise on their website that DSL in markets like Pope County have speeds up to 15 Mbps. But it would not be unusual in a county like yours for equipment to be older and speeds slower than this.

Charter (Spectrum)

While Charter is a giant company their pricing structure is one of the simplest in the country. The company is going through some major turmoil in that they are moving prices in the recently acquired Time Warner markets to Charter prices, which in many cases are higher, especially since Time Warner was generous in handing out continuing specials and promotions.

Broadband Pricing

The company currently has only two broadband products. The base product offers speeds up to 60 Mbps, with the caveat that in smaller and older markets the speeds might be less than that. They also have a premium service at 100 Mbps which is mostly available in metropolitan areas. The company has also announced that they are making the upgrades to DOCSIS 3.1 that will allow them to offer speeds as high as 1 gigabit. They have not yet announced any pricing for the faster products.

Pricing is as follows:

Charter Internet (60 Mbps)	
Advertised Promotion Price	$29.99
Regular Price	$39.99
(Product includes mandatory activation fee of $49.99)	
Ultra Internet	
Advertised Promotion Price	$89
Regular Price	$99
(Product includes a $199 activation fee)	

Charter does not charge for a cable modem. They are the only large company not to do so and compare this to Comcast which charges $10 a month for the modem. They will charge a one-time activation fee of $9.99 plus $5 month for their WiFi router.

There are no data caps on broadband monthly download.

Telephone Pricing

Residential Telephone Service is only available as part of a bundle and not as a standalone product. Depending upon the bundle, the voice product which comes with the most popular features adds $10 to $15 per month to the cost of a bundle.

Cable TV Pricing

Charter's TV pricing is as follows:

Basic Cable $23.99

Expanded Basic $52.99

Charter TV Select $62.99
Spectrum Select $64.99
These two packages add some additional digital channels to the expanded basic package.

Spectrum Silver $84.99
Is Spectrum Select plus one additional digital tier plus HBO, Showtime, and Cinemax.

Spectrum Gold $104.99
Adds The Movie Channel, Starz, and EPIX to the Spectrum Silver.

There are also numerous other ways to add digital tiers, foreign language programming, and premium channels.

There is a fee called a Broadcast Service Charge of $6.05 per month that is add to all of the TV prices list above.

They also offer inside wire maintenance for $4.99 per month

There is monthly fee of $3.99 to $5.00 (depends on the package) per month per settop box. A DVR-capable box is $11.99 per month.

An interactive guide is $6.99 per month.

This product offering is the opposite of the company's broadband offering. It's complex with a lot of options. And unexpected and hidden fees can really inflate a cable bill.

Cellular Data

Cellular data is some of the most expensive broadband in the US. Most data plans charge about $10 per downloaded gigabit of data. To put that into perspective, about 25% of US households now routinely download over 100 gigabits of data per month, mostly video. Comcast says that 10% of their customers download over 300 gigabits per month. If billed at cellular data prices, 100 gigabits would cost over $1,000 per month (and there have been reports from people living in rural areas who have gotten gigantic bills from the cellular providers).

In the last few months AT&T began offering fixed cellular data products in some markets. This is not available everywhere, and even where it has been rolled out it doesn't seem to be available at every tower, meaning they might be offering this only at cell sites where they have excess cellular capacity.

These new products are not advertised on the AT&T web site. But I know somebody that just signed up for a fixed cellular plan for $60 per month that includes a 250 GB data cap. For $100 per month AT&T will raise the cap to 500 GB. These plans don't offer any faster speed than what is available to any cellphone user in an area, but instead just increase the data cap for home usage of the broadband. AT&T installs a small dish on the home to receive the broadband. Since this new product hasn't gotten a lot of press there is no way yet to know if this will be offered nationwide or just where AT&T is the incumbent telco.

For homes with no other broadband alternatives this will at least provide a sizable monthly data allowance, even though rural cellular speeds are often slow and will vary depending on how far a customer lives from a cell tower.

Satellite Data

Satellite data is very expensive, but not quite as costly as cellular data. The best broadband prices for downloading 1 gigabit of data from the four major satellite providers are: Exede at $5.50 per gigabit, HughesNet at $7.00, DishNet at $1.80, and StarBand at an incredible $27. All of them have tiny monthly data caps and they generally cut a customer off for the rest of the month once the cap is hit.

C. The Connect America Fund

There are two federal broadband programs that come from the Connect America Fund, which is part of the FCC's Universal Service Fund. Funding from these two programs will be used to improve broadband in some parts of the county.

The Universal Service Fund today is funded primarily from surcharges on telephony revenues. Originally, the USF was funded by surcharges on landline telephones and special access circuits only, but eventually a surcharge was also placed on cellphones.

The first program is aimed at the largest telcos like CenturyLink and is called Connect America Fund II (CAF II). The FCC has set aside $1.7 billion per year for the six years starting with 2016 to build or upgrade rural broadband. These funds were made available to census blocks that have little or no broadband today.

There is only a little CAF II funding coming to Pope County. CenturyLink accepted funding of $33,275 per year for the six years to bring better broadband to a few dozen households located along the southern border of the county. CenturyLink is likely to use the money to improve DSL to those customers. CAF II requires that customers must be upgraded to data speeds of at least 10 Mbps download and 1 Mbps upload. Note that those speeds are far slower than the FCC's own definition of broadband—25 Mbps download and 3 Mbps upload.

The other Connect America Fund program has a much greater impact on the county. The program is called ACAM and can be awarded to the smaller telcos in the country. Companies accepting the ACAM funding have ten years to use the funding, with 2017 to be the first year. The following companies have accepted ACAM funding in the county:

- Runestone will be using the ACAM funding to finish building fiber-to-the-premises in their service territory.
- Hanson Communications (Starbuck Telephone) has accepted ACAM money and plans to build fiber in the Starbuck area.
- TDS (Mid-States) accepted ACAM funding and plans to improve DSL in the Sedan, Terance and Brooten areas.

D. The Consequences of Poor Broadband

As the county is already aware, there is a glaring lack of broadband in a lot of the rural parts of the county. The homes without access to adequate broadband represent almost half of the households in the county, so this is a significant issue.

We found a unique situation in the county—there is a significant amount of rural fiber already built in the county today (or being built over the next few years). This means the county will become a mixture of fiber "haves" and "have nots" often living within proximity to each other. For example, Starbuck and a number of rural customers will be getting fiber while Glenwood, Villard, Sedan, and a significant part of the eastern two-thirds of the county will not. Glenwood has broadband today provided by both Charter (Spectrum) and CenturyLink.

It's also important to note that a lot of the rural customers in the county have no good broadband options today. For example, Charter's cable network in Glenwood only serves where the network has been built and anybody outside that footprint, even by a very short distance, can't get cable modem broadband. CenturyLink's DSL extends for a few miles from locations that have a DSL hub, but the speeds drop drastically with distance and the DSL that can be bought in some parts of the county is not significantly faster than dial-up. There are some rural customers that can get fixed wireless service provided by point-to-multipoint radios. The quality of this broadband can vary widely around the states; we've seen speeds as slow as 1 Mbps or as fast as 50 Mbps. Customers that can't get any of these products are left with buying satellite broadband, using their cellphones for broadband, or having no broadband at home.

There are significant economic implications for having parts of the county without good broadband. Lack of broadband causes all kinds of problems for rural homeowners including:

- Lower Property Values: There are now 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. This means it is going to become hard to attract people to live in the rural parts of the county and, more significantly, homes without broadband are going to become harder to sell. Without a broadband solution, the rural parts of the county are going to 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.

  In Pope County, this might mean that the rural areas without broadband will fare poorly over time compared to those parts of the county with good broadband. It is likely to become easier to sell a home or to build a new home where there is fiber. And it is likely that this will lower the property values in the areas without broadband.

  This also has implications for economic development. For example, it's not hard to foresee companies that would rather operate in a part of the county that has fiber rather than locating in Glenwood if it doesn't get fiber. That is generally contrary to the way that counties want to attract businesses and possibly changes the nature of the business community.

- Education: It's incredibly hard to raise kids today in a home without adequate broadband. The issue is not just data speeds, but also the total amount of data that even elementary students have to download. For example, some satellite broadband providers have speeds up to 15 Mbps, but the plans have tiny data caps that make it impractical for a home with children. The same is true with cellular data; we have heard horror stories of people with kids ending up with astronomical broadband bills for using broadband from cellphones for home use.

  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 video in class. The whole education process is increasingly moving to the web and kids without access to the web are lacking the tools that their peers take for granted.

- Working at Home: More and more jobs today can be done at home, even if only part time, but people living without adequate 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.

  Many of your residents commute to jobs in other counties and many of those employers would allow commuters to work a few days a week from home if they had an adequate broadband connection. Telecommuting is good for everybody. Avoiding a commute to a distant office saves a lot of money for employees. 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. Commuting is also a greener alternative, saving a lot of gasoline and cutting down on carbon dioxide emissions.

- 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, shopping at sites that have videos, 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.

- Medical: There has been talk for well over a decade of the Internet improving medical care in rural areas and for the elderly. We are finally starting to see some of this come to pass. There are now the beginnings of telemedicine in rural Minnesota and other rural areas where patients are able to connect to specialists in the urban areas without having to make the long drive in for an appointment. We now see support for children with special needs being provided by Skype. Over the next decade, telemedicine is expected to become routine. For residents without good broadband in their homes, telemedicine is being done from doctor's offices in county seats and other towns with broadband.

  In the last few years there have been over 100 start-up companies exploring technologies that will allow people to stay in their home longer as they age. Most of the new technologies being explored involve the use of real broadband. There are dozens of different approaches being investigated and it's certain that some of these technologies will be in play within the coming decade. This is one use of broadband that looks to be sufficiently funded because these new technologies are competing with the extraordinarily high cost of moving elderly people to institutional care.

- Agriculture. The whole agriculture industry is relying on broadband to a significant degree. There are numerous new inventions like drone farm equipment, sensors that monitor crops or livestock, or useful software services in the cloud that are of huge benefit to farmers.

- Future Services: The broadband world isn't standing still and the need for broadband has been growing at an exponential rate since the mid-90s. Residences in the US have doubled the amount of bandwidth they use about every three years since 1995, and that trend is expected to continue at this pace for the foreseeable future. To put this into perspective, if a home needs 6 Mbps download today to be happy (a typical DSL speed), then nine years from now that same house is likely going to want 48 Mbps download speeds (doubles three times).

  It's hard for people to visualize the impact of anything that grows at an exponential rate. Look around at other things that increase at exponential rates. Computer processing speed has been doubling about every 18 months since the early 60s. This phenomenon is known as Moore's law, named for the engineer who noticed it. It is this exponential growth that means that the computing power in your smart phone is far faster than the best PC you could buy for your home a decade ago. Because of exponential growth, your smartphone is now far more powerful than the best supercomputer of twenty years ago.

  Every industry expert expects the need for broadband to keep growing. Every year the size and the amount of things we do online grows—the files and programs we connect to become larger and the download speeds needed to be effective grow. It's been that way since we've gotten online and there is no end in sight for new uses for broadband. As just one example, both Netflix and Amazon now offer customers the ability watch video in the 4K format, which requires 8 times more bandwidth than HD video.

  It's not just video that's causing the bandwidth growth. Everything we do online takes more bandwidth over time. Files get larger, web pages get busier, and we use more and more applications at the same time. As an example, when social media sites began embedding video in the last few years the bandwidth needed to be on a service like Facebook grew much larger.

  Another growing area of broadband usage is surveillance cameras. These are particularly useful on farms to allow for monitoring of animals and remote parts of the property. We are just now starting to see the use of smart home devices—things in the homes that connect to the internet. Just this Christmas saw the release of virtual reality headsets for the first time—the precursors for home devices that will allow for immersive entertainment similar to the Start Trek holodecks—and big users of bandwidth.

  These things are just the beginning. There are future things still on the drawing boards. Just as we couldn't have known 20 years ago how the Internet would change our lives and our homes, we can't imagine today all that's coming in the next 20 years.

II. ENGINEERING DESIGN AND COSTS

Finley Engineering did the engineering analysis and prepared a cost estimate of the cost of building broadband in unserved and underserved parts of the county. There were three engineering solutions considered:

- Build fiber everywhere in the study area.
- Build fiber to Glenwood, Villard, Sedan, and to homes near the proposed fiber routes with everybody else served with point-to-multipoint wireless broadband.
- Same as the option above but exclude Glenwood.

A. Network Design

Following is a description of the data we gathered and the approach we took to the engineering analysis.

Study Area

The county elected to look at a study that brings broadband 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. This means that the following areas were not included in the study:

- Danvers and Hancock exchanges served by Federated Telephone Cooperative. These areas are currently served by a Fiber to the Home Network and are listed as served by the MN Deed office maps.
- Cyrus, Kensington, and Lowry exchanges served by Runestone Telecom Association. These areas are currently served or will soon be served by a Fiber to the Home Network and are listed as served by the MN Deed office maps.
- The city of Starbuck. Mediacom is currently advertising download speeds over 100Mbps and is listed as served by the MN Deed office maps.

The study area includes the rest of the county. For purposes of determining the cost of a broadband network, the analysis was done for the following portions of the county:

- The City of Glenwood
- Villard, Sedan, and areas around that lake where homes are relatively dense and located close to roads
- The rural parts of the county.

Passings: The telecom industry uses the term passing to mean any home or business that is near enough to a network to be a potential customer. We verified passings through the use of county GIS information that showed us the location of all occupied buildings in the study area. We determined that the number of passings are as follows:

City of Glenwood	929
Villard, Sedan, and around lake	1,412
Rural	2,285
Total	4,626

Road Miles: Analysis of the GIS data and also MDOT maps show that there are about 765 miles of streets and roads in the study area. These are roads that 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 all of these roads. It's likely that in a detailed design some efficiencies could be found that would result in small reductions in the road miles that need fiber.

Basic Network Design

Fiber Backbone

All three network designs utilize the construction of a backbone fiber. A map of the proposed fiber ring is shown as Exhibit III. The purpose of the fiber ring is to provide a redundant path to bring fiber signal to and from either fiber nodes or wireless towers in the different network configurations.

The ring we have chosen is 67.6 miles long. Obviously other routes could be chosen to reach the same or similar locations.

It's possible that if the county was served by edging out from the current service territories of one or more telcos, or if only a portion of the county was going to get broadband, that the ring might not be needed. However, in a full fiber build these same roads would still require fiber, so there would be no significant savings or change in overall price from eliminating the ring or taking down different roads. The ring fiber would be self-healing, meaning that the network would stay functional in the event of a fiber cut.

A ring design was chosen since it would be able to feed either FTTP huts or wireless towers depending upon the design chosen. The design placed huts at the following six locations to house equipment and fiber optic splitters for distribution to subscribers. Again, the buildings could be located elsewhere, but we think six nodes are the best design for reaching all homes with fiber.

1. Glenwood North – located North of Minnesota Avenue in Glenwood and would serve the north half of Glenwood and rural subscribers.
2. Glenwood South – located South of Minnesota Avenue in Glenwood and would serve the south half of Glenwood and rural subscribers.
3. Villard – located on the southern edge of Villard and would serve Villard and rural subscribers.
4. Bangor – located on County Hwy 8 between Lake Johanna and Gilchrist Lake and would serve rural subscribers.
5. Barness – located south of Starbuck near the intersection of 295th Avenue and 270th St and would serve rural subscribers.
6. White Bear – located north of Starbuck on 180th St and 280th Avenue and would serve rural subscribers.

In all scenarios, we based pricing upon recent quotes received from vendors like Calix, AdTran, Clearfield, Cyan, and others. Finley is not proposing any specific vendors as we are vendor neutral. The costs chosen are representative of current electronic costs.

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

Fiber Drops

The primary reason that the study was broken into separate study areas is due to the length of fiber drops. We found that the average length of the drops in Glenwood, Villard, Sedan, and areas around the lake had relative short drops with an average length of 100 feet. But in the rest of the county the average length of fiber drops looks to be about 750 feet and there are numerous homes that are located far off of roads. This is one of the longest average loop lengths we have ever seen and it adds considerably to the cost of building to homes in the rural areas. In terms of quantities, we assumed the 100 foot drop length for 2,341 passings and the longer 750 foot drops for 2,285 passings.

The All-Fiber Network Scenario

The first option studied was 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 design of the fiber electronics.

Since we don’t know if one or more of the existing telcos in the area might build broadband to the study area, we designed a network for the whole study area that stands on its own in terms of a design. As mentioned earlier, that design assumes a fiber ring and also the construction of six fiber huts to hold electronics.

However, should the existing telcos build out from existing fiber networks there would likely be some savings from our cost estimates. For example, a network might be designed with fewer needed huts if existing huts could be utilized. If the network was designed without a fiber ring there could be savings on the ring electronics.

We took the most conservative approach to the design. The network has been designed as if only one service provider would serve the whole area. In doing so we have not started with any assumption that there are existing fiber assets that might benefit the fiber build. This means that our estimated costs are, by definition, conservatively high.

In Pope County, the soil is relatively soft and deep and allows for relatively easy construction for buried fiber (as opposed to places with a lot of rocks). 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.

For electronics, the first design issue to consider is whether to centralize or distribute the electronics in the network. The second design issue looks at using a star versus a ring topology. A third issue in the design is to determine whether to use distributed splitter locations or local convergence points for splitter locations.

In the all-fiber study, we chose the locations of the huts so that no customer was more than 12 miles away from a hut, the maximum recommended distance for a signal on a FTTP network. That is 12 miles of fiber along a road, not a 12-mile circle. The study shows the need for six huts to act as PON local originating points.

The design uses huts for the FTTP remote sites. These huts are large enough hold all of the needed electronics and fiber splitters. The huts are air-conditioned and normally are put on a small plot of land and put behind a fence for security. At wireless tower sites we used smaller cabinets rather than huts since the electronics are smaller than at fiber hubs.

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. The major difference in the two technologies is the number of lasers in the network. In a PON network, one laser in a hut can light up to 64 home lasers (although it’s more typical to light no more than 32). With active Ethernet there must be one laser in a hut for every laser at a home or business.

The cost of the network was determined using the pricing for PON electronics. This allows for delivery of up to 1 gigabit of downstream data to customers today and ought to be upgradable in the near future to 10 gigabits. There are not likely to be any customers in the rural parts of the county that would insist on having a dedicated Ethernet feed, which requires active Ethernet technology. An end user will want a dedicated feed when they don’t want to share bandwidth with other customers anywhere in the network, and that sort of requirement is generally only made by very large data users, like a school system, or security-conscious customers like a military or government building. In today’s market the cost of using active Ethernet probably adds at least 15% to the cost of the network.

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 a 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.

When designing FTTP networks, there are options for how many customers to serve from one neighborhood fiber point. The technology will allow up to 64 customers to share a PON system. Since there are not many customers in the rural areas, the rural network was designed with a 1x16 fiber split while Glenwood was designed with a 1x32 fiber split. Having a lower split allows the signal to travel farther. If in the final design there are a few customers more than 12 miles from a hut they could be accommodated by placing them on a fiber that has a split of 1x8 or even lower.

Customer Electronics

The customer electronic device used to serve customers in a PON network is referred to in the industry as an ONT (Optical Network Terminal). This is an electronic device that contains a laser and which can connect to the fiber optic signal using light from the network and convert that signal to 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 and so the study doesn't choose between the two types of units.

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.

Hybrid Fiber and Wireless Network (Hybrid 1)

We next considered a hybrid network. This network built fiber to the homes in Glenwood, Villard, and Sedan. It also build fiber to homes and businesses that are located along the proposed fiber ring (292 passings). The design then assumes that other customers would be served using point-to-multipoint wireless technology.

The wireless network begins by assuming nearly the same fiber backbone route as in the all-fiber study. There would be a few short lateral fibers built to get to existing tower sites. We see the following benefits for this network design:

- The ultimate goal of the county is to find a way to serve all homes and businesses in the county with fiber. Building a ring provides the basis for future fiber expansion even if some parts of the county start using wireless technology.
- A design that includes a fiber ring to serve the wireless towers will pass 292 homes and businesses for the routes we chose. We've seen several DEED grants that received funding to serve customers along similar backbone fibers.

- Fiber allows the delivery of large amounts of bandwidth to the towers, which then results in the highest quality wireless product. While it is possible to feed towers with point-to-point wireless radios instead of fiber, these connections are not as robust or reliable as fiber. With a fiber network the amount of bandwidth that can be delivered to a given tower is nearly unlimited, which will be important as wireless technology improves over time.
- Fiber networks are generally among the most reliable components of modern networks. Usually the electronics on a fiber network are designed with redundant switchover, meaning that the network can quickly heal itself in case of an electronics failure. In addition, other than an occasional fiber cut, the fiber is generally reliable. Wireless backhaul systems are also reliable, but not as reliable as fiber systems.

The wireless network was designed with 6 total towers. This includes leasing space on three existing towers (White Bear, Glenwood, and Westport) and building three new towers at Bangor, Barness, and Sedan. Since it's possible that an operator might be unable to get onto one of the existing towers we've included sufficient contingency in our pricing to accommodate building another tower if needed.

These locations were used in the study to create a network that is capable of being within 6 airline miles of each potential customer. We have included a propagation map of wireless coverage as Exhibit IV. Before building an actual network we would highly recommend doing a more detailed propagation study to determine the optimum location of the new towers. Such a study would consider trees and other details not included in our study.

For this kind of network, the towers should be as tall as possible because the taller they are, the easier it is to see down to homes. Any tower that is taller than 190 feet must be registered with the FCC and meet some additional obligations (such as having a blinking light on the top). The towers included in this study are 300 feet tall. But again, with final engineering, the heights could be changed if needed for any or all towers. Finley determined that the cost to change the height of a tower would add $86,500 per tower to instead build 400-foot-tall towers, or decrease by $46,500 per tower to build a 200-foot tower.

At each tower is a set of radio transmitters and receivers that will communicate with customers. Each tower site has more than one transmitter and each transmitter is designed to transmit in a 60 to 120 degree path, called a sector. Thus, it takes at least three transmitters to serve the full circle around one base station. Each sector can comfortably handle a set number of point-to-multipoint connections, and so multiple sectors means the ability to serve more customers.

We are always asked how fast the customer broadband connections are in a network, and in this kind of network the answer is: it depends. As mentioned earlier, the two most important limiting factors affecting data speeds are the specific spectrum being used and the distance between a customer and a tower, with customers who are close capable of getting faster speeds than those who are farther away. The overall goal with our design was to try to design a network capable of delivering 25 Mbps or more to customers.

There are several different frequencies of radios that can be used for the wireless deployment.

- The primary frequency used for this technology today is WiFi. This is the same WiFi frequency used to deliver broadband inside homes. WiFi is really two frequencies – one at 2.4 GHz and another band at 5 GHz. Probably the biggest advantage of WiFi in this use is to use each frequency to serve different customers – matching each customer to the one that gives them the best signal.

- New radios also often include the 3.65 GHz frequency that was recently approved for rural broadband by the FCC. There are several advantages of this frequency over WiFi. First, the channels in this frequency naturally allow for greater bandwidth delivery. The 3.65 GHz frequency handles trees much better than WiFi. But no frequency is perfect with foliage and some customers, particularly those farther away from the tower, might need to take some steps like cutting down trees to improve reception.
- Radios used for this purpose today are largely software tunable and we envision networks that use both 3.65 GHz and WiFi, and which might be able to accommodate future frequencies allowed by the FCC.
- There is another wireless technology that will be available in a few years for rural wireless broadband. The frequency is referred to as white space radio and uses the same frequencies that are deployed by UHF television channels (channels above channel 13). The FCC recently finished an auction where TV stations offered up their frequencies which were then sold in an auction to bidders. The frequencies were bought by the wireless carriers like T-Mobile and AT&T. Dish Networks also bought spectrum. The surprise buyer was Comcast which is now entering the wireless business and has announced partnering with Charter to do so.

  Now that the auction is over it is expected that the FCC will release some portions of this spectrum for public use. The benefit of this frequency is that it can carry a larger data signal (wider channels) as well as travel farther than existing frequencies. This frequency is not going to be available everywhere in the US, but the areas where it's likely to not be available are mostly near the oceans since some of this frequency is used by the Navy. The promise of the white space frequency is that it probably could be used to serve 50 Mbps service to about the same number of customers on a 3.65 MHz network getting 20 Mbps.

Another side benefit of wireless networks is that they don't care about political boundaries, and so it is likely that a network would be able to pick up some customers outside the county. The 6-mile radius is only a limitation for delivering quality bandwidth. Many wireless companies sell slower products at greater distances; there might be many customers 10 miles from a tower willing to pay for 5 Mbps broadband if all they can get today is dial-up. So there could be some small amount of additional revenue available that is not reflected in the business plan.

There would be some capital savings to replacing the fiber ring with point-to-point microwave links. Such a network would not deliver as much bandwidth to the towers as fiber which would result in slower customer data speeds.

Hybrid Fiber and Wireless Network (Hybrid 2)

This version of the study is the same as Hybrid one described above except that it excludes serving Glenwood. We know from working with small telcos in the past that many of them are uncomfortable competing in towns with decent broadband, and so we this version excludes Glenwood which has decent cable modem service from Charter (Spectrum).

We had several customers in Glenwood take speed tests and we saw actual speed of nearly 60 Mbps download. As described elsewhere in this report Charter has a simple broadband structure and that is their basic speed. The company has also announced that they will be bringing speeds as high as 1 Gbps to all of their Minnesota properties.

Product Assumptions

We assumed that the all-fiber network would be capable of delivering the triple play products of broadband, telephone, and cable TV. We have assumed that the wireless customers would not be able to receive cable TV but could get VoIP.

Other Capital Costs and Considerations

Following are some of the additional capital costs that we considered in the financial models.

Triple Play Capital

The studies all assume that any ISP that builds to these rural areas would either already be delivering the triple play elsewhere or else would be able to buy these services from one of the existing ISPs in the area. We already know that a rural business as small as this one would not be able to support the construction of a large headend building, a full cable TV headend, a telephone switch, and the other assets needed to provide those products.

The business plans include the electronics needed at the customer location to provide services. For example, in the versions that assume the delivery of cable TV, there are settop boxes provided to customers. There are also voice gateways provided to deliver Voice over IP (VoIP). These are small boxes that allow the use of existing telephone wiring and telephones served from a broadband network, nearly identical to the little devices supplied with VoIP services like Vonage.

Other Assets: The business plan also includes the other assets needed to operate a triple play business. This would include new vehicles for the outside technician. The business plan includes a computer for every employee along with furniture and office equipment.

Inventory/Spares: The business plan includes inventory. This inventory consists spare fiber, settop boxes, ONTs, and spare cards for all the electronics.

Battery Backup: Historically, engineers designed many FTTH networks with battery backup for the ONT. However, many small fiber providers have stopped providing batteries. The batteries were installed to provide power to telephones in the case of a power outage at the home. However, there are fewer and fewer phones in existence that are powered from the phone line and most phones must be plugged into an outlet. When such a phone loses power it can’t be powered by the battery. Our design does not include a battery backup, but a provider could provide optional batteries for customers who really want one.

In one of the oddest rulings we have ever seen out of the FCC, in 2015 they ordered that every voice provider must offer a battery backup solution for customers that buy telephone service that is not delivered on copper. Here is what the FCC ordered:

- The ruling only covers residential fixed voice services that do not provide line power (which is done by telephone copper). This does not apply to business customers.
- The back-up power must include power for all provider-furnished equipment and anything else at the customer location that must be powered to provide 911 service.
- From the effective date, companies must describe to each new customer, plus to every existing customer, annually the following:
    - The solutions offered by the company to provide 8 hours of backup for phone service, including the cost and availability.
    - Description of how the customer's service would be affected by loss of power.
    - Description of how to maintain the provided backup solution and the warranties provided by the company.
    - How the customer can test the backup system.
- Within three years of the effective date of the order, a provider must provide a back-up solution that is good for 24 hours and follow the above rules.
- What all of this means is that in the future, providers will be required to offer an optional battery backup plan for customers, but they will be able to charge enough to recover their costs. We have not included this cost in the study since the assumption is that the business would be able to charge the full cost of buying any such optional battery backup systems to the customer.

B. Network Cost Estimates

Following are the cost estimates for constructing the network and the other assets needed for each business plan scenario.

Capital Assumptions in the Study

Capital is the industry term for the assets required to operate the business. The capital expenditures predicted in these models reflect the results of the engineering studies referenced in Section II of the report. The launch of a broadband network requires a significant investment in the fiber network and electronics and this is by far the biggest cost of getting into the business.

Below is a summary of the specific capital assets needed for each base scenario. The amount of capital investment required varies by the technology used as well as by the number of customers covered by a given scenario.

Telecom capital includes several broad categories of equipment including fiber cable, electronics for FTTH, huts and wireless towers, wireless electronics, and customer devices like cable settop boxes, VoIP gateways, and WiFi modems. In addition to capital needed for the network, there are operational capital costs predicted for assets like furniture, buildings, computers, vehicles, tools, inventory, and capitalized software.

We have tried to be realistic in our estimates so that hopefully the actual cost of construction will be something lower than our projections. One way we were conservative was by including a 10% construction contingency in the cost of the primary assets to cover any cost overruns.

However, it is important to remember that our estimates are very high level. Generally the type of estimate made here, which is our best guess at the total cost of each asset, is good enough to see if it makes sense to move forward and consider these projects in more depth.

We have assumed that there is capitalized labor in several of the asset cost estimates. Capitalized labor is when a company uses its own employees to build an asset and then adds the cost of those employees into the cost of the asset. It has been assumed that there would be employees and/or temporary installers involved in installing service for some fiber and wireless customers (although in the initial construction this would mostly be done by contractors).

The studies all assume that the provider of service will not build a new cable TV headend or buy a new voice switch for the provision of cable TV or telephone service. If the new provider is an ISP that already offers those products elsewhere, the assumption is that they would transport in the products over the fiber backbone.

One major category of capital cost in the study is the cost of fiber drops. These are the fiber connection from the street to the home or business. In looking at the cost of drops we divided the study area into three regions – Glenwood, the areas around the lake and smaller towns, and very rural customers. Finley Engineering estimates that the average length of the rural drops is 750 feet, which is longer than what we normally see. This means that in the rural parts of the county homes and businesses are located at a significant distance from the road. We don’t see that everywhere and in some counties customers live close to roads even in rural areas. The consequence of the longer length of rural drops is a higher cost for loops than we often see elsewhere and is a significant factor in driving the cost of the network in Pope County. We note that the long drops are avoided in the scenarios where rural customers are served with wireless – one of the factors leading to those scenarios that have much lower capital costs.

Following is the capital required for the base case for each of the three scenarios at a 60% customer penetration. These represent the capital expended during the first four years, which for most projects are covered by borrowing before the business becomes cash positive. The capital costs would be higher or lower if there were greater or fewer customers than the 60% used to calculate these figures.

Fiber Everywhere

	Base
Land	$ 120,000
Vehicles	$ 70,875
Tools	$ 50,000
Buildings	$ 395,094
Furniture	$ 6,750
Computers	$ 18,273
Voice Gateways	$ 83,880
Data Routers/Switches	$ 125,000
Settop Boxes	$ 445,329

Fiber Electronics	$ 2,493,794
Fiber Drops	$ 6,231,774
Fiber Network	$19,091,246
Inventory	$ 50,000
Capitalized Software	$ 89,335
Total	$29,271,350

Hybrid 1

	Base
Land	$ 120,000
Vehicles	$ 70,875
Tools	$ 50,000
Towers/Huts	$1,172,029
Furniture	$ 6,750
Computers	$ 18,273
Voice Gateways	$ 83,880
Data Routers/Switches	$ 125,000
Settop Boxes	$ 131,917
Fiber Electronics	$ 654,039
Wireless Electronics	$ 726,516
Fiber Drops	$1,074,147
Fiber Network	$4,577,690
Inventory	$ 50,000
Capitalized Software	$ 89,335
Total	$8,950,451

Hybrid 2 – No Glenwood

	Base
Land	$ 120,000
Vehicles	$ 70,875
Tools	$ 50,000
Towers/Huts	$1,172,029
Furniture	$ 6,000
Computers	$ 15,090
Voice Gateways	$ 63,270
Data Routers/Switches	$ 125,000
Settop Boxes	$ 41,180
Fiber Electronics	$ 478,628
Wireless Electronics	$ 757,105
Fiber Drops	$ 587,727
Fiber Network	$2,912,490
Inventory	$ 50,000
Capitalized Software	$ 86,375
Total	$6,535,769

Fiber Costs

In all of the options the most significant cost is the cost of fiber. Finley has significant and recent experience in designing and building fiber in rural Minnesota. The estimated cost to build fiber in Pope County is based upon this recent experience.

For each type of construction, separate estimates were made for fiber materials, labor, splicing, and miscellaneous costs. Miscellaneous costs include such things as manholes, handholes, or other methods of providing access to the fiber.

The estimated costs for building the fiber for the three different options are as follows. Not included in the below costs are engineering as well as a 10% construction contingency included in the business models to be conservative.

All-Buried FTTH Option

	Buried
Fiber	$ 5,664,808
Labor	$ 9,271,002
Engineering	$ 2,240,371
Contingency	$ 1,915,065
Total	$19,091,246
Miles	765
Cost/Mile	$24,956

Hybrid 1 Option

	Buried
Fiber	$1,169,154
Labor	$2,190,381
Engineering	$ 503,931
Contingency	$ 714,224
Total	$4,577,690
Miles	103
Cost/Mile	$44,444

Hybrid 2 Option (No Glenwood)

	Buried
Fiber	$ 855,410
Labor	$1,211,268
Engineering	$ 310,002
Miscellaneous	$ 535,810
Total	$2,912,490
Miles	85
Cost/Mile	$32,265

Note that the contingencies also covers electronics, but the study included all of the contingency as fiber costs.

The differences in cost per mile of construction are due to the different kinds of construction. Construction is most expensive in Glenwood where the majority of the town would be constructed using boring. The least expensive parts of the network are the rural miles that can often be direct buried in soil along the sides of the road. The cost of construction is also affected by the density of homes since there is a cost to provide access to the fiber using handholes and other access devices. That means it would cost more to build fiber in places like along the lake where the density of homes per mile is higher than the most rural portions of the county.

Customer Costs

Residential Fiber Electronics Costs: The model assumes that the hardware electronics for an ONT cost $242. In the models, it was assumed that company personnel would do the installation, which is generally a lower-cost option than hiring external contractors.

This design uses ONTs that are designed to deliver only voice and data. There are older ONTs on the market that allow for delivery of a separate analog TV data path, but newer networks assume that the cable TV offering will be digital and delivered over the IP data path. This requires the use of IPTV where video is 100% digitalized and delivered in an IP data format to the settop box. IPTV is becoming the video delivery method of choice in the fiber industry and is even being considered by cable companies. In the scenarios that considered cable TV, it was assumed that a basic settop box costs $115 and an advanced one costs $240.

Fiber Drops: Fiber drops are the fiber that connects between the distribution fiber and a customer's location. In this study the cost of fiber drops is significant. The assumption has been made that with the volume of drops needed plus the anticipated speed of network deployment that the drops during the first four years of the project would be installed by external contractors.

The cost for fiber drops in Glenwood, Villard, Sedan, and the areas around the lake are estimated to cost $838. That includes $288 of materials and the rest as labor. The much longer drops in the rural areas were estimated to cost $3,581. That includes $463 of materials and the rest for labor. In both cases the costs would be even more should you have any of the drops engineered, but most drop contractors determine the best way to handle the drop at each site without being pre-engineered.

There are ways that the nonrural drops could be done at lower cost using preconnectorized drops. These are drops that come in preset standard lengths and that can be plugged into the ONT without the need for splicing. There could be some modest savings using this method if it's determined that the actual drop lengths are somewhat predicable and fit the available lengths of drops that are available.

Starting the in the fifth year there are only a few drops added each month and it's assumed that this would be done by company technicians, for a substantial saving on labor costs.

It might be possible to save some on labor costs should a builder be able to somehow assemble their own construction team for the rural drops. But the prices included in the study represent recent pricing being paid in several Minnesota projects to external contractors.

Business Costs

We assumed that the businesses in this area would be able to use the same ONTs and drops as residences, with identical costs. There may a few businesses that would require more expensive ONTS, but that would add only a tiny amount of extra cost to the study.

Wireless Radios

Customer wireless CPE costs $184. This consists of a small dish and receiver electronics. We also assumed that company personnel would do the installation for wireless customers rather than external contractors.

Triple Play Services

We have assumed that the ISP operating this network would already be providing these services for other customers in the area. Thus, there was no cost in the model for a voice switch or a cable TV headend. To be conservative we have added in some routers and servers, but these might not be needed.

Other Assets

The business plan also includes the other assets needed to operate a triple play business. This would include new vehicles for the outside technician. The business plan includes a computer for every employee and furniture and office equipment. The business plan includes inventory, which would consist of spare fiber and spare electronics.

Backhaul Options

Each of the telcos in the area already has a backbone connection to get bandwidth to and from the open Internet. The forecasts assumes that the new customers would be served by one or more of these telcos, and thus there would not be a need for a new and separate backbone connection to the Internet. This means there would be no additional transport cost, but there would be an additional cost to buy bandwidth.

C. Competing Technologies

Following is a more in-depth discussion of the technologies that are currently provided in the rural areas today.

Wireless Technologies

There is always a lot of confusion about wireless technology since there are so many different frequencies in use and different technologies used for each. It is likely that there are rural residents in the county today using the following wireless technologies for broadband:

Cellular Data

There are rural customers all over the US that use their cellphone data plans as a way to get or to supplement a home broadband connection. There are several reasons why this is a major problem and concern. Cellular data is the most expensive bandwidth in the US. The cell phone companies sell it at between $8 and $15 per downloaded gigabit of data. To put that into perspective, a significant percentage of households today already download over 100 gigabits of data per month. Somebody using that much bandwidth with cellular data would be spending $1,000 a month.

The cellphone companies justify the high prices by arguing that they must limit usage to avoid network congestion. They have argued that big users tie up networks and make it hard for others to get good service. A few years ago, Michael Powell, ex FCC Chief and head of the NCTA, admitted that data caps are not about congestion but are about 'pricing fairness,' which means they are not about fairness at all, but about charging more to large data users.

We also know that data caps are about money due to the recent practice of zero-rating. That is the practice where wireless carriers will give customers unlimited access to data and video that they sponsor but count video from anybody else against monthly data caps. If you can watch all you want of DirecTV Now on your AT&T cellphone then there is obviously plenty of capacity at cell sites.

There is some validity in the cellular companies' claims in that cellphone networks were not originally designed to deliver data. The cell towers were spaced to maximize voice coverage. Data transmissions travel for a shorter distance than voice and so the data coverage from any given cell tower is not as good as the voice coverage. Further, cell towers can only handle some set number of customers for data purposes. This is why you can't get coverage when you're in a sports stadium or convention center with a lot of other people.

Another issue with cellular data is that the speeds in rural areas are not as fast as those in urban areas. Cell phone companies have made a lot of upgrades over the last decade or so, upgrading first from 2G to 3G data and then to 4G data with a few intermediate steps in between. While most urban areas now have 4G data, the vast majority of rural cell towers are still at 3G data speeds.

Like all wireless bandwidth, the speeds seen by customers is directly in proportion to how far they are from the cellular tower. Cellular data speeds diminish quickly with distance; people who are not close to a cell tower are going to get relatively slow speeds.

5G Cellular

There have been a lot of press announcements recently about the upcoming 5G cellular technology and the press releases from both AT&T and Verizon would make one believe that we will be seeing gigabit speeds for cellphones. What are the real facts about 5G? Consider some of the following:

First, there is no standard yet for 5G and a standard isn't expected until late 2018. The Next Generation Mobile Network Alliance (the group that will be developing the standard) states that the standard is going to be aimed at enabling the following:

- Data rates of several tens of megabits per second should be supported for tens of thousands of users.
- 1 gigabit per second can be offered simultaneously to workers on the same office floor.
- Several hundreds of thousands of simultaneous connections to be supported for massive sensor deployments.

How does this stack up against AT&T's claims that 5G will be bringing gigabit speeds? According to OpenSignal (who studies the speeds from millions of cellular connections), the average LTE download speeds in the 3rd quarter of last year for the major US carriers were 6 Mbps for Sprint, 8 Mbps for AT&T, and 12 Mbps for both Verizon and T-Mobile. This is what we are getting today from 4G. The 5G standard is going to be aimed at improving speeds for regular outdoor cellular usage to 'several tens of megabits per second,' which means speeds of maybe 20–30 Mbps.

The gigabit hype comes from the part of the standard that will address the capability of what are called millimeter waves (very high frequencies). The 5G standard will include the ability to use high frequencies to deliver very fast speeds. However, this is a very different application than cellphones and so while everyone reading the announcements of gigabit wireless are expecting those speeds for cellular data – it will just not be the case.

The 5G standard is going to allow for combining multiple very high frequencies together to create a high bandwidth data path of a gigabit or more. But there are characteristics of millimeter wavelengths that limit this to indoor usage inside the home or office. For one, these frequencies won't pass through hardly anything and are killed by walls, curtains, and to some extent even clear windows. In addition, the signal from these frequencies can only carry large bandwidth a very short distance—perhaps sixty feet. This technology is really going to be a competitor to WiFi while using cellular standards. It will allow the fast transfer of data within a room or an office and will provide a wireless way to transmit something like Google's gigabit broadband around an office without wires.

These millimeter waves are not going to be of any use outdoors, or at least no farther away than a patio. This technology cannot be used for roaming cellphones. The use of multiple antennas for multiple high frequencies is going to require an intricate and complicated antenna array at both the transmitter and the receiver. In any case, the distance limitations of the millimeter frequencies means this will never be used for outdoor cellphone coverage.

So the 5G standard might enable really fast speeds inside the home, at a convention center, or maybe a hotel, assuming that those places have a fast internet connection. But the 5G standard is not shooting for gigantic increases in cellphone speeds.

The problem with this kind of hype is that it convinces nontechnical people that it's a bad idea to invest in fiber because gigabit cellular service is coming soon. While nothing could be further from the truth, the positive press along with the market confusion over this are probably great for AT&T and Verizon.

Point-to-Multipoint Data

The second kind of wireless network is a point-to-multipoint data network that is transmitted from one central transmitter to many individual points. This is the technology recommended in this report for the hybrid network designs.

There are three current slices of spectrum that can be used for this purpose and two more that will be coming on the market in the next few years:

- 900 MHz: This spectrum has been available for this application for many years. This is the spectrum used back in the 70s and 80s to provide the bandwidth for garage door openers and cordless phones. This spectrum got saturated; in urban areas there were many stories about people opening their neighbors' garage doors when they made a phone call.

  This spectrum can still be used today in a point-to-multipoint radio system. The best characteristic of this spectrum is that it travels well through impediments like trees and it can go for a long distance—over ten miles. The down side is that, since it has a low frequency, the channels aren't very big and it can only deliver a few megabits per second of data speed.

- WiFi: WiFi is short for ***wi****reless* ***fi****delity* and is meant to be used generically when referring to any type of 802.11 network. The FCC has currently set aside two swaths of frequency for WiFi: 2.4 GHz and 5.7 GHz. In a point-to-multipoint network, these two frequencies are often used together. The most common way is to use the higher 5.7 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 3–4 miles from a transmitter. They have a theoretical cap of 28 Mbps on the bandwidth that can be delivered, and in ideal conditions they can achieve that much speed. But the signals are disrupted by trees and leaves and can be degraded by rain, snow, or even just heavy humidity. The ideal condition is in the flat, open southwest desert; everywhere else performs worse than the ideal.

- 3.65 GHz: The FCC authorized the 3.65 GHz–3.70 GHz frequency for trials of public use in 2006, and is just now making it available for widespread use in rural applications. This spectrum is promising because the existing trials showed that it can penetrate trees much better than the 2.4 GHz WiFi. We are recommending this frequency in this study.

  There are a few limitations of this spectrum. The spectrum cannot be used close to existing government installations or satellite earth stations that use the spectrum. Since these facilities are mostly near to a few submarine bases, it should not be an issue in Minnesota.

  The spectrum will be licensed for a very affordable $280 fee. However, the license is not exclusive and every user of the spectrum will be expected to coordinate with other users. This is not like a normal FCC license and it is not first come first serve. Everyone using the spectrum in a given area is expected to work with others to minimize interference. The FCC will act as the arbiter if parties can't work this out together.

  There are different rules for using the spectrum depending upon how it is deployed. The FCC rules suggest using radios that use other spectrum in addition to 3.65 GHz. For radios that only use this spectrum the usage is limited to the 25 MHz band between 3.65 and 3.675 GHz. Radios that allow for a shift to other frequencies when there is contention can use the full 50 MHz channel within this frequency.

The frequency can support bandwidth on one channel up to 37 Mbps download. It's possible to bond channels within the frequency band or with other unlicensed spectrum to get even faster throughput. It's theoretically possible with bonding to get speeds of 100 Mbps.

Radios for this frequency are readily available from most of the major point-to-multipoint radio manufacturers. The price of the base stations and customer CPE are slightly higher than the cost of radios in the unlicensed bands.

In practical application, this spectrum can be used to deliver up to 25 Mbps at six miles from the transmitter, with more bandwidth for those customers who are closer than that. It can theoretically transmit to the horizon, but at greatly diminished speeds. The network proposed by Finley Engineering has the goal of delivering 25 Mbps or more to customers.

- White Space Spectrum: The FCC has been doing trials in what is called white space spectrum. This is spectrum that is 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 FCC order refers to whitespace radio devices that will work in the spectrum as TVBD devices.

  The FCC auctioned a lot of this frequency earlier this year, with the buyers ranging from the big cellular companies and Comcast. This was called an incentive auction, because TV stations that give up their spectrum will share in the sale of the spectrum. 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.

  The downside of the spectrum is that it won't be available everywhere. In some places the TV stations have kept their spectrum. In other cases there is already something else, generally some government use, occupying part of the spectrum.

  There are two possible uses for the spectrum. On a broadcast basis, this can be used to make better hotspots. A 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. That's easily twice as far as what can be delivered today using unlicensed spectrum. Physics limit this to about 45 Mbps of total bandwidth for a single channel, but it will be possible to bond together multiple channels. While not at fiber speeds, this spectrum can enhance rural broadband. It is likely to be at least a few more years before the FCC releases this spectrum and equipment becomes available from vendors.

  One issue to be worked out is that the FCC rules require the radios using this frequency to use what they are calling cognitive sensing. What this means is that an unlicensed user of the spectrum will be required to vacate any requests for usage from a licensed user. While this would not be a problem 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.

Wireless vs Fiber

In general, wireless technologies are not as good as fiber for delivering data. There are many who claim that wireless is the future and that it is a waste of time to build fiber. Most of the time people making these claims are talking about broadcast networks like cellular systems. They believe that 4G and future 5G cellular technologies are going to deliver large amounts of broadband and that fiber is not really needed. There are many reasons why that is not true; consider the following:

- In the US, the FCC has chopped almost all of our spectrum into tiny channels. This was done years ago before there was any concept of needing fast data, but these channels make it a challenge to cobble together a fast data product over wireless. To make a fast connection means tying together a number of channels at the same time from different frequencies. This can be done, but what it means in practice is that from any one cell site, only a few users can be using big wireless data at the same time.
- Wireless data capabilities drop off significantly with distance. The physics of wireless spectrum dictates that the higher the frequency, the shorter the distance that data can be sent.
- The best frequencies for sending data a long way are the somewhat longer frequencies like 700 and 900 MHz. These frequencies have small channels and can only deliver a few megabits of data. These are some of the primary frequencies used in 3G and can send out the smaller data pipes for 10 miles or more.
- The higher the frequency, the less the distance. For instance, the primary WiFi frequency is 2.4 GHz. It can send out a strong signal, perhaps 100 Mbps, but this is only good for about 150 feet from a hotspot.
- The other free frequency is 5 MHz. It can do up to about 200 Mbps, and theoretically up to almost a gigabit, but this is only good within a room. It won’t travel more than about 60 feet from a hotspot.
- What these data limitations mean is that in order to have robust broadcast wireless data you must have cell sites that are close together. That means having them deep into neighborhoods. The cellular companies are already starting to build mini-cell sites in cities to get cell sites close together and ultimately there might be a few in every block. But each of those cell sites has to be fed by fiber and so it would be as expensive to build this fiber-fed wireless network in rural areas as it is to put fiber into homes and businesses.

Contrast this with fiber that has almost limitless data capacity. Today, consumer fiber networks are already delivering gigabit speeds. That is fifty times faster than the best rural wireless solution available today. There is even a 10-gigabit residential fiber product in St. Paul, which is 500 times faster than the best wireless solution. While the wireless solutions are not going to get better because they are limited by physics and not by technology, fiber can always be improved by using faster and cheaper lasers. The difference between the two technologies is so gigantic that there is no real comparison.

When people talk about gigabit wireless, they are talking about having a wireless technology that will deliver that much speed within a room. This has only been done in a lab, but those kinds of speeds will eventually be available within your living room. While there will undoubtedly be technological improvements in techniques to deliver rural wireless, those improvements will probably increase the capacity of the signal a few times, but not nearly to the speeds that fiber can deliver today.

DSL and Copper Technology

In the county any telco not using fiber, such as CenturyLink and TDS, are using DSL (Digital Subscriber Line) to deliver broadband. DSL works by using the higher frequencies that are available on a piece of copper wire. These frequencies are not used for voice service. DSL is used to provide an Ethernet data path over the copper that can be used to deliver customer broadband service. There are different kinds of DSL standards, each of which has a different characteristic in terms of how much bandwidth they deliver and how far the signal will travel. The most important characteristic of DSL is that customer data speed decreases with the distance the signal travels.

The general rule of thumb is that DSL can deliver a decent amount of bandwidth for about 2 to 2.5 miles over copper. The vast majority of people in the rural areas are more than 2 miles from a town; they are able to get only very weak and slow DSL, if they're able to get any DSL at all. The large telcos will sometimes sell DSL with speeds as slow as 124 kbps, or just barely faster than dial-up.

DSL signal strength is also affected by the quality of the copper. The newer the copper and the larger the gauge of the copper wires, the better the signal and the greater the bandwidth. Most of the copper wires in the county are 50 years old or older and have outlived their original expected service life.

Hybrid Fiber Coaxial Network

Charter (Spectrum) operates a Hybrid Fiber Coaxial (HFC) network. Hybrid refers to the fact that an HFC network uses both a fiber backbone network and a copper network of coaxial cable to deliver service. HFC networks are considered lean fiber networks (meaning only a 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.

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

In an HFC network, all of the customers in a given node share the data available to that node. This means that the numbers of customers sharing a node is a significant factor—the smaller the node the stronger and more reliable the data product. Before cable systems offered data services 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 the data pipe for each node. It is this node-sharing that has always given a cable network the reputation that data speeds will slow down during peak usage times, like evenings. If nodes are made small enough then this slowdown does not necessarily have to occur. If nodes were made as small as PON fiber networks (less than 32 homes), then the data delivery issues would be similar, but cable company nodes today are typically between 100 and 500 homes, with an average size being around 250 homes.

The amount of data that is available at a given node is a function of how many ‘channels’ of data the cable company has dedicated to data services. Historically a cable network was used only for television service, but in order to provide data services the cable company had to find ways to create empty channel slots that no longer carry programming. Most cable systems have undergone a digital conversion, done for the purpose of freeing up channel slots.

The technology that allows data 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 cable companies in the country are currently using DOCSIS 2.0 or 3.0 that allows them to bond together enough channels to create data products as fast as about 250 Mbps download. However, there is now a new standard, DOCSIS 3.1, that theoretically allows all of the channels on the network to be used for data and which could produce speeds as fast as 8–10 Gbps if a network carried only data and had zero television channels.

The one big data limitation of a DOCSIS network is that the standard does not anticipate symmetrical data speeds, meaning that download speeds are generally much faster than the upload speeds. This is not an issue for most customers, but it does give a fiber network a marketing advantage and there are customers who care about upload speeds. If an HFC network wanted to offer gigabit upload speeds they would need to dedicate an additional 24 empty channels just for the upload, something nobody is ever likely to do.

There is a distance limitation on coaxial cable, but since these networks are not often built in rural areas this rarely comes into play. Unamplified signals are not generally transmitted more than about 2.5 miles over a coaxial network. This limitation is based mainly on the number of amplifiers needed on a single coax distribution route. Amplifiers are always needed for coax distribution over a couple of thousand feet. Modern cable companies try to limit the number of cascaded amplifiers on a coax route to 5 or less. They will want fewer amplifiers if they are trying to deliver top data speeds.

III. Financial Business Plan Analysis

The goal of the financial analysis was to see if there is a way to provide profitable broadband to the study area.

We looked at the following specific scenarios:

- **Fiber Everywhere**: This builds fiber to pass all homes and businesses in the study area.
- **Hybrid Model Everywhere**: This scenario builds fiber in Glenwood, Villard, and Sedan as well as to customers that live near the backbone fibers that serve the wireless towers. The remaining customers are offered fixed wireless broadband.
- **Hybrid Model without Glenwood**: This scenario excludes Glenwood and builds fiber to Villard and Sedan as well as to customers that live near the backbone fibers that serve the wireless towers. The remaining customers are offered fixed wireless broadband.

Within these three scenarios we looked at different options.

- **Method of Financing**. We compared financing each option using revenue bonds, general obligation bonds and normal commercial financing.
- **Customer Penetration Rates**. Past experience has shown that the number of new customers that get onto a new network is probably the most important factor needed to achieve success. For each option we looked to see how the business would fare with an overall 60% customer penetration and an overall 70% customer penetration. We then looked to see for each scenario the percentage of customers that would be needed for the network to achieve financial breakeven. We defined breakeven as the ability to operate the network for the long-run while maintaining positive cash.

Finally, we looked at what we call sensitivity analysis. We wanted to see the impact of changing the other important variables in the studies. We looked at the impact of higher interest rates on debt. We looked at the impact of getting some grant financing. We considered the impact of increasing the rates for broadband products. Finally, we looked at the impact of increasing the amount of equity in a project (meaning less debt).

A. Business Plan Key Assumptions

This section of the report looks at the detailed assumptions that were made in creating the financial business plans. There are some assumptions that are common to most or all of the scenarios studied and other assumptions that are unique to specific scenarios.

The business plans created are detailed and contemplate all aspects of operating a broadband network in the County. The business plan assumptions used in the forecast include our best estimate of the operating characteristics for such a business. As a firm, CCG consults to hundreds of communications entities that operate triple play businesses. We not only work with clients to develop original business plans, but we work with them to help maximize profits with existing businesses. This has given us a lot of insight into how triple play businesses work and we are experienced in how businesses really operate under all sorts of conditions. 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 for these business plans was to determine the breakeven scenario. This tells us the minimum number of customers needed for a given scenario to pay for itself. Breakeven is defined as a business plan with the minimum number of customers where the operating revenues always cover the full costs of operating the business – that means operating expenses, debt payments, and ongoing future capital requirements needed for growth and maintenance.

Following are some of the key assumptions that were used in all of the scenarios studied:

Study Area

We used two criteria in establishing the parts of the county that were included in the study area. First, we excluded all parts of the county that already have fiber-to-the-premise or are expected to be getting fiber in the near future. This means that parts of the county along the western and northern borders, including Starbuck, were excluded from the study. For the rest of the county we considered the FCC and Minnesota DEED definitions for areas that are considered as unserved or underserved. Those definitions defined Glenwood as underserved and the rest of the county as unserved.

The study area is shown on Exhibit II. The areas in green were not included in this study.

Incremental Analysis

It's important to note that all of the projections were done 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 business line will be able to generate enough revenue to cover the full cost of entering the new market.

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 the new venture might look like. For example, if one of the existing telcos in the area was to undertake one of these business plans, they would allocate some of their existing costs to the new venture. The classic textbook example of this is that some of the existing cost of the general manager of the telco would be allocated to the venture for the accounting books. However, the cost of the salary of the general manager is not considered in an incremental analysis. 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 to the telco of entering the new market, because the allocation of this expense would improve the financial performance of the existing business and would then not be considered when looking at the new venture.

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 a service provider can do better than these plans by taking steps to launch the new business faster than what is shown in these projections.

Following are the major milestones as predicted by these forecasts:

- Financing: All of the forecasts assume that the financing is available in January 2018.
- Construction: Core construction of the network is done during the spring and summer of 2018. That doesn't mean that all of the construction needs to be finished by then and some of the rural construction can be completed in 2019.
- First customers: The forecasts show the customers coming onto the networks in the following sequence:
    - First customer in Glenwood – October 2018
    - First customer along the lake – May 2019
    - First rural customer – August 2019

There are steps that the new business could take to significantly improve this time line, and consequently do better than these projections:

- Presales: We've seen service providers that are able to get earlier revenues when they presell 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 parts of the county was completed.
- More Concentrated Build Schedule: It's always possible to build faster than shown in these forecasts if the service provider insists on a faster construction schedule. Basically, for these kinds of networks, the amount of network that can be built increases by adding more construction crews.
- Outsource Customer Connections: A lot of small companies like to connect customers using their own employees. However, to do so means that the limiting factor on the speed of the roll-out of the business depends upon the number of daily installations that can be done by existing employees. The time line envisioned by these forecasts supposes that companies will use external contractors to perform most of the installations.
- Get Temporary Help: There are often other bottlenecks at small companies that can slow down customer installations. This could mean the need for more sales and marketing staff, additional customer service reps, or inside technicians needed to provision new customers. Service providers should strongly consider using temporary employees during the roll-out of a major new market.
- Evaluate Based Upon Speed to Market: Any given service provider might tackle the business plan in a different sequence than shown in these forecasts. For example, in the hybrid scenario they might determine that the fastest way to launch the business might be to deploy rural wireless customers before fiber customers.

Revenue Assumptions

It has been our experience in recent years that a new broadband business in rural markets does not need to offer lower prices to get customers. Faster broadband and good customer service are the keys to success for areas that have not had adequate broadband before. Thus, for purposes of the study we tried to set broadband prices at market rates, meaning the rates that are being charged in the county today for faster broadband. In highly competitive markets it's sometimes necessary for a new competitor to lower rates to get customers. But in this market, particularly in the rural parts of the county, the goal should be to deliver a quality product at a fair price and not try to gain market share with big discounts.

As was described earlier, there are a number of existing telephone companies already operating in the county. We looked at the rates of three independent telephone companies operating in the county. This includes an analysis of the rates of Runestone Telecom Association, Federated Telephone Cooperative (part of Acira), and Hanson Communications. We also considered the rates charged by CenturyLink and Charter (Spectrum). The rates used in the study don't reflect what is being charged by any one of these providers, but are rather a rough composite of all of their rates.

It was not easy choosing product prices based upon so many different companies. The products and the rates at the small telcos are different than the rates of CenturyLink and Charter. All of the providers offer different broadband speeds and also bundle products together in different ways, making it hard to pick a price for a given product that would represent all of the service providers. If one of more of the telcos decides to look at this opportunity, one of the first things they would want to do is to substitute their own rates for the ones chosen for these studies.

One of the issues to decide for any prospective provider is how to set the rates in Glenwood. This is the only portion of the study area that already has significant broadband competition today from both CenturyLink and Charter (Spectrum). It is not uncommon these days to see different rates in competitive hub towns compared to the surrounding rural areas. In this study the prices were set the same for the whole study area.

In the all-fiber scenario, we assumed the delivery of the normal triple play of video, voice, and high-speed data. We also assumed that the products would be as simple as possible. As an example, the incumbent telephone companies in the county offer a wide range of different kinds of telephone products. We assumed that a new business would offer only a few options. For instance, for residential service we have assumed only a basic telephone line and a telephone line with unlimited long distance.

Telephone Rates

Our study used the following very simplified pricing for residential phone service:

Basic Local Line	$27.00
Line with Unlimited Long Distance	$45.00

We've assumed that both kinds of lines include a full package of features like voice mail, caller ID, etc. If a provider charged extra for these features they would probably get a little more revenue than predicted by our business plan.

The above prices also include any Subscriber Line Charge that is added to the basic rate. All of the telcos in the county charge this rate today, which is a regulatory fee defined by the FCC that the telephone companies bill and keep as revenue. Charter does not charge this fee.

Our business plan keeps the assumptions simple and the $27 basic telephone rate includes a few dollars per month for long distance. It's been our experience recently that most customers make long distance calls using cell phones. Those that want to make many long distance calls from a landline usually opt to buy the unlimited long distance plan. Our assumptions are probably a little conservative in that there could be some customers that still make a lot of long distance calls and pay on a per minute basis.

Our assumption in the study is that the basic line would have the same limited local calling scopes that exist in the county today. Today customers in any one telephone exchange only get free calling to a small number of other places, as shown below. Customers must pay long distance to call anywhere else on their landline. Following are the long distance calling scopes for the exchanges in and around the county today. Most customers in the county are served from telco central offices located inside the county, but a few are served from locations outside the county.

Exchange	Phone Company	Can Call for Free
Located in the County		
Cyrus	Runestone	Morris, Starbuck
Glenwood	CenturyLink	Brooten, Lowry, Sedan, Starbuck, Terrace, Villard
Lowry	Runestone	Glenwood, Kensington, Starbuck
Sedan	TDS	Brooten, Glenwood, Terrace
Starbuck	Hanson Comm	Cyrus, Glenwood, Lowry
Villard	CenturyLink	Glenwood
Located Outside the County		
Benson	CenturyLink	Danvers
Hancock	Federated	Bellingham, Big Bend, Cerro Gordo, Chokio, Correll, Danvers, Dawson Holloway, Madison, Marietta, Milan Morris, Odessa, West Marietta

Customers buying the unlimited long distance plan would be able to call anywhere, including all parts of the county, as part of their plan. These plans today often include Canada and even some other international locations.

The above prices do not include taxes and other fees that are billed and submitted to tax authorities. This includes several state and federal taxes as well as a fee to help fund the FCC's Universal Service Fund.

The study is less specific with business phone rates. Businesses are often interested in other features that include such things as easily being able to put a call on hold or transfer calls to another phone line. Businesses also differ in terms of how many lines they buy, although many of the small businesses in this county would likely have only one telephone line. In the models we have assumed a monthly telephone revenue per business of $60 per business customer. We think this assumption is conservative and there might be a few businesses that would greatly exceed that average.

Cable TV Products

Offering competitive cable TV in a new rural market is a challenge. In this case the customers in Glenwood are already going to have TV from either Charter or satellite. In the rural areas today every existing TV customer is using satellite. This means there is already a lot of competition for cable.

No small provider can really compete on price with the satellite providers and landline prices are almost always significantly higher than satellite prices. For a small company the cost to buy the programming is much higher than what is paid by the huge satellite companies. Still, some rural telcos have surprisingly high cable TV penetration rates, particularly cooperatives where customers choose to buy from a company that they also own. But it's been our experience that when any small provider moves into a new rural market a lot of the existing customers are going to elect to stay with their satellite cable product.

Small providers are at an additional disadvantage in that they are forced to raise cable rates every year since the cost of programming goes up significantly every year. For the past decade, programming costs have risen steadily by around 7% per year, but in the last few years has exceeded 10% annually for many small cable operators. This is one of the main causes of the annual rate increases done by cable companies.

What I think matters most in this kind of model is the difference between the cable retail rates and the programming costs—what is called gross margin in accounting terms. I've made the assumption in the models that this margin will stay the same going into the future. The easiest way to do that from a modeling perspective is to not increase either the cable TV prices or the cost of programming over time. That holds the margin per customer the same and it makes the assumption that any cable TV provider will pass on any increases in programming costs to customers. In recent years the majority of my clients have adopted that philosophy and have decided that they will not eat increased programming costs.

The cable rates charged today by the existing service providers in the county are hard to compare. They each have different ways of bundling cable TV with other products. They also don't carry the identical channel line-up (which is also different for Charter and the satellite providers).

The whole industry expects that something drastic is going to change with the cable TV product during the coming decade. There is now a lot of alternate programming available on the Internet and perhaps it's expected that a lot of households will cut the cord and will not buy traditional cable products. This has been reflected in the study by showing the penetration rate for cable dropping over time. But nobody has a good crystal ball on how cable might change, so this is probably the one assumption in the study that might have the most variance compared to what has been projected in these studies.

The industry might also undergo other changes. For example, the major cable companies are now offering skinny bundles, which means small line-ups of just the essential channels that customers say they want to watch. It might be possible in the future for this business to offer something like skinny bundles and be more profitable than what is shown in the studies. The other extreme is also possible in that it might become economically infeasible for small companies to offer cable TV. The margins on cable TV in the model are small enough that either of these two extremes would not have a major impact on the overall financial results.

The model assumes the following cable TV products. These products would be the same for residents and businesses.

Basic Cable: \$27. This is the line-up of network channels like ABC, NBC, CBS, FOX, and PBS plus a few other local or low-cost channels.

Expanded Basic: \$68. This will include perhaps 60 to 75 channels. It would include the basic lineup and add the most popular cable networks like ESPN, Disney, Comedy Central, etc.

Digital: \$78. This would include the largest package of channels (but not premium movies) and would match the top tier offering by the satellite or local cable companies.

Movie Channels: These are extra and can be added to the other packages. These are priced close to cost in the projections since there is not much margin on movie channels for small cable operators.

Pay-per-View: A few years ago pay-per-view generated decent revenue for many cable operators. But today most small cable providers either don't carry pay-per-view movies or offer them largely at cost. Many cable operators still carry pay-per-view special events like wrestling, but the amount of net margin from this is generally small and so it is not included in the studies.

DVR Service: The business plan assumes a monthly fee for DVR service, or the ability for a customer to record shows. The cable provider must offer a DVR settop box capable of recording shows, much like a TICO box. The studies assume a monthly rate for DVR service at \$6.95. There is also an additional charge for the settop box.

Settop Box Fees: We've assumed a charge of $5.00 per month for each cable settop box provided to customers. We note, however, that Charter does not charge for boxes today, but has included these fees in their cable rates.

Broadband Products

We have assumed that the new networks being built by these business plans would deliver much faster data speeds than are available to residents today. In the areas outside of Glenwood broadband speeds are very slow or not available today. By FCC definition these area of the county are considered to be unserved.

The models do not recommend specific data speeds, but instead show three tiers of broadband that are labeled as Low, Medium, and High. It's hard to predict where any given service provider might set the speeds, and some service providers will offer more than three speeds. But as an example of how this might look, CCG has many clients with fiber networks where the low speed would be between 30 and 50 Mbps, the medium speed between 75 and 100 Mbps, and the high speeds somewhere between 250 Mbps and 1 Gbps. The models assume the following rates:

Residential	
Low	$ 45
Medium	$ 65
High	$ 85
Business	
Low	$ 55
Medium	$ 75
High	$ 95

Most service providers charge more to businesses for broadband.

It's typical that customers will buy the lowest speed product they are comfortable with in order to save money. The studies assume that 60% of customers will buy the lowest speed product and only 10% the highest speed. That mixture between products can change drastically depending upon the price differences between products. For example, Comcast, the biggest cable provider in the country, charges $150 for a gigabit product and very few households are willing to pay that much for a broadband connection. The distribution of the penetration rates of these products is predicated on the price differences assumed in the above prices. But if the highest speed product was priced much higher it would be expected that fewer customers would choose the product.

These are shared data products, meaning that the overall bandwidth to provide them is shared among multiple customers. This is not to say that the data path to a given customer is not secure, because the transmission to any specific customer is encoded for privacy purposes. Still, there might be some business customers that will want a dedicated data product that is not shared with anyone else. The network can accommodate this by providing such customers with an active ethernet connection. Prices for these services would cost a lot more than shared data services. It would be surprising if there are any businesses in the rural parts of the county that would ask for dedicated broadband.

The financial models assume that the data 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. Very few small service providers impose data caps and Charter is one of the few large cable companies that doesn't use them. There are data caps on CenturyLink DSL, but it's been widely reported that the company often doesn't bill for data overages.

Wireless Network Data Products

In the hybrid scenarios we studied some parts of the county would be served with point-to-multipoint wireless technology rather than with fiber. The speeds on this technology are much slower than on fiber, but the studies still assume a 3-tier pricing. But here the low speed might be 10 Mbps and the highest speed 50 Mbps. The prices assumed in the study are:

Residential	
Low	$ 45
Medium	$ 65
High	$ 85
Business	
Low	$ 45
Medium	$ 65
High	$ 85

Here we've made no distinction between residential and business rates. We also assume a different distribution of customers buying the various products. The model assumes that only 50% of customers buy the lowest speed product and that more customers would opt for the faster products. We've assumed that only 20% of businesses would opt for the slowest product.

Customer Penetration Rates

The factor that has the most probable impact on the revenues is the number of customers projected to buy services, which we refer to in the industry as the customer penetration rate.

In the forecasts, we looked at customer penetration rates in several different ways. We started the analysis using what we call expected rates. The expected rates are an estimate on our part that allowed us to build the starting models. We looked at two models of expected penetration rates, one at 60% and one at 70%. We have witnessed the construction of broadband in a number of rural markets in the last few years and we have seen customer penetration rates in those markets range between 60% and 80%, with one or two even a little higher.

There is no reason to think that the rural portions of the study area won't do as well as other rural markets. What is harder to predict is the possible take rate in Glenwood since there are broadband alternatives there. We have seen competitive overbuilds in towns this small in other parts of Minnesota that have achieved penetration rates in the range of 50% to 60%, with a few even higher – in towns that have an existing broadband provider. But it's almost certain that a new broadband network would fare better in the rural parts of the service area than in Glenwood.

The only real way to understand the potential broadband penetration rate would be to do a survey or a canvass and quantify the potential customer interest in the service area in buying broadband from a new network. But we find that surveys are the most accurate once the facts are clearer. Customers are going to want to know the range of the prices being considered. They also often care about how the network will be financed and who the service provider might be. So a survey done at this early stage might not as accurately predict the eventual take rate as a survey done closer to launch of the network.

Because we can't be sure about the customer penetration rates we instead look at the penetration rate issue by calculating what we call the breakeven penetration rate. This represents the minimum number of customers that are required for a scenario to reach cash breakeven. Cash breakeven looks at the total expected cash derived from revenues and then compares it to all of the cash needs of the business, which includes operating expenses, any payments on debt and ongoing capital costs for maintaining and growing the network. We calculate the breakeven penetration rates by lowering customer penetration in the models until they reach a point where the future business cannot maintain a positive cash balance. We discuss the specific breakeven penetration rates for each scenario below.

Other Future Revenues

The forecasts also suppose that these businesses will generate additional revenue over time from business lines that are not specifically identified in the projections. As service providers continue to see declines in telephone and cable TV customers (as shown in these projections) many of them are entering new business lines. Already today we see small ISPs offering

- Security: This is burglar alarms, motion detectors, smoke and CO2 detectors and other devices to create a home security suite.
- Home Automation: I see companies now offering the service of connecting Internet of Things devices. This might include surveillance cameras, smart thermostats, smart lighting, watering systems, smart door locks and other devices that automate the home or office.
- Managed WiFi: This is a product where the service provider helps to improve the WiFi system in homes by placing networked WiFi routers, and then also making it easier in the future to add devices to the WiFi network.

The business plan is not specific about which future products might be introduced and in fact it could be products that we don't even envision today. Since we can't know the specific products the forecasts include the net margin—the cash profits—from these future revenue sources rather than trying to predict both the revenue and expenses. The forecasts also add this slowly. For example, the forecasts predict that there will be new products of some sort sold to only 3% of customers by 2020 with an average margin for those few customers at $10 per month. This doesn't add a lot of bottom line to the model, but we are certain that over time all small ISPs will offer services that are not included in the base forecasts.

Expense Assumptions

Expenses are the recurring costs of operating the business once it's built. We strive when building financial projections to be conservatively high with expense estimates. It's often less costly for an existing service provider to add a new market than what is shown in these projections. For example, if we predict the new business might need to hire additional staff for customer service or for field technicians we often find that existing staff at service providers are able to pick up much of the new work load without having to hire more employees.

We made the following assumptions about expenses:

Employees: Labor is generally either the largest or second largest expense of operating a broadband network (cable TV programming is the other large expense). Our models assume that a service provider will need to hire additional staff to take care of the added 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 30% of the basic annual salary. That would cover payroll taxes and other taxes like workman's compensation, as well as employee benefits.

As a reminder, these models are incremental and only consider the additional labor needed because of the customers added. At a minimum, the new business would require the following two additional types of employees:

Customer Service Representative: Takes new orders, answers customer questions about billing, services, etc. We've assumed the business will require 2 new positions for the all-fiber scenario and 1.5 new positions for the hybrid scenarios.

Install/Repair Technician: This function installs new customers and visits customers for needed repairs. We've assumed the business will need 2 new outside technicians for all scenarios.

Accountant/Bookkeeper. We've assumed the business will require ½ of an accountant due to adding the new market.

There are obviously other functions that must be done in a new business. For example, a service provider must have a general manager. There will generally be an accountant or bookkeeper of some sort. There might be intermediate management in charge of the technicians or customer service representatives. There might be full-time marketing people. But as described above, this analysis would not show these functions unless it was necessary to hire new employees due to adding the new market.

We anticipated that construction contractors will build the fiber and/or wireless networks. We've also assumed that the installations at the customer site would 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, there are some start-up costs included in each scenario. There are expenses associated with launching a new business or new market and rather than list them all specifically we have included them as start-up costs. There are start-up costs even for an existing ISP.

Sales and Marketing Expenses: Every scenario is going to require a significantly high customer penetration rate to be successful. We used the assumption that there would be a marketing effort to sign customers (instead of the word-of-mouth that often happens in rural markets). It would be too risky to spend the money to build a network without knowing for sure that there are enough interested customers to allow the business to pay for itself. Marketing expenses shown in the models are likely going to be for that effort. It's possible that such money would be spent earlier than shown in the model. There have been rural start-ups that have been able to sign up customers using community volunteers, so it's possible that the marketing costs could be lower than shown.

Cable TV Programming: Almost all small cable operators purchase cable signal from the National Cable Television Cooperative (NCTC), a cooperative of small cable providers. NCTC currently provides programming to nearly 20 million subscribers, meaning they get some of the best prices for programming in the industry.

As described above, in these models the assumption has been made that the gross margin on cable TV per customer will remain the same throughout the study period. This was done in the model by showing no increase in cable rates and also no increases in cable programming costs. This assumes that the service provider will pass all programming cost increases on to customers. Should they not do this then the forecasts will perform worse than shown.

Delivery of Triple-play Products: The projections assume that the new business will not construct a headend to provide the triple play services. If the service provider is already offering these products then the assumption is that they would deliver the same product to the new customers in the same manner that they delivery to existing customers. If the county or some new provider was to operate the business it's assumed that they would buy the wholesale services from another service provider.

Since this is an incremental model the assumption is made that the service provider will pay to gain wholesale access to the products. This includes a monthly fee to pay for voice lines and a monthly fee for use of the cable TV headend.

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 was served by a new entity then the cost of bandwidth would be higher to also cover the cost of transport to reach the Internet.
- Internet Help Desk. The monthly fee for this service covers several different functions. This fee would cover those functions used to deliver broadband such as spam monitoring and security. This also includes network monitoring. And the fee includes the help desk function, which is the function of assisting customers with broadband and network issues.
- Tower Rental. For the hybrid scenarios there is an assumed cost to lease space on existing cellular towers in the county.

Software Maintenance: Triple-play providers 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, 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, of charging bills to credit cards, and of charging bills directly as debits to bank accounts.

Taxes: The model assumes that the business will pay property taxes on towers and huts but no other major operating taxes. It's possible that these assets would not be assessed property taxes since the definition of what gets taxed varies widely by jurisdiction.

The forecasts do not include any taxes that are assessed to customers. For example, this business would be expected to charge and collect various telephone taxes. These kinds of fees are normally added to the customer bill, and thus customers directly 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 to the forecasts, but rather are just a pass-through.

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.

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 5 years). The cost of a new vehicle is then depreciated monthly to write off the asset over the 5 years, or 60 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 also accounting standard practices.

Soft assets like software are instead amortized, using the same process as depreciation.

Financing Assumptions

One of the most significant costs of building a broadband network is the financing cost needed to raise the money to pay for the network. We know the county is not interested in operating an ISP, but if no other solution surfaces, then the county could finance the project and partner with somebody else to operate the business. For the sake of that option, it's worth understanding the difference between public financing and commercial financing.

In the study we look at three different financing options: revenue bonds, general obligation bonds, and normal commercial financing. There is a potential fourth option which would be to combine the two types of financing as has been done in Sibley/Renville counties to form RS Fiber and that was recently done in nearby Swift County in a public/private partnership between Federated Telephone Cooperative and the county.

Benefits of Bond Financing

There are several major benefits for using bond financing:

- 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 out for 25 to 30 years. It's difficult to finance a commercial loan longer than 15 years. The longer the length of the loan, the lower the annual bond payments.
- Bonds can be used to 100% finance a project, meaning there is no need for cash or equity to fund the new business. Lack of cash equity is generally the requirement that creates a challenge for traditional commercial financing.
- Bonds often, but not always, have lower interest rates. The interest rate is dependent upon several factors including the credit-worthiness (bond rating) of the borrower as well as the perceived risk of the project.
- 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 buying the bonds and raising the needed funds.

Benefits of Commercial 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 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. They money just sits there to be used to help make bond payments should the project have trouble making the payments. Bond insurance works the same way and a borrower will pre-pay and insurance policy at the beginning of the bond that will cover some defined amount 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 five years.

- Construction Loans. Another reason that commercial financing usually results in smaller debt is through the use of construction loans. 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 used. However, bonds borrow all of the money on day one and begin accruing interest expense on the full amount borrowed on day one. Construction loans also means that a borrower will only draw loans they need 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 in order to pay a project off early or to refinance the debt. This contrasts to bonds that often require that the original borrowing be held for a fixed number of years before it can be retired.

Combining the Two Kinds of Financing

There are benefits to combining the two kinds of financing:

- Banks will often consider the financing that comes with bonds as the equivalent of equity, meaning that the commercial partner will not require as much, or even no, cash equity.
- In terms of the amount borrowed, the two methods work well together if construction loans are used to cover the construction and bond financing is used for the longer-term financing costs.
- Combining the two methods works to produce a payment term that is longer than a traditional commercial loan.
- Combining the two methods also usually means lower debt payment 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 has to hit their debt ceiling. Just as an aside, the debt ceiling is often the main impediment to funding project 100% with bonds.

Fiber projects are generally large projects and the required funds can easily exceed the ability of a government to fund it 100%.

What are Revenue Bonds?

A lot of fiber systems have been financed with revenue bonds. These are bonds that are primarily secured and payments guaranteed to the bond holder from revenues of the project. With a pure revenue bond the borrowing government would not be directly responsible for repaying the bond should the project go into default. With that said, having a default would still be a financial black-eye that might make it hard for a defaulting borrower to finance future projects. This means that revenue bonds still carry some risk to the borrower if the project is not a success.

However, it is getting harder to finance a project with 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, meaning that there is added surety in the financing or else the borrower is not taken completely off the hook in the case of a default. For example, we’ve seen revenue bonds where the borrower was on the hook to replenish the debt service reserve fund if it ever got used. This structure basically works the same as a general obligation bond because the borrower would be on the hook for unsatisfied bond payments.

Revenue bonds generally have a higher interest rates than general obligation bonds due to the perceived higher risk to the bondholder.

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.

In Minnesota many kinds of general obligation bonds require a referendum approval by a simple majority of voters. There are some kinds of economic development bonds and other types of GO bonds that don’t require a referendum, although government entities sometimes hold a referendum anyway just to make sure the public supports the initiative being financed.

General obligation bonds generally can get the lowest interest rate available for a given government borrower.

Commercial Loans

If any other telcos or cooperatives in the area decide to build broadband they are likely to borrow the needed money using typical commercial loans. Commercial loans for telcos are either borrowed from bonds, including specialty banks like CoBank that specialize in telco projects.

Telcos can also borrow a government loan from the RUS, a division of the Department of Agriculture.

As described earlier, a typical structure for a commercial loan is for the borrower to provide some sort of equity (meaning upfront cash). This requires either accumulated cash in the bank of the borrower, or in some cases grant funding. It's not untypical for a lender to want to see at least 20% equity in a project, meaning that the borrower contributes 20% of the cost of the project from their own loans.

Commercial loans usually use construction financing, meaning that funds are only drawn as needed from a preapproved line of credit. Once construction is complete then commercial loans convert into normal bank loans with a payment schedule, similar to bonds.

In general the interest rates for commercial loans are higher than bonds, although not always depending upon the credit-worthiness of the borrower. And commercial loans generally have a shorter term, normally not longer than 15 years, although there have been a number of recent loans made for 20 years.

One issue that commercial borrowers face is the needed surety to guarantee payments of loans. It's not untypical for a telco to have to pledge their entire company in order to get financing, meaning that their whole business is at risk if the new project fails. This tends to means that commercial service providers prefer to tackle projects that they are sure will be successful while government entities are generally happy if a fiber project can reach breakeven.

Comparing the Different Financing Methods

We looked at the cost of all three kinds of financing for the major scenarios we studied. Following is a summary of the borrowing costs needed to build fiber everywhere using revenue bonds, general obligation bonds, and commercial financing.

Following are the costs to fund the whole fiber project with a revenue bond for a 60% expected take rate:

Assets	$29.27 M
Bond Fees	$ 0.62 M
Working Cash	$ 2.01 M
Capitalized Interest	$ 5.43 M
Debt Service Reserve Fund	$ 2.84 M
Total	$40.20 M

Here is the project instead funded with general obligation bonds. In this case the assumption has been made that the interest rates are the same for the two methods, but it's likely that the interest rate on GO bonds would be less, lowering the amount of funding even more:

Assets	$29.27 M
Bond Fees	$ 0.57 M
Working Cash	$ 1.84 M

Capitalized Interest	$ 4.95 M
Total	$36.70 M

Finally, here is the same project funded with a commercial loan requiring 20% equity:

Equity	$ 6.80 M
Loan	$27.20 M
Total	$34.00 M

Why the Projections are Conservative

We always try to make our business plans conservative. By conservative, we mean that an actual business plan ought to perform a little better than we are projecting. Following are some of the conservative assumptions used in the business plan:

- The models contain no "home run" revenues. These would be sales of larger broadband products such as leasing space on a tower to a cellular company or selling bandwidth to the local schools. We know that every fiber business gets some of this kind of revenue, but we took the conservative approach of not showing it because we can't guess how much and when such opportunities might occur.
- The engineering estimates include a 10% contingency. We think the estimates of construction costs are solid and this contingency might not be needed.
- In the model, we show an increase in the cost of wholesale bandwidth over time. However, industry costs for raw data might be less than we are projecting and might even drop over time.
- 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.
- If the community was to undertake a preconstruction sign-up campaign to identify customers before the start of construction, then capital expenditures could be lower since the customer drops and electronics could be installed during the initial construction at a lower cost than installing customers individually later.

B. Business Plan Results

It is never easy to summarize the results of complicated business plans to make them understandable to the nonfinancial layperson. In the following summary are some key results of each study scenario that we think best allows a comparison of the numbers between scenarios. We look at the amount of cash generated over the life of the plan as well as at the years when each plan achieves positive net income and debt breakeven. Those two new terms are defined as follows:

Positive Net Income: The year when the business shows a positive profit defined in the normal accounting sense. This uses the taxation and public accounting definition of profitability and includes depreciation and amortization, which are not cash expenses. The net income also does not consider repayment of debt principle and annual operating capital. Reaching positive net income is an important milestone for a new business and is one of the ways that the public will judge your success. Just note, though, that the business can have a positive net income and still not have enough cash to operate the business.

Debt Breakeven: The year when the business has generated enough excess cash that would enable the retirement of the remaining debt. Many loan and bond covenants don't allow cash from a business to be used for anything else, like dividends, until the debt has been retired.

The way to measure profitability in a new business is going to differ according to the structure of the business. A municipal business, for example, generally measures success by the ability of the business to generate enough cash to operate without any external subsidy. While for-profit business would generally use something like net income to measure profits.

It is important that a business always have cash in the bank to meet its obligations. In this particular business plan the ideal situation would be to always have at least $0.5 M in the bank to have a cushion against nonlinear monthly expenditures. Not all expenditures are spent evenly throughout the year and so you need to have a cash cushion to allow for those times of the year when the expenses are higher than normal or when the revenues are lower than normal.

Following are the results of the various scenarios:

Fiber Everywhere, Municipal Financing

This scenario looks at building fiber everywhere and funding with municipal bonds.

Anticipated Cost

	Revenue Bonds	GO Bonds
Asset Costs	$29.3 M	$29.3 M
Debt	$40.2 M	$36.7 M
Equity	$ 0.0 M	$ 0.0 M
Total	$40.2 M	$36.7 M
Passings		
Fiber	4,626	4,626
Penetration Rates	60%	60%
Years until Positive Net Income	Never	Never
Years until Cash Covers Debt	Never	Never
Cash after 25 Years	($28.3 M)	($27.9 M)

Pros

- Gets fiber to everybody.

Cons

- This model runs out of cash immediately after the end of construction and accumulates large negative cash deficits.
- This could not be financed without some sort of pledge of tax revenue. The project cannot support the cost of bonds.

Fiber Everywhere, Commercial Financing

This scenario looks at building fiber everywhere funded with normal commercial debt, assuming a required 20% equity contribution from the borrower. That 20% could be some combination of cash equity and/or grant financing.

Anticipated Cost

	60% Penetration	70% Penetration
Asset Costs	$29.3 M	$30.6 M
Debt	$27.2 M	$27.9 M
Equity	$ 6.8 M	$ 7.0 M
Total	$34.0 M	$34.9 M
Passings		
Fiber	4,626	4,626
Penetration Rates	60%	70%
Years until Positive Net Income	Never	Year 25
Years until Cash Covers Debt	Never	Never
Cash after 25 Years	($14.4 M)	($10.4 M)

Pros

- Gets fiber to everybody.
- Equity could be cash and/or grants.

Cons

- This model runs out of cash immediately after the end of construction and accumulates large negative cash deficits.
- This could not be financed without some sort of pledge of tax revenue. The project cannot support the cost of bonds.

Hybrid 1, Municipal Financing

This scenario builds fiber in Glenwood, Villard, Sedan, and for those close to backbone fibers. Everyone else in the study area is offered wireless broadband.

Anticipated Cost

	Revenue Bonds	GO Bonds
Asset Costs	$ 9.0 M	$ 9.0 M
Debt	$12.4 M	$11.3 M
Equity	$ 0.0 M	$ 0.0 M
Total	$12.4 M	$11.3 M
Passings		
Fiber	1,358	1,358
Wireless	3,226	3,226
Total	4,626	4,626
Penetration Rates	60%	60%
Years until Positive Net Income	Year 4	Year 4
Years until Cash Covers Debt	Year 13	Year 12
Cash after 25 Years	$23.6 M	$24.0 M

Pros

- Fiber offered to 1,358 homes and businesses. Everybody in the county gets offered some sort of broadband.
- Financial plans are viable and can be financed.
- Builds a backbone fiber that can be used for future fiber expansion.
- Revenues and generated cash flows are sufficient to pay off the bonds well before the assumed 25-year due date.

Cons

- Probably only the fiber portions of the projects would be eligible for DEED grants (although the basis for those grants changes every year).

Hybrid 1, Commercial Financing

This scenario builds fiber in Glenwood, Villard, Sedan, and for those close to backbone fibers. Everyone else in the study area is offered wireless broadband.

Anticipated Cost

	60% Penetration	70% Penetration
Asset Costs	$ 9.0 M	$ 9.3 M
Debt	$ 7.8 M	$ 7.9 M
Equity	$ 2.0 M	$ 2.0 M
Total	$ 9.8 M	$ 9.9 M
Passings		
Fiber	1,358	1,358
Wireless	3,226	3,226
Total	4,626	4,626
Penetration Rates	60%	70%
Years until Positive Net Income	Year 4	Year 4
Years until Cash Covers Debt	Year 14	Year 12
Cash after 25 Years	$12.1 M	$17.8 M

Pros

- Fiber offered to 1,358 homes and businesses. Everybody in the county gets offered some sort of broadband.
- Financial plans are viable and can be financed.
- Builds a backbone fiber that can be used for future fiber expansion.
- Revenues and generated cash flows are sufficient to pay off the bonds well before the assumed 25-year due date.

Cons

- Probably only the fiber portions of the projects would be eligible for DEED grants (although the basis for those grants changes every year).

Hybrid 2, Municipal Financing

This scenario excludes Glenwood and builds fiber to Villard, Sedan, and to those close to backbone fibers. Everyone else in the study area is offered wireless broadband.

	Revenue Bonds	GO Bonds
Anticipated Cost		
Asset Costs	$ 6.5 M	$ 6.5 M
Debt	$ 9.1 M	$ 8.3 M
Equity	$ 0.0 M	$ 0.0 M
Total	$ 9.1 M	$ 8.3 M
Passings		
Fiber	429	429
Wireless	3,226	3,226
Total	3,655	3,655
Penetration Rates	60%	60%
Years until Positive Net Income	Year 4	Year 4
Years until Cash Covers Debt	Year 13	Year 12
Cash after 25 Years	$16.7 M	$17.0 M

Pros

- Fiber offered to 429 homes and businesses. Everybody in the county gets offered some sort of broadband.
- Financial plans are viable and can be financed.
- Builds a backbone fiber that can be used for future fiber expansion.
- Revenues and generated cash flows are sufficient to pay off the bonds well before the assumed 25-year due date.

Cons

- Probably only the fiber portions of the projects would be eligible for DEED grants (although the basis for those grants changes every year).

Hybrid 2, Commercial Financing

This scenario excludes Glenwood and builds fiber to Villard, Sedan, and to those close to backbone fibers. Everyone else in the study area is offered wireless broadband.

Anticipated Cost

	60% Penetration	70% Penetration
Asset Costs	$ 6.5 M	$ 6.7 M
Debt	$ 6.2 M	$ 6.2 M
Equity	$ 1.6 M	$ 1.6 M
Total	$ 7.8 M	$ 7.8 M
Passings		
Fiber	429	429
Wireless	3,226	3,226
Total	3,655	3,655
Penetration Rates	60%	70%
Years until Positive Net Income	Year 4	Year 4
Years until Cash Covers Debt	Year 14	Year 12
Cash after 25 Years	$8.4 M	$13.1 M

Pros

- Fiber offered to 429 homes and businesses. Everybody in the county gets offered some sort of broadband.
- Financial plans are viable and can be financed.
- Builds a backbone fiber that can be used for future fiber expansion.
- Revenues and generated cash flows are sufficient to pay off the bonds well before the assumed 25-year due date.

Cons

- Probably only the fiber portions of the projects would be eligible for DEED grants (although the basis for those grants changes every year).

Breakeven Scenarios, Hybrid Models

There is no breakeven shown for the Fiber-everywhere scenario since it looks impossible for that scenario to generate enough cash to stay cash solvent. But the two Hybrid scenarios can break even at relative low customer penetration rates. Breakeven is defined as a business case where the business always maintains positive cash flow, meaning that the revenues of the business cover the operating expenses, debt payments, and ongoing operating capital costs.

	Hybrid 1 Comm Debt	Hybrid 2 Comm Debt
Anticipated Cost		
Asset Costs	$ 8.5 M	$ 6.3 M
Debt	$ 7.7 M	$ 6.2 M
Equity	$ 1.9 M	$ 1.6 M
Total	$ 9.6 M	$ 7.8 M
Passings		
Fiber	1,358	429
Wireless	3,226	3,226
Total	4,626	3,655
Penetration Rates	43%	49%
Years until Positive Net Income	Year 7	Year 7
Years until Cash Covers Debt	Year 20	Year 20
Cash after 25 Years	$3.6 M	$3.6 M

The breakeven penetration rate is important because it allows assessment of the risks of the project. In this case the Hybrid 1 Scenario can reach cash breakeven by getting a 43% customer penetration rate. That rate seems achievable considering the rural nature of the study area. The Hybrid 2 Scenario needs a 49% penetration, which, while higher than Hybrid 1, still seems like an achievable goal.

What Conclusions Can We Draw from the Financial Scenarios?

We can draw the following conclusions:

- **Fiber Everywhere:** There doesn't seem to be a reasonable business plan for funding fiber to everybody today. The cost of the rural fiber network is too costly. To make this scenario work would require more than 70% equity which is not reasonable. This scenario cannot likely be funded and would require ongoing subsidies to maintain operations.

- **Hybrid 1 Plan:** This scenario builds fiber to Glenwood, Villard, Sedan, and to those living near the backbone fiber that goes to cellular towers. This scenario looks like a good financial opportunity. It has a very reasonably obtained breakeven at 43% residential penetration. If the project can achieve penetration rates higher than 43% (something that is highly likely) the project generates significant excess cash that could be reinvested over time to build fiber to everybody. There are portions of the network that will qualify for DEED grants. For example, the business plan builds fiber to unserved customers in Villard and Sedan as well as to customers that live along the fiber routes that feed the wireless towers.

- **Hybrid 2 Plan:** This plan is the same as Hybrid 1 with the exception that it excludes Glenwood. The breakeven for this scenario is 49% of residential customers. Without Glenwood this scenario generates less cash and takes longer to pay off the debt than the Hybrid 1 plan. But the plan would still be cash-flow positive and generate excess cash at customer penetration rates greater than 49%.

C. Sensitivity Analysis

While each of the financial forecasts is based upon numerous assumptions, only a few of these assumptions have the potential to significantly change the results of the analysis. For example, the results of the studies would change only slightly by changing the assumed salary of one of the new employees. But the study results can change more significantly if changing the interest rates on the debt.

The following sensitivity analysis looks at the impact of changing those assumptions that can most affect the results. We looked at the sensitivity analysis for the two hybrid scenarios. The sensitivity analysis is also based upon the commercial financing option since that is the most likely way a network will be financed.

The sensitivity analysis specifically tested the following variables:

- Changing the interest rate on debt.
- Changing customer data prices by $5 per customer per month.
- Financing part of the project with grants.
- Increasing equity on the commercial loans.

Following are the results of each of these scenarios, compared to the base expected case. This comparison lets you see the bottom line impact of each change.

Sensitivity Analysis for the Hybrid 1 Scenario

Paying a Higher Interest Rate: This looks at the impact of decreasing the interest rate by 100 basis points from 5.5% to 6.5%.

Effect of this Change

	Base Case	Revised Study
Amount Borrowed	$ 7.8 M	$ 8.0 M
Equity	$ 2.0 M	$ 2.0 M
Interest Rate	5.5%	6.5%
Debt Term	20 Years	20 Years

Positive Net Income	Year 4	Year 4
Debt Breakeven	Year 14	Year 14
Cash After 25 years	$12.1 M	$11.3 M

As would be expected, a higher interest rate reduces long-term cash flow. In this case, the cash generated over the study period decreases by $0.8 million.

Increasing Customer Prices: In this scenario, the data prices are increased by $5 per month for both residents and businesses.

Effect of this Change

	Base Case	Revised Study
Amount Borrowed	$ 7.8 M	$ 7.8 M
Equity	$ 2.0 M	$ 2.0 M
Interest Rate	5.5%	5.5%
Debt Term	20 Years	20 Years
Positive Net Income	Year 4	Year 4
Debt Breakeven	Year 14	Year 12
Cash After 25 years	$12.1 M	$14.7 M

This demonstrates that the business plan is sensitive to prices. In this case, increasing the price of the broadband products by $5 increases the cash by $2.6 million over the study period. But this also provides a cautionary tale for this business plan. One of the first things a new business will often do when getting started is to lower the prices in an attempt to get more customers. The impact of lowering the prices temporarily for new customers, such as through an introductory special, would be minor. But lowering the prices permanently would have a significant negative effect on the business plan.

Getting $1M in Grant Funding: This scenario calculates the impact of funding $1M of the project with grants.

Effect of this Change

	Base Case	Revised Study
Amount Borrowed	$ 7.8 M	$ 6.9 M
Equity	$ 2.0 M	$ 1.7 M
Grant Funding	$ 0.0 M	$ 1.0 M
Interest Rate	5.5%	5.5%
Debt Term	20 Years	20 Years
Positive Net Income	Year 4	Year 4
Debt Breakeven	Year 14	Year 12
Cash After 25 years	$12.1 M	$13.4 M

As would be expected, funding part of the project with a grant lowers both the amount that must be borrowed as well as contributed equity. This shows that a $1 M grant would reduce borrowing by $0.9 M while also increasing generated cash flow for the project by $1.3 M.

Increasing Contributed Equity: In this scenario, the contributed equity was increased from 20% of the financing costs for the project to 30%.

Effect of this Change	Base Case	Revised Study
Amount Borrowed	$ 7.8 M	$ 6.7 M
Equity	$ 2.0 M	$ 2.9 M
Interest Rate	5.5%	5.5%
Debt Term	20 Years	20 Years
Positive Net Income	Year 4	Year 4
Debt Breakeven	Year 14	Year 12
Cash After 25 years	$12.1 M	$13.6 M

The amount of the loan drops by $1.1 M which results in cash for the project also increasing by $1.5 M. This means the entire benefit from increasing contributed equity is completely negated by the cash generated at the project. There is no benefit to increasing equity unless required by the lender.

Sensitivity Analysis for the Hybrid 2 Scenario

Paying a Higher Interest Rate: This looks at the impact of decreasing the interest rate by 100 basis points from 5.5% to 6.5%.

Effect of this Change	Base Case	Revised Study
Amount Borrowed	$ 6.2 M	$ 6.3 M
Equity	$ 1.6 M	$ 1.6 M
Interest Rate	5.5%	6.5%
Debt Term	20 Years	20 Years
Positive Net Income	Year 4	Year 4
Debt Breakeven	Year 14	Year 15
Cash After 25 years	$8.4 M	$7.7 M

As would be expected, a higher interest rate reduces long-term cash flow. In this case, the cash generated over the study period decreases by $0.7 million.

Increasing Customer Prices: In this scenario, data prices were increased by $5 per month for both residents and businesses.

Effect of this Change	Base Case	Revised Study
Amount Borrowed	$ 6.2 M	$ 6.2 M
Equity	$ 1.6 M	$ 1.6 M
Interest Rate	5.5%	5.5%
Debt Term	20 Years	20 Years
Positive Net Income	Year 4	Year 4
Debt Breakeven	Year 14	Year 13
Cash After 25 years	$8.4 M	$10.5 M

This demonstrates that the business plan is highly sensitive to prices. In this case, increasing the price of the broadband products by $5 increases the cash by $2.1 million over the study period.

Getting $1M in Grant Funding: This scenario calculates the impact of funding $1M of the project with grants.

Effect of this Change	Base Case	Revised Study
Amount Borrowed	$ 6.2 M	$ 5.3 M
Equity	$ 1.6 M	$ 1.3 M
Grant Funding	$ 0.0 M	$ 1.0 M
Interest Rate	5.5%	5.5%
Debt Term	20 Years	20 Years
Positive Net Income	Year 4	Year 4
Debt Breakeven	Year 14	Year 13
Cash After 25 years	$8.4 M	$9.4 M

As would be expected, funding part of the project with a grant lowers both the amount that must be borrowed as well as contributed equity. This shows that a $1M grant would reduce borrowing by $0.9 M but increasing generated cash flow for the project by $1.0 M.

Increasing Contributed Equity: In this scenario, the contributed equity was increased from 20% of the financing costs or the project to 30%.

Effect of this Change	Base Case	Revised Study
Amount Borrowed	$ 6.2 M	$ 5.3 M
Equity	$ 1.6 M	$ 2.3 M
Interest Rate	5.5%	5.5%
Debt Term	20 Years	20 Years
Positive Net Income	Year 4	Year 4
Debt Breakeven	Year 14	Year 12

Cash After 25 years	$8.4 M	$9.5 M

The amount of the loan drops by $0.9 M while the cash generated increases by $1.1 M. This means the entire benefit from increasing contributed equity is completely negated by the cash generated at the project. There is no benefit to increasing equity unless required by the lender.

The takeaway from the sensitivity analysis is that the financing details are crucial to the potential success of the business. In this case the most sensitive variable is customer pricing, so care must be taken in setting those prices since an overall difference of $5 per customer per month in rates makes a significant difference in performance.

The analysis also shows that these business plans are not particularly vulnerable to changes in interest rates paid on debt as long as the changes aren't too large. Unless something drastic happens to the economy it's hard to imagine a 1% swing in interest rates that was used in this analysis.

It's also obvious and intuitive that obtaining grant funding makes a significant difference in funding a project. First, lenders view grants the same as equity, making it easier to borrow. But maybe even more significant is the bottom line impact to a service provider by saving on contributing their own equity and the benefits of borrowing less.

The analysis also shows that the impact of increasing the equity of these business plans is minor. The increase in cash generated by the project is roughly equal to the savings on financing costs – so the goal ought to always be to put in the minimum amount of equity needed to obtain financing.

EXHIBIT I: SERVICE AREAS OF THE INCUMBENT TELEPHONE COMPANIES

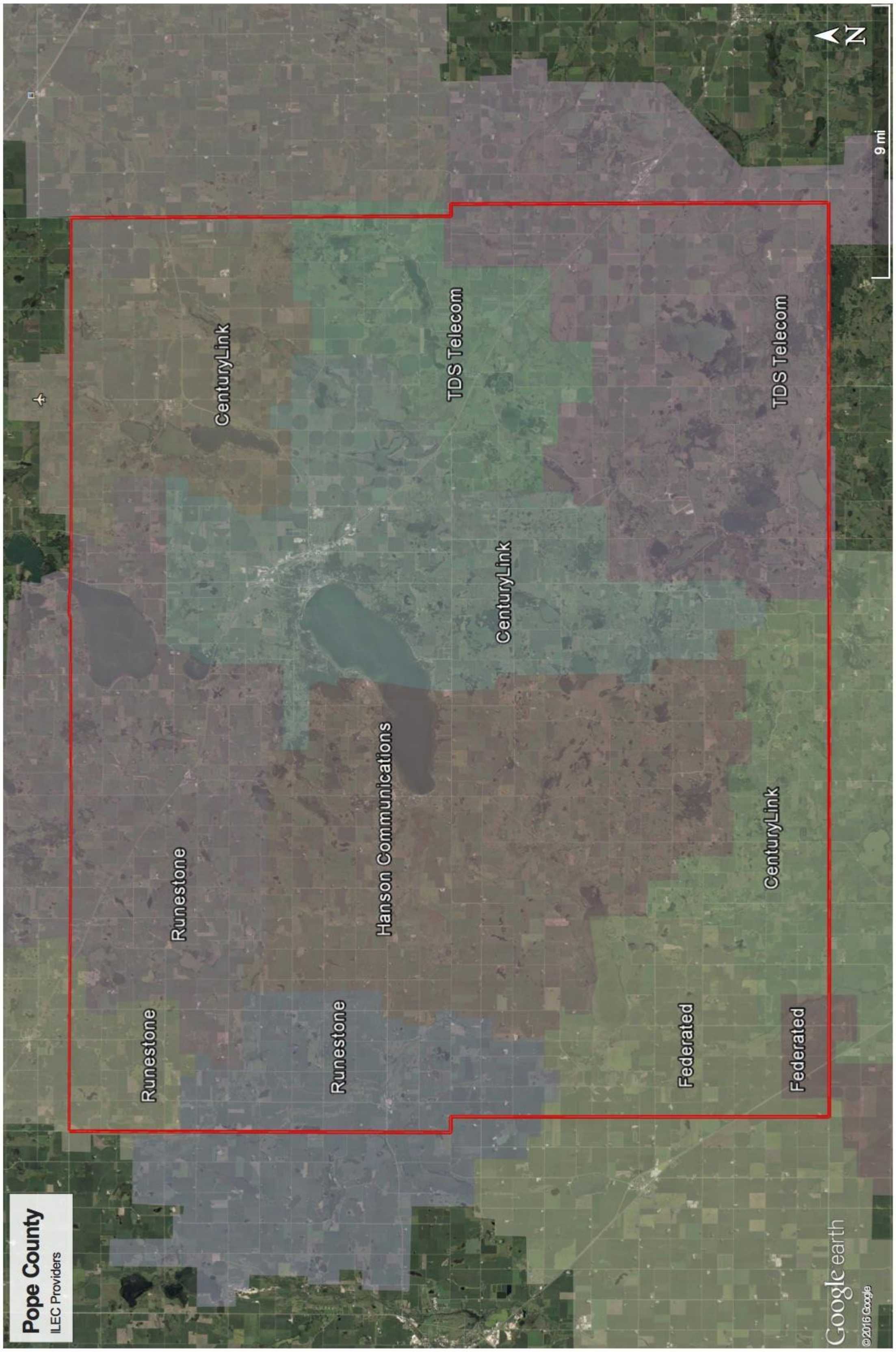

EXHIBIT II: STUDY AREA

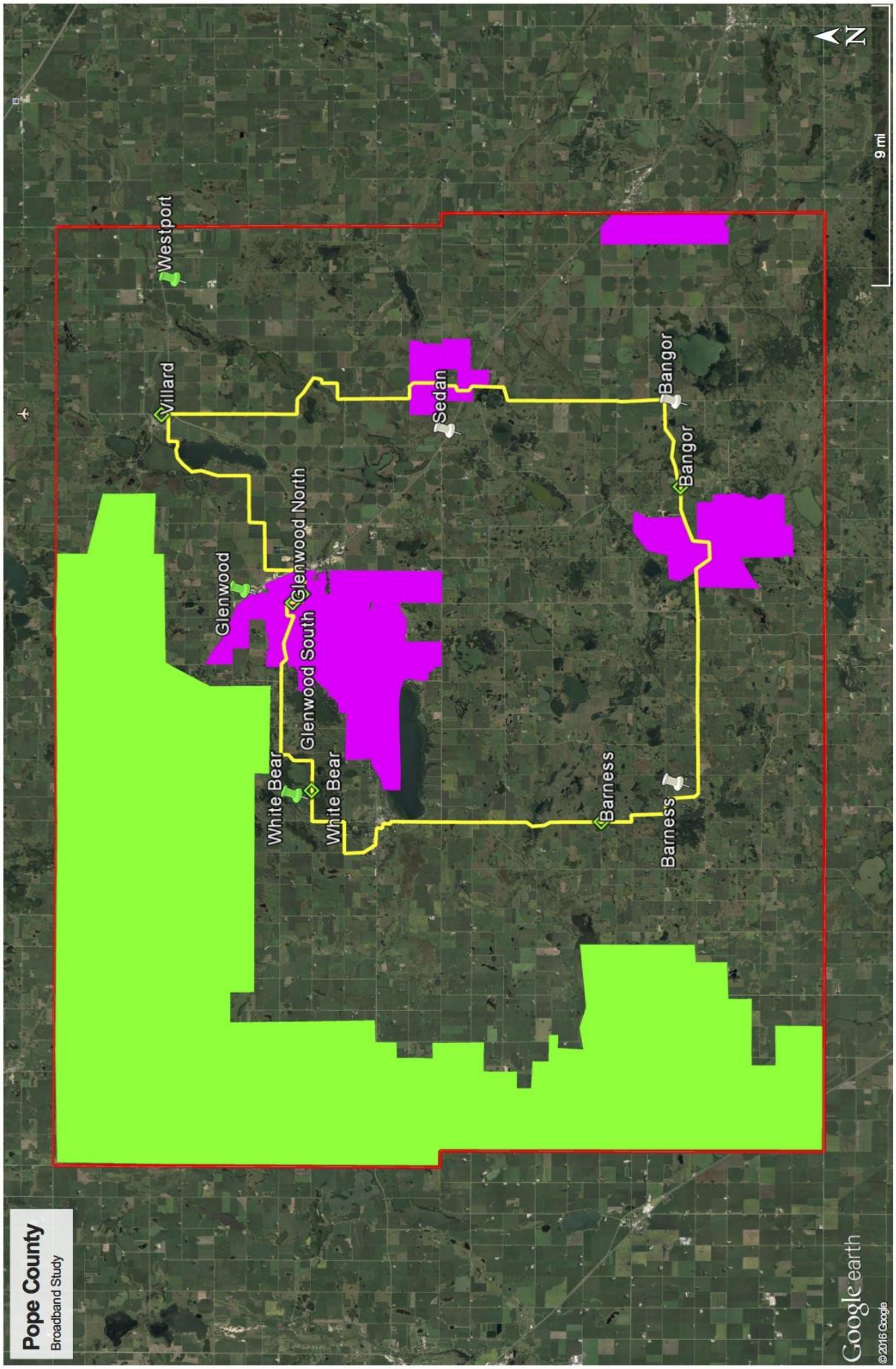

EXHIBIT III: MAP OF THE PROPOSED FIBER RING

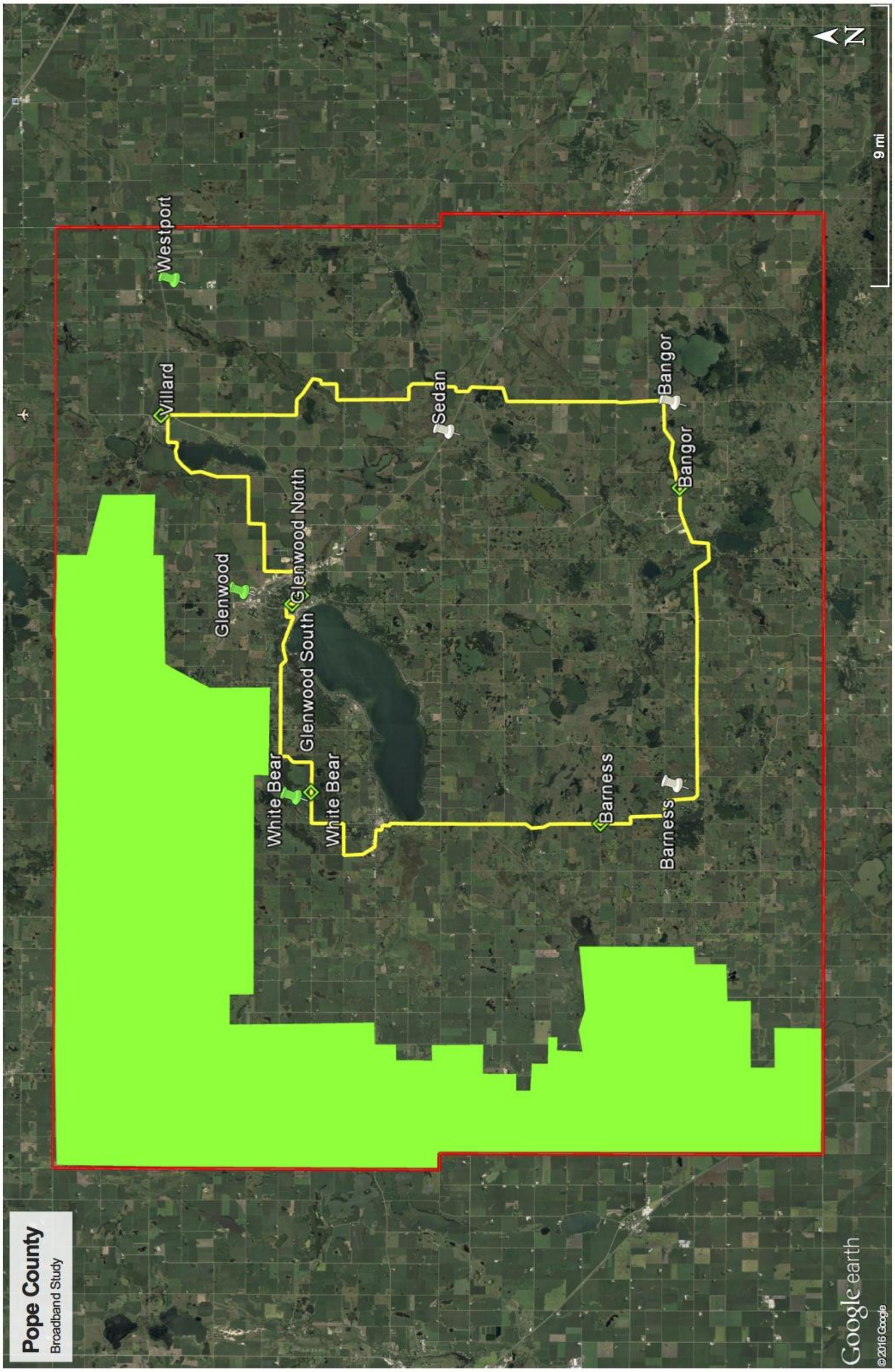

EXHIBIT IV: PROPAGATION MAP OF WIRELESS COVERAGE