

# **Manchester Township Options for a Broadband Network**

**November 19, 2018**

Doug Dawson  
President  
CCG Consulting



# Table of Contents

	Page
<b>I. Executive Summary .....</b>	<b>3</b>
<b>II. Findings / Recommendations .....</b>	<b>5</b>
<b>III. Next Steps .....</b>	<b>8</b>
<b>IV. Engineering Analysis.....</b>	<b>11</b>
A. Primary Engineering Assumptions .....	11
B. Fiber Network Design Parameters .....	14
C. Network Costs .....	21
D. A Wireless Network? .....	27
<b>V. Results of the Financial Analysis .....</b>	<b>31</b>
A. Studies Considered.....	31
B. Business Plan Assumptions .....	32
C. Summary of Financial Findings .....	36
D. Findings from the Financial Analysis .....	47
E. Financing Options.....	48
<b>VI. Business Structure .....</b>	<b>56</b>
A. Standalone Commercial ISP / Cooperative .....	56
B. Partnering with Other Townships.....	60
<b>VII. Other Issues.....</b>	<b>60</b>
A. Connect America Fund.....	60
B. Faster Broadband Coming? .....	62
<b>VIII. Exhibits .....</b>	<b>69</b>
A. Exhibit I. Map of CAF II Coverage in Washtenaw County .....	69
B. Exhibit II. Summary of Financial Results .....	70

# I. Executive Summary

Manchester Township hired CCG Consulting to look at options for funding a broadband network and solution for the rural portion and/or all of the township. While we've done hundreds of similar studies over the years, this is one of the smallest communities we've ever studied and we knew it was going to take some creativity to find a workable solution.

In our first conversation with the township broadband committee we heard that the hope was to be able to finance the study with something other than tax financing. This meant concentrating on scenarios that use normal bank financing and providing service using a commercial ISP or a cooperative.

There are three factors that make it a challenge to create a viable broadband solution in the township:

- The small number of potential customers in the rural township;
- County policy on burying fiber;
- The likely requirement that funding will require significant equity.

The rural township has just over 1,000 residences and businesses. This creates several challenges to building a self-sufficient fiber business. First, the density is low; there are slightly less than 10 households per mile of road. The low density means that the cost of building fiber is expensive when calculated on a cost per home. The relatively small number of residences also means that it will be challenging to operate a profitable ISP serving such a small number of customers. Operating an ISP is an economy-of-scale business, meaning the business is more efficient with greater numbers of customers. It's hard to perform some of the basic needed ISP functions with a small customer base.

The county has a policy that requires burying fiber in the public rights-of-way. That's routine around the country. However, in the township the public right-of-way, which is 10-15 feet off the side of roads, passes through trees and woods for the majority of the rural portion of the township. Construction in wooded areas is significantly more expensive than burying fiber in the ditches on the edge of roads. The cost of the fiber is the largest cost component of bringing broadband to the township, and this project will need to find the lowest possible cost of construction in order to be reasonably feasible.

Our study considered different methods of fiber construction, and the two lowest cost options are to put fiber on existing utility poles or to place it in the ditch on the side of roads. If you want to move forward after this feasibility study we've made two recommendations concerning fiber costs. First, you should pay up-front for additional engineering to determine the lowest possible cost of construction. The chances are that the cheapest solution might be some mix of aerial and buried fiber. We believe our cost estimates are conservative, and they include a 10% construction contingency, and with more engineering you could more definitively know the cost of fiber. Second, we recommend that you lobby the county to make an exception to build along the side of roads. This is a common construction methodology and we can demonstrate that this won't cause harm to the roads. If the county is at all reasonable they ought to be willing to consider relaxing that restriction.

Even if you are able to achieve the lowest cost network possible, this is still an expensive project when it has to be paid for by a low number of households. We considered business plans that also build fiber in the Village. That adds more customers to the size of the business to make it more efficient. Because the Village has a higher household density, adding them to the study also lowers the cost of the network per customer.

The biggest challenge to make this work is going to be to obtain financing. If the project is not funded with tax revenues, then any solution that means raising money conventionally at banks is going to require significant equity. Equity means cash that is put into the business that is not a loan – and that means somehow coming up with cash from residents of the township to help fund the network.

The most optimistic amount of equity needed is \$3.6 million, and most scenarios require more than that (as mentioned earlier, this mostly depends of the cost of building the fiber). That amount of equity would require a contribution by each homeowner up front of \$3,550 or else monthly payments of \$47 per month if financed over 10 years or \$35 per month if financed over 15 years. The residents of the rural part of the township are going to really want broadband to be willing to finance it this way out of their pockets.

Any solution is going to be expensive for homeowners, and it's important to remember that if you don't find a solution nobody else is likely to bring broadband to the township. AT&T is likely to eventually offer cellular broadband with speeds in the range of 10 Mbps. It's unlikely that you are going to see anything better than that unless you find your own solution.

You also asked us to consider a wireless option. Our engineers report that the woods and trees in the township makes it difficult to serve more than perhaps half of the people in the rural areas with wireless broadband. The trees also mean that many customers wouldn't get the same kind of fast speeds that you hear about for wireless networks in places like open farming areas.

Following is a summary of the results of the study, followed by specific recommendations of what you should do next if you want to keep moving with the idea of getting broadband.

## II. Findings / Recommendations

Following are the key findings of our investigation:

### THE PROBLEM

**Lack of Broadband.** This study was initiated because there is no reasonably priced quality broadband in the rural parts of the township. While the Village has broadband options, there is almost no broadband in the areas outside the Village. Areas without broadband suffer in many ways including lower housing prices and difficulties selling homes, major challenges for families with students, the inability to work at home and the inability to take part in a society where more and more things are done online.

### BASIC FACTS ABOUT THE TOWNSHIP

**The Study Area.** We studied two scenarios. The primary concern is to find broadband for the rural areas outside of the Village. The primary study area is those rural areas. Since the best network solution for the rural areas includes building a fiber through the Village, this basic study area also includes those in the Village living near that fiber route. The second study area is the entire township including the Village.

**Potential Customers.** We used several local sources of data for counting homes and businesses in the two study areas. For the study we wanted to count potential customers, which in the telecom industry are called passings. The passings (potential homes and businesses) used for the study areas are as follows:

<u>Rural Study Area</u>	
Rural Households	1,012
Rural Businesses	18
Village Households near to fiber	114
Village Businesses near to fiber	<u>28</u>
Total	1,172

<u>Total Township Study Area</u>	
Rural Households	1,012
Rural Businesses	18
Village Households	938
Village Businesses	<u>51</u>
Total	2,019

**Road Miles.** The road miles considered in the studies are as follows. Note that all studies include a fiber route built to Chelsea to provide a connection to the Internet.

Rural Study Area

Roads with Public Right-of-Way in Township	86.0
Road with Private Right-of-Way in Township	17.0
Road on way to Chelsea (public right-of-way)	11.0
Streets passing through the Village	<u>1.5</u>
Total	115.5

Total Township Study Area

Roads with Public Right-of-Way in Township	86.0
Road with Private Right-of-Way in Township	17.0
Road on way to Chelsea (public right-of-way)	11.0
Streets passing through the Village	<u>17.0</u>
Total	131.0

**ENGINEERING FINDINGS**

**Aerial vs Buried Fiber.** We considered network designs for both buried and aerial fiber (on poles). In general, buried fiber is preferred, when affordable, since it provides the lowest ongoing maintenance costs.

There is one major issue with burying fiber in the roadways. The county has a policy of only allowing fiber to be placed in the public rights-of-ways. In the township that right-of-way was established many decades ago and today the right-of-way is in the middle of trees and woods on the side of the road for most properties. The county will not allow burying fiber in the ditches along the side of roads. Placing the fiber in the trees means constructing through the woods using a process known as boring. The fiber could be placed along the edges of the road on the 17 miles of private roads in the township (assuming the road owners give permission). Boring through the woods is much more expensive than plowing the fiber on the sides of the road and makes the project too expensive to consider.

It’s also possible to place the fiber on the existing electric utility poles. These poles are largely on private rights-of-way that were obtained by the electric company when they built the electric grid.

**Electronics.** The electronics chosen for the design use a technology called Passive Optical Network (PON). This network can deliver a gigabit of broadband to each home and business (and more if needed).

**Total Asset Costs.** Following are the assets required to launch each of the three different construction scenarios. These assets assume the business would have a 70% customer penetration rate. The asset costs would increase or decrease with greater or fewer customers.

<u>Rural Study Area</u>	<u>All Buried</u>	<u>Aerial in Public Right-of-Way</u>	<u>All Aerial</u>
Fiber	\$7,630,000	\$6,000,000	\$4,860,000
Electronics	\$ 501,293	\$ 501,293	\$ 501,293
Drops	\$ 744,111	\$ 744,111	\$ 744,111

Operational Assets	\$ 558,335	\$ 558,739	\$ 558,739
Total	\$9,433,739	\$7,803,739	\$6,663,739

<u>Total Village Study Area</u>	<u>All Buried</u>	<u>Aerial in</u>	
		<u>Public Right-of-Way</u>	<u>All Aerial</u>
Fiber	\$ 8,384,000	\$6,744,000	\$5,604,000
Electronics	\$ 798,892	\$ 798,892	\$ 798,892
Drops	\$ 1,095,407	\$1,095,407	\$1,095,407
Operational Assets	\$ 645,145	\$ 645,145	\$ 645,145
Total	\$11,223,444	\$9,283,444	\$8,143,444

There are additional ways to lower the fiber costs. The above estimates are conservative and include a construction contingency. If more engineering was done before financing, it's possible that the contingency might not be needed. Additionally, the prices for the electronics and fiber drops assume paying an external contractor to make the installations. There is a savings possible if installations were made by the ISP staff – however, it would take a lot longer to connect everybody to the network.

**Wireless Alternatives.** There doesn't appear to be any wireless alternative that can bring broadband to every household in the rural township areas. Even if a network design could be found to serve a majority of households, the speeds will be far slower than bringing fiber.

## **BUSINESS PLAN RESULTS**

**Business Structure.** If the study can't be financed with tax revenues, then the only viable business structures are to create your own ISP or possibly somehow join an existing cooperative. The two likely structures for a commercial ISP would be a for-profit corporation or a cooperative. The financial results also show that it's not feasible to ask a commercial ISP to operate the business since the profits they would want to make for operating the business adds too much cost for the business to cover.

**Penetration Rate.** The penetration rate is the percentage of potential customers in the study area that buy service. The base studies assume a 70% penetration rate in the rural areas and a 60% penetration in the Village. We considered options with higher penetration rates for the rural township.

### **Business Plan Results**

There is a detailed description of the results in Section V of this report. There is also a high-level comparison of all studies considered in Exhibit II.

**Rural Study Area – Fiber.** It doesn't look feasible to bury the network, but there are feasible options with an aerial network on poles. There is no scenario using standard bank financing (providing 20% equity) that looks feasible – none of the study scenarios generate enough cash to cover debt payments. This scenario looks to be feasible if a large amount

of equity (\$5 million to \$6 million) can be used to help fund the construction. That is a large amount of equity to raise in a rural township area that only has 1,012 homes.

**Whole Village Study Area.** It also doesn't look feasible to bury the fiber in this scenario. There are no feasible scenarios that are viable with normal bank financing (20% equity). However, there seem to be numerous options for making this work with more equity (between \$3.2 million and \$4.6 million). There are scenarios using the higher equity that return significant cash profits over 20 years, higher than the equity provided.

**Sensitivity Analysis.** All studies include numerous assumptions that are described in Section V. There are factors that could improve the study results. Primary would be getting more customers than the predicted 70% penetration. There are also improved financial results with lower interest rates or higher prices. There would also be financial benefits from partnering with other townships to create an ISP.

### **III. Next Steps**

Here we address the steps that we think come next after the township digests this report.

#### **Cost of Fiber Construction**

The cost of building fiber is the most significant cost of getting broadband in the township. The goal is to find the lowest construction cost possible. Our studies are always a little conservative on the high side, and you should pin down the cost of the network before seeking funding. That's going to require some additional engineering. The good news is that engineering won't go to waste and would be the first step you'd take if building the network.

There are several areas where detailed engineering might point to lower construction costs. First is for what the industry calls make-ready for placing fiber on poles. This is the work that is done prior to hanging fiber on poles. We've estimated that cost at \$20,000 per mile of aerial fiber. That's an average cost we've heard from several contractors that build fiber in Michigan. However, we hope that cost will be lower in the township. The poles there don't carry many different wires like exist in many other places. We also observe that the power company seems to have done a reasonable job in trimming trees around the existing poles. An accurate estimate of the make-ready costs requires an engineer to look closely at each existing pole. Once done you'd have an accurate estimate rather than our high-level one.

Our study also includes a 10% construction contingency. We always add that in a feasibility study to make sure our estimate is high enough. Once you've done more engineering that cushion can likely be lowered, and maybe even eliminated. In the financial analysis we've looked at the impact of saving construction money in this manner, which is labeled as the "lowest cost" of construction.

## **Lobby the County**

One of the issues that contribute to the high cost of fiber is a requirement by the county that buried fiber be placed into the public right-of-way. That's not an unusual requirement, but in the township that right-of-way is 10 – 15 feet off the side of the roads, meaning it runs through woods and trees. Burying fiber in the woods is expensive. There is a much less expensive option if you could place fiber in the ditches at the edges of the roads. We are aware of many places in Michigan where companies like AT&T and Frontier have placed fiber at the edge of the roads – that construction probably preceded any restrictions by the county. The county seems adamant about this requirement and it's going to require an exemption from them to place fiber at the edge of roads. From a practical perspective building at the edges of the roads is a great solution. There are very few existing utilities using that space and the construction can be done without harming the public roadbed.

## **Determine the Business Structure**

There are several options for business structure:

- Create a for-profit ISP corporation
- Create a for-profit cooperative
- Somehow join an existing cooperative
- Partner with any of the above with other townships.

If you want to consider starting a new cooperative, then research needs to be done on exactly what that means in Michigan. We recommend that you get legal advice from a lawyer that specializes in cooperative law as well as a regulatory lawyer who can make sure there are no additional specific legal impediments or hurdles in the state for cooperative broadband companies.

It might be possible to somehow meld this venture into an existing cooperative. That will be complicated by the fact that this project needs significant funding, but it's not impossible to make this happen.

## **Get Feedback from Citizens**

Since you can't use tax financing, the only way to finance the network is by some form of bank financing. Banks don't make loans for 100% of the cost of projects and will require a significant equity contribution to make the project viable. While there might be a few sources of external equity, all or most of the equity is going to have to come from homeowners.

The most optimistically low amount of equity needed is \$3.6 million, and most scenarios are higher than that (as mentioned earlier, this mostly depends of the cost of building the fiber). That lowest amount of equity would require a contribution from each homeowner up front of \$3,550 or else monthly payments of \$47 per month if financed over 10 years or \$35 per month if financed over 15 years. The residents of the rural part of the township are going to need to really want broadband to be willing to finance it this way out of their pockets.

### **Socialize This with Other Townships**

There looks to be significant financial savings if an ISP or cooperative could be formed to include other townships. The fiber business benefits from economy of scale, and so forming a larger ISP brings expense savings for all participants. In addition to operational efficiency from serving a larger number of customers there is also other savings from working with other townships. For example, the study includes the cost of building fiber to Chelsea to connect to the Internet. However, if one or more of the townships north of you also decided to build fiber this expense could be reduced or eliminated.

### **Investigate what it Means to be an ISP**

You might be intimidated by the concept of creating a cooperative or other business to operate a ISP. This is something that CCG has done many times. A detailed description of that process is beyond the scope of this project and you might want to engage us to help you understand the effort required once you get that far along in the process.

### **Talk to Local Banks**

One of the keys to making a project work without tax financing is to borrow money from a bank or other similar source of funding. In our experience the place to start is usually at local banks, so you might want to go ahead and seek local bank that might be interested in the project.

### **Pledge Drive / Build Only to Success**

If you get serious about the project, one of the most important factors will be how many people will agree to join the new network. The only reliable way to do this accurately is with what we call a pledge drive. This involves getting every homeowner in the township to tell you if they would be willing to pledge to buy broadband on the network. You'll definitely need a firm commitment for anybody that would have to contribute equity. You'll want to undertake a pledge drive before getting serious about funding.

## IV. Engineering Analysis

In this section we will look at the engineering analysis performed as part of this study. The purpose of our engineering estimate was to find the most affordable fiber for serving everybody in the township. Derrel Duplechin of CCG visited the township to look at local conditions that affect network costs.

### A. Primary Engineering Assumptions

Following are the primary assumptions made in designing and determining the price of the fiber network.

#### Passings

In the telecom industry we use the term passing to mean any home or business that is near enough to the network to be a potential customer. We worked with the township and also looked at several sources of Census data to determine the number of potential passings in the study areas.

We also counted businesses in the study area. For a fiber study we are interested in counting businesses that have their own physical address, meaning that we don't count home-based businesses, farms, or any other business that doesn't have a separate standalone street address. We've found the best way to count businesses in this manner is to use the street view in Google Maps to identify business locations.

We settled on the following passing to be used in the study:

Rural Township	
Households	1,012
Businesses	<u>18</u>
Total	1,030

Village	
Households	938
Businesses	<u>51</u>
Total	989

Additionally, in the township model the network design requires a fiber that would pass through the Village. The model assumes that residences and businesses close to that fiber were potential passings. This consists of:

Fiber Passing through the Village	
Households	114
Businesses	<u>28</u>
Total	142

When these passings are added to the rural township passings, the total passings for rural studies are 1,172. The total passings for the whole township study is 2,019.

### **Miles of Fiber Construction**

It appears to us that fiber would have to be built on almost all existing roads in the township in order to provide service. In an actual engineering design there might be a few places, such as near the end of a road or street where there could be a small savings from not building to every road mile, but such savings would be tiny. We counted road miles by using GIS data provided by the county. The GIS maps provide accurate locations and measurements for the existing roads.

The study was performed using all “named” roads in the township. That is, any road that has a number or a name. This would have excluded private lanes and long driveways as direct fiber miles – although customers in such circumstances would still get fiber.

There are several kinds of roads in the township. The majority of roads have existing public rights-of-way. This would be roads that are built and maintained by the state, county or Village. Public rights-of-way were established many years ago, generally when an area first got electric service. All utilities have the inherent right to build on public rights-of-way. However, to do so generally requires a permit from the government entity that owns and maintains each section of the road.

There are some private roads in the township. Building along these roads requires obtaining rights-of-way from the owners of the roads, be that private citizens or neighborhood associations. These are generally, but not always, easy to obtain – but a private owner is not legally obligated to allow a construction along their road. Rather than filing formal permits, the process for gaining private right of way is to ask for written permission by each owner of roadway.

Following are the number of miles of road included in the two separate studies we considered:

<b>Rural Business Plan</b>	
Roads with Public Right-of-Way in Township	86.0
Road with Private Right-of-Way in Township	17.0
Road on way to Chelsea (public right-of-way)	11.0
Streets passing through the Village	<u>1.5</u>
Total	115.5
<b>Total Rural Plus Village Plan</b>	
Roads with Public Right-of-Way in Township	86.0
Road with Private Right-of-Way in Township	17.0
Road on way to Chelsea (public right-of-way)	11.0
Streets passing through the Village	<u>17.0</u>
Total	131.0

In the broadband world we consider the cost of networks in terms of relative density. Since there are 1,030 passings along 115.5 miles of roads in the rural township, the density is 9 homes per

mile of fiber. That is definitely a rural density number. It's easy to contrast this with the village, where with 17 miles of streets the density is 58 homes per mile of fiber.

Most traditional cable companies won't build in neighborhoods where the density is lower than 20 homes per mile – and that is generally used as the dividing mark between rural and non-rural density.

### **The Issues of Building Fiber in the Township**

There are several issues affecting the cost of building fiber in the township that are unusual compared to most places in the country.

#### County Right-of-Way Issue

We learned when Lyndon Township wanted to construct a fiber network that the county has a policy that forces anyone that wants to bury a new utility to build in the public right-of-way. That is not an unusual requirement.

A utility right-of-way is a zone that is set aside by the road owner where utilities are allowed to place facilities, be that fiber, water lines, gas lines, utility poles, and so forth. Most roads have a right-of-way zone on both sides of the road. The exact dimensions of rights-of-way vary locally and are determined by the specific road owner. In many places, particularly in towns, the underground rights-of-way are somewhere directly under the streets. A city doesn't want to have to tear up sidewalks or deal with tree roots growing through utility lines and most towns allow utilities directly under streets. In bigger towns where all of the utilities are underground, even this wider right-of-way can get very crowded, and it's sometimes hard to find a place to put new fiber.

However, in the township these official rights-of-ways are located roughly 10 feet from the edge of the road and have been almost entirely overgrown with trees since they were established many years ago. The county seems to be inflexible on this issue. Building in the woods is more expensive than building along the edges of the roads. Trees must be cleared and cut in the crowded and wooded public rights-of-way – something residents generally don't want.

To some degree the county's position is unfair. First, over time they've allowed companies like Frontier and AT&T to build directly under or along the roads in other parts of the county. There are numerous places where there are underground cables running under the edge of the road rather than in the official rights-of-way. We suspect this means that the county either didn't enforce this policy in years past, or perhaps that these telcos didn't ask for permission to build outside the official right-of-way.

Further, there is plenty of "empty" and available building spaces in the ditches and areas immediately touching the roads. There are very few existing utilities in these spaces and there would be no harm to the roads or to other utilities to allow fiber construction along the roads rather than in the woods.

One way to control the cost of building fiber would be to lobby and pressure county officials into being more reasonable. However, Lyndon Township tells us that they were unable to get such permission and believes this would be an uphill battle.

### **Location of Utility Poles**

Interestingly, much of the existing power poles are not in the public rights-of-way. They are mostly further off the roads and the power company obviously obtained private permission to place the poles many years ago when they first built the local power grid.

It looks like the power company has done a pretty good job keeping the power line paths open. They seem to be doing routine tree trimming and other maintenance so that they can get access to the pole lines when there are problems.

Having the poles on private rights-of-way creates some interesting issues. Most parties that own poles in public rights-of-way are required by federal law to allow access to those poles to anybody that wants to place a wire on them. The two exceptions are rural electric coops and poles owned by municipal electric companies.

In the township the utility poles are owned by Consumer Energy. They are a large for-profit electric utility and they have allowed other utilities to share their poles all over the region. However, the vast majority of the Consumer poles around the state are probably located in public rights-of-way where they are required by law to allow access. Our guess, however, is that the company won't make a distinction between public and private right-of-way and will allow new fiber on all of their poles. But theoretically they could say no to placing fiber on the poles or even on the ground beneath the poles. Electric companies, in general, want other utilities on their poles. They charge annual rental fees to be on each pole and they like the extra revenue.

## **B. Fiber Network Design Parameters**

Our design goal was to look at the most affordable option for getting fiber to every home in the township. We looked at several different options for building fiber:

- Boring Fiber. Boring uses a construction technique that digs a hole to a depth of perhaps 3 – 4 feet and then uses a drill to bore horizontally through the soil. This creates a path through which empty conduit is pulled, and once in place, fiber is pulled through the conduit. This is the most expensive kind of fiber construction and the boring process is slow and tedious as numerous short sections of the network are constructed with each boring sequence.

Boring is the only reasonable technique to use if the network was to be built in the public rights-of-ways that run through the trees along the sides of the road. This boring process would bore through tree roots and other obstacles along the path, other than large rocks.

- Plowing Fiber. Plowing is a technique where a specialized plow, built into a large truck or a device like a backhoe pushes a conduit into the ground. This technique can only

work where there is easy access to the fiber path – no trees or other impediments, and where the ground is soft enough to accept the plow. In the township this technique could be used if the network was to be placed in the ditches along the sides of the various dirt roads. Plowing in those areas, just off the road, is not disruptive to the road surface.

Even when plowing is used there is a requirement for some boring. For example, it might be necessary to bore under a driveway where the plow would otherwise encounter macadam. Boring is still often used to reach houses on the opposite side of the road. For example, if fiber was plowed along the left side of a road, connections could be made to that fiber to serve customers that live on that same side of the road. However, the fiber must somehow cross the road to get to customers on the right side of the road. For unpaved private roads the road owner might also allow these crossings to be plowed, but doing so digs a small ditch through the roadway. For most roads the fiber must be bored under the road so that the road surface is not disturbed.

Plowing might also be an option to place fiber in the ground underneath the existing electric utility poles. The biggest question that would need to be answered is if there is enough clearance along those paths for the cable plow. The cost for plowing under the electric poles is probably a little less expensive than plowing along the side of the road since there are probably fewer impediments to work around. But building further off the road in the pole right-of-way means a longer bore to reach the other side of the road. Overall this probably costs roughly the same as plowing in the roadside ditches.

In both bored and plowed construction, part of the cost of the network is the creation of access points where the ISP can tap into the fiber. These access points are either placed in pedestals (small boxes that sit along the fiber path) or handholes (devices in the ground with a cap, much like many water meters).

- Aerial Fiber. As has already been discussed, fiber can be placed on existing utility poles. The number one issue of getting fiber onto poles is if there is enough space on the poles to accept a new fiber. If there is not enough space, then the fiber builder must pay for extra work that's called "make-ready" in the telecom industry. FCC rules say that it is the financial responsibility of a new attacher to a pole to pay for any work needed to move or rearrange the existing wires on a pole.

Make ready could be simple and only need a few existing wires rearranged to make space. However, make-ready can be expensive if the poles don't have enough room and the new fiber provider would need to pay to build new poles and to move all of the existing utilities to the new pole.

Our observation of the poles in the township is that they are reasonably ready to accept a new fiber. Since the poles are largely in the woods there is much of the network we didn't see on our visit, and determining the exact cost of make-ready would be a first step to take before building a network.

Our fiber design provided a fiber for every existing passing in the township. The design was also robust enough to provide fibers for the many vacant lots in the township, so it could accommodate growth for many years – possibly for decades unless there is a pocket of extraordinary growth. Any buried fiber will be in conduit, which is a big plastic tube, generally orange. Additional fiber can be pulled through the conduits in the future should the need for more fiber arise – at a greatly lower cost than building new fiber.

One important aspect of the network design is that a fiber is constructed to Chelsea, which is the nearest place where your network can connect to the open Internet. We could not find any fiber that could be used to make this connection in the township or anywhere nearer than Chelsea. It would be possible to pick up some extra revenues by serving homes along this fiber – with the caveat that there aren't a lot of passings located directly along Highway 52.

There are a number of pros and cons for deciding between an aerial and a buried network. In Michigan, which frequently has ice storms, wires on poles can be damaged and broken. We find it to be a telling indicator that AT&T doesn't have their wires on the poles – because the company has almost always chosen poles over buried construction when the option is available. However, other factors might have affected AT&T's decision, such as not wanting to build on private right-of-way or not coming to terms with the electric company.

When the price differential is not too large, our clients almost always choose a buried network. Buried fiber is not susceptible to storm and weather damage. Even in areas that flood, the fact that fiber carries no current is not a problem. Buried fibers are prone to being cut by construction and in some parts of the country that seems to be a recurring issue. In the township we'd expect a decent number of fiber cuts in the future on a buried network when new homes are built. Contractors are pretty careful to locate and not cut existing utilities in towns, but we see far less care taken in rural areas.

The big difference between the two kinds of construction is generally cost, which will be discussed in more detail below.

### **Active versus Passive Electronics**

One of the first decisions to be made when looking at a fiber network is determining if it is better to use active or passive fiber electronics.

An Active Optical Network (AON) dedicates a fiber for each user between the customer location and the electronics hub. This means each customer has a dedicated path to the electronics and does not share bandwidth directly with another customer in the neighborhood. An AON network has many more field lasers than a passive network since there are two lasers for each customer at the two ends of the network.

In an AON network, everything is encoded as data between the electronics and the customer. This means all services must be digitized and delivered as an IP data stream to the user. The AON uses only 2 wavelengths on each fiber—one for transmission of data to the users and one for transmission of data from the users.

The vendors currently making Active Optical Network equipment include Enablence, Calix, and PacketFront.

The other choice is to build a Passive Optical Network (PON) which uses passive hardware to "split" the signals so that a single high-powered laser can be shared by up to 64 customers (more typically for 32 customers). This technology requires less fiber than an AON since many customers in an area share the same single fiber over which the information carried on the fiber is "split" into 32 individual fiber drop paths for delivery to homes or businesses. In construction, one fiber "feeds" a passive splitter that takes the information that is transmitted onto the feeder fiber and distributes it across 32 or 64 individual fiber drops similar to the way water in a single pipe can be sent to 32 individual locations by placing a 1-to-multiple pipe junction on a single feeder water pipe.

PON technology uses bandwidth on the fiber differently than the AON. The PON electronics divide up the optical wavelengths on the fiber to allow 1 wavelength to transmit data and voice to the users, another wavelength to receive data and voice from the users, and a third optional wavelength to transmit RF video (like traditional broadcast Cable TV video on a cable network) to the users over one fiber strand. In this manner, the PON network can transport both analog signals and digital signals into the home.

Vendors for PON equipment include Alcatel-Lucent, Adtran, Zhone, Huawei, Calix, and Enablence.

Today passive optical networks use the GPON (Gigabit Passive Optical Network) technology. This technology uses Ethernet signaling for the customer delivery path. In a GPON system there is still the capability for three separate data streams—one for cable TV and two more for downstream and upstream data. The currently available GPON technology can deliver 2.4 Gbps of downstream data and 1.2 Gbps of upstream.

A new PON standard called 10-GPON will enable 10 Gbps downstream and 2.5 Gbps upstream to be shared among 32 customers. This technology is being designed to coexist with current GPON technology which holds great potential for future upgrades in network capacity. This technology is just now becoming available in the market.

There is now also a variation of GPON called WDM PON which uses a different color or laser light to each of the customers. This brings some of the best characteristics of an active network into the PON network since this makes it possible to deliver different amounts, and even dedicated amounts, of bandwidth to each customer.

FTTP technology is expected to continue to grow in available bandwidth as volume sales of the technology decrease laser costs. The limiting factor is the development of these cheaper lasers. Already in the lab are systems that will deliver a terabyte of download speed and such technology upgrades will be introduced as laser prices drop.

In this study we have calculated the cost of the network using passive electronics. But with the small footprint in the township the cost difference between the two technologies is negligible; you could choose either technology

## **PON Network Design**

In designing a PON network there are several different network architectures in use in various systems around the world. 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.

Large communities need to use distributed PON huts where PON electronics are housed. In a larger community, a design will place huts in several locations about town that will contain PON electronics which will light the fibers that will be split and assigned to each home. However, in a small community like the township all of the PON electronics can be placed at the core with no requirement for remote huts. We have assumed that these electronics would be placed at the township building. But they could optionally be placed into a small hut.

In a PON network, even when the electronics are in the core, there is a need to have small field cabinets where the fibers are split. These are where one feeder fiber is connected to the fiber to serve up to 32 homes. There are two possible designs for splitter location design: a) distributed splitter locations where PON fiber is split at several locations and thus splitters are distributed along the PON fiber, and b) local convergence point splitter locations where all PON splitters feeding a certain geographic area are located at the same cabinet.

Our design uses a “local convergence point” splitter architecture. This type of architecture ensures that the splitters that serve a general geographic area are all located within the same splitter cabinet. This design also makes it easier to make sure that a given splitter cabinet isn’t overloaded. This is important if there is ever a need to upgrade the core electronics. The local convergence point also ensures that the FTTH common electronics are most efficiently utilized—thus saving money on optics and electronics.

In our model design, we estimated the placement of 8 splitter locations using a 288-count splitter cabinet for PON distribution. This would provide 8 X 288, or 2,304 potential customer locations within the township, making the design ready to handle significant future growth. We added three additional splitter cabinets in the design that includes the Village – noting that there is one splitter cabinet in the Village already included in the township design.

## **Connecting Customers to the Network**

Customers are connected to the network using a fiber “drop.” That’s the industry term for the small fiber that connects a home or business to the fiber network along the roads or on the utility poles.

Fiber drops are smaller fibers than the ones used along roads and generally contain four fibers. There are several different ways to install drops:

- Aerial Drops. If the fiber along the roads are placed on the utility poles, then a fiber drop is connected from the fiber on the pole to the home or business. Today the most common technique used for fiber drops is to buy ones that already have fiber connectors. These ‘pre-connectorized drops can be plugged into a small device on the pole that has been designed for the purpose in a similar way that cables are plugged into a computer. These drops come pre-configured at different lengths. The alternative is to splice the fiber at the pole and at the home, which is more labor-intensive and requires specialized tools.
- Direct-buried drops. Drops can be plowed directly through the soil in a yard using a small plow machine a little larger than a lawn mower. The drop wires used for this purpose have a hard outer coating and are hardened to make them difficult to cut.
- Buried drops in conduit. It’s also possible to install a conduit through the yard, which is a hollow plastic tube, and then pull the fiber through the empty conduit. This technique usually uses the same boring techniques that were described for building along the roadways. Most fiber providers will directly bury as many drops as possible since that’s more cost effective. They will typically only use conduit and boring when they have to go beneath parking lots at businesses and other kinds of impediments that make it impossible to direct bury. Drops in the village might use a combination of these techniques with a conduit running beneath a sidewalk or driveway with portions of the drop buried.

The electronics used to serve customers is referred to in the industry as an ONT (Optical Network Terminal). This is an electronic device that contains a laser and which can connect to the fiber optic signal using light from the network and convert to traditional Ethernet on the customer side of the network.

Traditionally the ONTs have been placed on the outside of buildings in a small enclosure and have been powered by tapping into the electricity after the power meter. But the most commonly used ONTs today can be placed indoors and are powered by plugging into an outlet, much like the cable modems used by cable companies. The cost of the two kinds of units are nearly identical and so the study doesn’t choose between the two types of units.

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 since they are protected from the weather. The industry is split on this choice but it appears that internal units are becoming the most predominant choice for new construction. One of the major contributing factors is the advancement of WiFi technology and the increasing number of wireless devices in the home – it’s easier to tie an indoor ONT directly to a WiFi transmitter.

ONTs are available in multiple sizes that can be categorized into units designed to serve homes and small business and units designed to serve large businesses. The study assumes that the smaller unit was used for the vast majority of customers. These units provide one to four Ethernet streams which is sufficient for the large majority of customers. You might possibly need larger ONTs for the several large employers in the Village.

Today most, but not all, ISPs provide a WiFi router for their customers. They have found that when customers have service complaints that it’s more often about the quality and performance of the WiFi router and not about the fiber network. Providing a high quality WiFi router can eliminate a

lot of the problems that come with cheap routers that customers might purchase on their own. Our study assumes that routers will be supplied.

Historically, many FTTH networks were designed with battery back-up for the ONT. However, many small fiber providers have stopped providing batteries. The batteries were historically installed to power telephones in the case of a power outage at the home. Old copper phones received power from the line and could be used when the power was out. However, there is no power in a fiber and thus a battery backup is required to maintain phone service.

In 2015 an FCC ruling declared that every voice provider must offer a battery back-up 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 this means is that any ISP offering voice must also offer an optional battery backup plan for customers, but they will be able to charge enough to recover the cost of the battery backup unit. 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.

## **Other Assets**

There are other assets required to support an operating fiber network. Following is a list of such assets. Most of these assets would be provided by the ISP. In most of the scenarios we considered that somebody other than the township would provide these assets – but if you were the ISP you would have to provide these assets.

- Building. We don't think that the township needs to construct a building. We have assumed that you will house the needed electronics in Township Hall. The electronics require two racks that need only a few square feet of floor space in a locked room or closet.
- Data Routers. The ISP must provide various servers and routers to handle the ISP functions. This would include providing email, security, IP addresses, web storage, and other

functions normally provided by an ISP. We've assumed that this equipment will be also be housed at Township Hall.

- Other Assets. The business plan also includes the other assets needed to operate an ISP. This would include a vehicle for an outside technician. The business plan assumes the need for computers, furniture, and office equipment. There will be an inventory of spare electronics and fiber needed in case of repairs.

## **C. Network Costs**

Our estimated costs for the required assets were estimated as follows:

### **Cost of Fiber Construction**

Because of the low housing density of 9 miles per mile of fiber, the cost of fiber construction is the single most important factor affecting the affordability of bringing better broadband to the township.

The cost of building fiber varies widely around the country. The factors that most affect fiber construction costs are:

- Labor, which varies significantly around the country.
- Topology. Things like the amount of rock or the type of soil directly impact the cost of buried fiber construction. It's harder to build on hills than in farmland.
- Condition of Utility poles. The cost of building fiber on poles is most heavily influenced by the conditions of the existing poles. Building on poles can be reasonable when the poles are tall and don't have many existing wires. But the cost to build on short and crowded poles can sometimes cost more than burying fiber.
- Density. It costs more per mile to build fiber in towns than in rural areas, with the other conditions being the same. This is due to the higher density and having to create numerous access points to the fiber. It's also costly to cross city streets repeatedly to serve customers on both sides of the street, and in some towns it is cheaper to build on both sides of a street (which doubles the cost).
- Local conditions. Numerous local issues can add to the cost of fiber construction such as narrow shoulders on roads, railroad and bridge crossings, local ordinances that add extra effort to the construction process, and so forth. In the township, one of the key factors is the county's refusal to allow construction in the ditch along the side of the road.

There are parts of the country where rural fiber construction is relatively inexpensive. For example, we have done a lot of work in Minnesota, and in the farming belts in the state the roads generally have extremely wide rights-of-ways and the soil is soft and deep, without rocks or other impediments. In rural areas with farms there aren't many driveways or other obstacles and construction using plowing can proceed quickly. We've seen buried fiber in recent years in Minnesota for under \$20,000 per mile.

At the other extreme in rural America are hilly, rocky places like the Appalachians. Rural roads in a mountain environment might have virtually no shoulders or rights-of-way. We've seen buried

costs in that region costing as much as \$100,000 per mile. Cities can be even higher, with large cities costing the most. We saw a recent estimate for building fiber in downtown San Francisco with fiber priced at \$500,000 per mile.

The township falls into the middle of this range for rural costs. We got our estimate of construction costs by talking to several construction companies that have done construction there in recent years, including the fiber construction currently being done in nearby Lyndon Township.

We estimated the cost of a network built to carrier class standards. That means such things as placing buried fiber into conduit. It means using quality access points that are intended to last for decades. It means burying fiber deep enough to minimize future fiber cuts. Fiber can be built to lower standards, but the savings from doing so are usually relatively small and shortcuts always end up costing more money in later years.

- We designed the network using only two sizes of fibers. We used a 72-count fiber for the main backbone of the network that connects across the township. Everywhere else is designed with a 48-count fiber. It may seem counterintuitive, but it's cheaper to design a network with the same count of fiber almost everywhere than it is to exactly right-size the fiber on each street. In a network with different sized fibers the contractor needs to procure and bring different sizes of cable to the township. When constructing with different sizes of fibers the contractor then needs to swap out cable reels during the construction process to get the right sized fiber for each street. It's more efficient to use the same size everywhere which simplifies the construction process and also the ordering process. While larger strands of fiber cost a little more than smaller ones, the vast majority of cost in building fiber is labor, and so anything that reduces labor can save overall cost.
- There could be a small savings by directly burying the fiber without conduit. This might best be considered at the ends of the neighborhood fiber runs and along private roads. We would strongly recommend using conduit along Highway 52 on the way to Chelsea.
- Our design assumes placing some extra handholes in locations where the township expects new homes in the next 5-10 years, That small extra cost now will save a lot of cost if and when future homes are built.

There are a number of cost components of fiber construction, as follows:

- **Materials.** This is the fiber cabling and the associated hardware needed for the network. For buried fiber this includes conduit. Buried fiber also requires access points along the route to use the fiber, primarily consisting of manholes. Aerial fiber includes hardware needed to lash the fiber onto the poles. There are also aerial access points pre-installed on poles to make it easier later to connect customer drops.
- **Labor.** Labor is the most expensive component of the cost of building a fiber network. The act of boring roads, trenching roads, or lashing fibers to poles are labor intensive. One significant cost for fiber networks is splicing where different strands of fiber are joined together. If a 48-pair fiber is joined with another then each of the tiny hair-sized wires must be connected to the corresponding fiber strand in the next cable. There is also splicing needed at the splitter cabinets where fiber is divided into strands to get to homes.
- **Engineering.** The engineering process involves in looking at detail at every foot of the township to determine the best place to place the fiber, the splices, any cabinets, etc. The engineers will determine the most cost-effective construction technique for each part of the

network and will decide where to bore or trench. For an aerial network the engineers will inspect every pole and propose a make-ready solution to the pole owner to make the poles ready for construction.

- Construction Management / Inspection. This role inspects the construction of the network to make sure that the contractor is following specification. This role is often done by the engineers. The construction management role also is often the party that keeps track of the cost of construction.
- Permitting / Rights-of-ways. This is the process of gaining permission to build the network. It generally means filing applications with the local, county or state government to get rights-of-way. It includes talking to homeowners to gain rights-of-way to build on private lands or roads. This can include work to gain special permission to cross impediments like bridges or railroad crossings, which are generally harder permission to get.
- Contingency. In doing cost estimations for fiber construction at the early feasibility stage of the process we always include a construction contingency. This is essentially money that would be set aside in case construction costs more than expected. This is also a normal aspect when financing fiber before complete engineering has been done – because most forms of financing cannot easily handle cost overruns. For now, the feasibility studies include a 10% contingency. As more engineering is done that contingency could be significantly lowered. If you were able to get a fixed quote for construction the contingency could be eliminated.

We considered the cost of the fiber network using various construction techniques so that we could understand the relative financial impact of different kinds of construction. A summary of these costs for building the rural township only, and a second version also including the Village, are as follows:

<u>Rural Township Only</u>	Highest Cost	Expected Cost	Lowest Cost
Bored Fiber Construction	\$7.63 M	\$0.00 M	\$0.00 M
Trenched Fiber Construction	\$0.00 M	\$0.88 M	\$0.00 M
Aerial Fiber Construction	\$0.00 M	\$5.11 M	\$4.86 M
Engineering	\$0.36 M	\$0.28 M	\$0.23 M
Construction Management	\$0.40 M	\$0.32 M	\$0.26 M
Permitting	\$0.04 M	\$0.04 M	\$0.04 M
Contingency	<u>\$0.76 M</u>	<u>\$0.60 M</u>	<u>\$0.49 M</u>
Total	\$9.19 M	\$7.24 M	\$5.87 M

<u>Township Plus Village</u>	Highest Cost	Expected Cost	Lowest Cost
Bored Fiber Construction	\$ 8.68 M	\$0.00 M	\$0.00 M
Trenched Fiber Construction	\$ 0.00 M	\$0.88 M	\$0.00 M
Aerial Fiber Construction	\$ 0.00 M	\$5.86 M	\$5.60 M
Engineering	\$ 0.41 M	\$0.32 M	\$0.26 M
Construction Management	\$ 0.46 M	\$0.36 M	\$0.30 M
Permitting	\$ 0.04 M	\$0.04 M	\$0.04 M
Contingency	<u>\$ 0.87 M</u>	<u>\$0.67 M</u>	<u>\$0.56 M</u>
Total	\$10.46 M	\$8.13 M	\$6.76 M

Following is a description of the assumptions supporting each of the above scenarios:

Highest Cost Option. This assumes that all the entire network is buried and done by boring. This is the most expensive construction method. From an operational perspective a buried network is the easiest and lowest cost way to operate the model in the long run. This is the option chosen by Lyndon Township and their reasoning was to not build an aerial network on poles due to the many ice storms expected in the area over time. The downside to this option is obviously the cost.

The highest cost estimate uses the following assumption for cost:

- Buried in Public Rights-of-way: \$68,000 per mile of construction. That doesn't include the engineering, construction monitoring, or contingency.
- Buried in Private Rights-of-way: \$60,000 per mile. This cost was assumed on the 17 miles of private rights-of-way in the township. We assumed that the road owners would allow construction in the ditches along the side of the roads rather than in the trees as required by the public rights-of-ways.

It is possible that the construction could be a little less expensive if you were allowed to bury the fiber underneath the utility pole rights-of-way – which is mostly private right-of-way. This can't be known without more detailed analysis. For example, the electric utility might not allow burying under their poles – for any portions of the pole network on public rights-of-way they are not required to allow access. It's also possible, that while it looked like to us that there was decent clearing of the paths around poles, there might not be sufficient room to allow for the needed construction equipment. But if the township wants to bury the network to the extent possible, this would be worth further investigation.

Expected Cost. By expected cost we mean building a network at the lowest cost possible at the costs estimated by the CCG engineers for the various types of construction.

The expected cost estimate uses the following assumption for cost:

- Build aerial fiber in the rural parts of the township where the roads use public rights-of-way. This cost is estimated at \$52,000 per mile; that doesn't include engineering, construction management, or contingency.
- Build aerial cable in the Village at an estimated cost of \$48,000 per mile. This cost is lower than in the township since there is easier access to the poles built along streets compared to getting equipment in to build along the electric right-of-way that is in the woods.
- Still plow buried fiber along private roads. This is estimated to cost the same \$52,000 as using the electric utility poles. This is lower than the cost of boring, shown above since it assumes that the private roads would allow you to cut into dirt road surfaces to cross roads rather than boring.

As can be seen by the tables of numbers below, going with aerial fiber is significantly less expensive than boring through the woods along the side of roads.

Lowest Cost. One of the major components of aerial construction is make-ready work. This is the cost of paying to create the needed space on poles that must be done before hanging fiber. The engineers working in the region tell us that the average cost of make-ready is about \$20,000 per mile. This includes the cost of rearranging the wires on poles where there is not enough clearance for fiber, and paying to replace poles where rearranging wires does not create sufficient space.

It's possible that the make-ready could be less, and these lower costs were determined by lowering the make-ready for rural fiber to \$10,000 per mile. We don't know if that is possible. However, our engineering observations is that there are some newer poles in the township (which wouldn't typically need make-ready) and that there seems to be sufficient space on many poles – mostly due to the fact that AT&T has put most of its network underground.

This would be worth more exploration before construction. As you can see from the tables of costs, lowering the make-ready costs has a significant impact on the cost of the network, lowering the cost, for example, for the township network from \$7.24 M to \$5.87 M.

It would require spending money on engineering analysis before funding a network, but with savings of this magnitude it's probably worth it. It's likely that the estimated costs of aerial fiber in the expected case are conservatively high, and so refining those costs could reduce the estimated cost of the network – the single most expensive part of the project.

Another Idea to Lower Fiber Costs. Another way to lower the cost of the network would be to get concrete bids for construction and eliminate the contingency. For example, if detailed engineering analysis showed that the contingency wasn't needed, then the cost of the expected network in the township would reduce from \$7.24 M to \$6.64 M. There is no guarantee that the contingency would not be needed. However, if you were able to negotiate a do-not-exceed cost for construction then you'd know the exact cost of the network. Otherwise you'd probably have to borrow the contingency amount to be safe.

Electronics. We priced the FTTH electronics in this study based upon recent prices we got from Calix. Calix is one of several FTTP vendors and we feel safe in using their prices because the equipment from all of the vendors has a similar cost. CCG is vendor neutral and we are not suggesting that you use Calix. Rather, our experience is that the cost of the FTTP electronics is similar between vendors and thus using a recent quote from any of the vendors is sufficient for predicting the cost of the network electronics. Calix just happened to be the most recent bid we had in hand.

There are two major components of fiber electronics. First is the core. The core "lights" the fiber and transmits the signal to customers. Calix calls this component an Optical Line Terminal (OLT). The other major component, mentioned earlier, are the ONTS that sit at each home and that are used to receive the light signal and translate it back into an electronic signal for inside the home or business.

We've estimated the cost of the OLT core electronics at \$92,000. This device would be placed at Township Hall and would be capable of providing the needed connections for the whole project. The price is a little higher for the version of the study that includes the Village since a few additional port cards would have to be added to the unit.

We have assumed that each ONT at the customer premises costs \$200. Our assumed cost of labor varies in different versions of the study since we considered options where these devices were installed by a local technician or installed by an outside contractor.

It is possible that a few ONTs could cost more. There are larger ONTs that can provide more voice ports for large businesses and there might be a few customers in the Village that might require the larger ONTs. However, the basic ONT will be sufficient for all residential and most business customers – and possibly for all business customers.

The network is able to accommodate a customer that wants a broadband connection faster than 1 gigabit. There are electronics available that can instead deliver 10 Gbps. The easiest way to accommodate such customers would be to serve them directly with one fiber, using active Ethernet, and there are sufficient pairs of fiber designed into the network to allow such connections. It's expected in the future that there will be 10 Gbps ONTs on the market that could provide faster speeds to any customer – these ought to be able to be overlaid onto a GPON network.

Fiber Drops. The cost of materials need for drops are similar whether the drops are buried or aerial. We estimate the cost of drop materials to vary between \$130 and \$150 per drop depending upon length. Just as with placing fiber along roads, the primary cost of fiber drops is labor. If this work is done by outside contractors we estimated labor costs between \$460 and \$780 per drop, with aerial drops costing less than buried drops. The study also looks at scenarios where company technicians install the drops, which can significantly lower the cost (but which would take a lot longer to get everyone installed).

Other Costs. We've assumed a cost of \$88,000 to upgrade and install the needed racks and power equipment in Township Hall. This would include building a cabinet to house the OLT core electronics, providing a rack of batteries to provide power in case of electric power outages, and a fiber management system for getting fiber into the building in an organized manner.

The plan also assumes a cost of \$11,500 for the installed cost of each splitter hut distributed throughout the neighborhoods. We've also assumed a cost of \$45,000 for the core routers that are used to supply lit bandwidth to the neighborhoods. Finally, there is an estimated cost of \$10,000 for the server needed to provide basic ISP routing functions and to connect to the world or to another ISP.

Construction Contingency. A contingency is essentially a fudge factor. When borrowing money to build a fiber network there is always a concern that the cost of the network will come in higher than estimated. It's normal to borrow more money than is needed as a hedge against cost overruns, and that extra borrowing is called a construction contingency.

The worry of cost overruns can be eliminated if the cost of the network can be known ahead of time. One way to lower the contingency would be to do additional engineering to better understand the cost of building the network. An engineer could look at every bit of the proposed network and could make a detailed cost of construction. For an aerial network this extra engineering can remove most of the risk of cost overrun. It's harder to eliminate the risks for buried fiber unless you are sure there are no unknown pockets of rocks or other underground impediments that might add to the cost of construction,

The ultimate way to eliminate risk is to get a fixed-price bid for building the network. You might be able to find a contractor to agree to build the network for a set price. A fixed-price bid is likely to cost more than otherwise, but it does eliminate any risk of cost overruns.

We've included a 10% contingency for the cost of fiber in this preliminary estimate. Since the cost of the network is the most important single factor in making this project work, if you move forward you'll want to do enough engineering to better pin down the cost of construction.

**Cost of Non-fiber Assets**

Following are the expected cost of the assets other than fiber for the rural township model and for the model that includes the Village. The following assets assume a 70% penetration in the rural township and a 60% penetration in the Village. Having greater or fewer customers would increase or lower the costs of both electronics and fiber drop.

	Rural Township	Includes Village
Vehicle	\$ 38,000	\$ 38,000
Tools	\$ 60,000	\$ 60,000
Huts / Upgrade at Township Hall	\$ 180,000	\$ 214,500
Core Routers	\$ 45,000	\$ 45,000
Customer WiFi	\$ 82,396	\$ 135,896
PON Electronics	\$ 513,255	\$ 824,624
Fiber Drops	\$ 773,374	\$1,146,212
Software	\$ 78,915	\$ 81,325
Inventory	\$ 50,000	\$ 50,000
Miscellaneous Support	<u>\$ 26,120</u>	<u>\$ 26,120</u>
Total	\$1,847,600	\$2,621,477

**D. A Wireless Network?**

We also considered a wireless network where customers would be served using a technology called fixed wireless where a connection is made from a tower to a dish placed at each customer's home. This technology has improved a lot in the last few years. However, we cannot find a solution that would provide coverage to most of the households in the rural parts of the township.

The primary problem in the township is the widespread presence of trees and foliage. The various spectrum bands used to provide this service are not good at penetrating trees or of dealing with other impediments like hills. In technical terms, this kind of wireless broadband needs a line-of-

sight connection, meaning there has to be a direct open path between the transmitter on a tower and the antenna on a home or business.

In ideal situations this technology can deliver up to 100 Mbps download – at least to a handful of customers. A more typical application would be to deliver 25 Mbps to 50 Mbps to customers within about 4 miles of a tower – with each customer needing that direct line of sight. A typical tower would optimally not serve many more than 200 customers, so it would probably require four towers, and possibly five, to satisfy the area’s wireless connection needs. Each tower would need to be connected to fiber, so there would still be a need for a fiber network, but with far fewer miles than the plan that brings fiber to everybody.

In looking at the topography and trees in the township our guess is that probably not more than half of the rural households could be served by this kind of wireless network. Additionally, even for those served, it’s likely that the speeds for many of them would be degraded due to foliage. It’s not untypical for this kind of wireless network in rural areas to deliver speeds in the range of 5Mbps to 10 Mbps – not what anybody would consider as broadband. The signals are also degraded by rain.

There are currently a few different slices of spectrum that have been approved can be used for this purpose and a few 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 are narrow and can only deliver only a few megabits per second of data speed.

- WiFi. WiFi is short for *wireless fidelity* 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.
- 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 becoming available for widespread use in rural applications. This spectrum is promising because the existing trials showed that it can penetrate trees a little better than the 2.4 GHz WiFi.

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. This should hopefully not be an issue in Michigan – but there could be a base station in the state.

The spectrum can 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. Radios today that can reach 100 Mbps include this spectrum.

- New 6 GHz WiFi. At the October 2018 open meeting the FCC announced that it is proposing to use up to 1.200 megahertz of the spectrum band between 5.925 GHz and 7.125 GHz (being referred to as the 6 GHz band) as unlicensed spectrum. This is a bold proposal and more than doubles the total amount of bandwidth that would be available for WiFi.

However, their proposal comes with several proposed caveats that will have to be considered before expecting the spectrum to be useful everywhere for rural broadband. First, the FCC proposal is that any place where the spectrum is currently being used for Broadcast Auxiliary Service and Cable TV Relay service that the spectrum only be licensed for indoor use.

In those places where the spectrum is being used heavily for point-to-point microwave service, the outdoor use would have to be coordinated with existing users by use of an automated frequency coordination system, or a database, that would ensure no interference. We assume one of the rules that will be needed will be a definition of what constitutes “heavy” existing point-to-point use of the spectrum.

In places where there are no existing uses of the spectrum it sounds like it would be available for outdoor use as well as indoor use.

This band of spectrum (if approved) would be a great addition to networks that provide point-to-multipoint fixed wireless service. The spectrum will have a slightly smaller effective delivery area than the 5.8 GHz WiFi ISM band now widely in use. The 5.8 MHz spectrum is already the workhorse in most fixed wireless networks and adding additional

spectrum would increase the bandwidth that can be delivered to a given customer in systems that can combine spectrum from various frequencies.

The key is going to be to find out what the two restrictions mean in the real world and how many places are going to have partial or total restrictions on the spectrum. Hopefully the FCC will produce maps or databases that document the areas they think are restricted using their two proposed criteria.

The biggest challenge to using this frequency will be if the large cellular carriers ask that this be licensed spectrum and not free spectrum for anybody to use.

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

There are two possible uses for the spectrum. On a broadcast basis, this can be used to make better hotspots. A 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 about 2 miles further than what can be delivered today using unlicensed spectrum.

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.

- Licensed Spectrum. There are licensed spectrum frequencies that can penetrate trees well. Unfortunately, this spectrum has all been purchased by the big cellular companies and big ISPs. That means it is not available to small ISPs. The sum of that is that much of the

spectrum used by the cellular companies in urban areas sits idle in rural America – but it is still not available to anybody other than the licensed holder. We are not aware of any licensed spectrum opportunities for the township.

Even if the FCC makes the 6 GHz and the White Space spectrum available for rural use, none of these spectrums overcome the line-of-sight and foliage issues. These various bands of spectrum, if all used together, might someday provide 150 Mbps connections in the wide-open prairies or desert areas of the country. But places with trees or rough terrain are not going to see the same benefits.

We find it hard to put together a wireless business plan for the rural township that might only reach half of the households there. While not nearly as expensive as fiber, this would still require millions of dollars of investments to provide relatively slow broadband speeds to only a few customers.

## **V. Results of the Financial Analysis**

As part of preparing this report we created a number of financial business plan models that study the feasibility of successfully funding and operating a broadband business in the township. Following is a discussion of the major assumptions used in creating the studies and the results of the analysis.

All studies looked forward for a 20-year future period. While that is a long time over which to make financial projections, the goal was to be able to see if the business would support paying off any debt needed to fund the network.

### **A. Studies Considered**

I normally look at a wide range of possible operating structures that can affect the profitability of a business plan. However, the township instructed me to concentrate on plans where the township acts as the ISP or a Cooperative takes that role.

Although the Village already has good broadband, we considered options that include providing broadband in the Village. In working around the country we usually see that even small towns with decent broadband, residents often prefer a locally operated ISP, particularly one that can bring fiber to their homes. It would be unlikely to get as high of a penetration rate in the Village compared to the rural areas that have no broadband – but a fiber ISP could probably do fairly well in the Village.

This means that instead we considered multiple scenarios where the township, or a local cooperative, operates the business (from a financial perspective those scenarios are identical). We looked at options that included and excluded the Village.

Our goals in creating business plans are simple. We look for scenarios where the business will always have sufficient cash on hand to operate. That means a plan where expected revenues are sufficient to cover the operating costs, the cost of paying off debt, and the capital costs needed to

continue to maintain the network in good operating condition. A scenario that doesn't stay cash positive would need an external subsidy of some sort to be able to survive. Further, we look for scenarios that can be reasonably financed.

The Cost of the Fiber Network. We quickly realized that the number one hurdle for making this work in the township is the cost of the fiber network, and it was immediately apparent that it did not look affordable to bury the entire fiber network, so many of our business models consider alternate network designs.

With and Without the Village. There are a lot of advantages to building fiber to the Village as well as to the rural areas. First, the ISP business benefits from what is called economy of scale. This means that the business is improved by having a greater number of customers. Further, the cost to build, on a cost per household, is far lower in the Village. Adding the Village to the business plan lowers the overall average cost per customer and improves business plan performance. We looked at scenarios with and without the Village to understand this dynamic.

Other Variables. There are other variables that can affect the performance of a fiber business. Probably the most important is what is called the penetration rate, or the percentage of customers that buy service from the new network. I look at the impact of changing penetration rates. Other key variables include the interest rate on debt, the term of debt (number of years for loan payback), the amount of equity required by banks, and prices paid by customers. We looked to see how all of these variables affect the business plan results.

We also created what we call the best-case scenario that looks at the impact of maximizing the impact of all of the variables.

## **B. Business Plan Assumptions**

### **Customer Revenue Assumptions**

In our model we've assumed two sets of products—broadband and telephone using VoIP. Most ISPs serving on fiber networks offer the two products. Even if the ISP does not own a voice switch, there are numerous options for them to buy wholesale voice to resell to your citizens.

The business plan does not include cable TV. At this small size it would be incredibly expensive to offer cable TV and it would certainly lose money. Since everybody in the township who wants TV likely has this today from satellite there shouldn't be any negative impact from not offering cable. Providing fast fiber speeds will give all customers numerous options for buying programming online.

The business could offer additional products. For example, many ISPs around the country are now offering other products like smart home services (smart thermostats, door locks, security systems, watering systems, etc.).

But for purposes of this modeling we've kept the product lines simple. Unless noted, the models assume the following products and prices for the ISPs:

100 Mbps broadband	\$60
250 Mbps broadband	\$75
1 Gbps broadband	\$90
Basic phone line	\$25
Phone line with unlimited long distance	\$35
Business broadband prices	\$10 more expensive for each speed

These would be “honest prices” with no additional hidden fees. The big ISPs today tack on extra fees that hide the true rate of buying products from them. Municipal ISPs instead use rates without the fees and gimmicks so that customers know the advertised prices are what they actually pay.

There is no assumed connect fee for customers

The models assume that prices for broadband are increased by 5% every third year. That’s an inflation rate of around 1.5% per year, which is lower than the assumed inflation rate for expenses in the model, set at 2.5% per year.

We are now seeing the bigger ISPs starting to raise broadband rates every year. Prices for broadband have held steady for a number of years as their numbers of broadband customers of the big ISPs grew rapidly. However, the big ISPs are now seeing a huge drop-off in cable TV revenues and landline revenues and they have all started to raise broadband rates. It’s a trend the whole industry expects. The primary industry analyst tracking Comcast told the company they ought to be charging \$90 per month for basic broadband – and the expectation of the industry is that they will get to that rate over time. We think this means that the low rate increase in these models is conservative and that the rest of the market is likely to have far higher rates twenty years from now than are shown in these models.

### **Customer Penetration Rates**

The biggest unknown in any fiber business plan is knowing how many customers will buy service. For now, at the feasibility study level, we usually guess conservatively. For purposes of the study we used the following estimates:

Rural Township	70%
Village	60%

In a project with a footprint this small we are certain that you’d want to first ask every resident if they want service before financing and building the network. At that point you’d no longer be guessing and would know the number of customers.

We believe the township penetration rate is conservative. CCG works in numerous rural markets and we see penetration rates in areas with little or no broadband, like in the township, vary between 70% to as high as 90%. It’s more likely that 75% to 80% of households would elect to subscribe to the new network.

The penetration rate for telephone service is conservative. It begins at 25% of households and decreases over time to 14%. Currently the national average penetration rate for landline telephones is around 45%. This rate tends to be higher in rural areas where the cell phone coverage is not as good as urban areas.

## **Expense Assumptions**

Expenses are the recurring cost to continue to operate the network and the fiber business. Following are the various major expense assumptions used in the models:

Inflation. The model assumes that expenses will increase 2.5% per year for inflation.

Employees. Labor is always one of the major expenses for offering broadband services. We estimate the following labor costs needed to support broadband in the township.

- **General Manager.** In an ISP business this small the general manager would need to wear many hats. In addition to supervising the staff and the operation of the network the GM would probably need to drive the sales process.
- **Field Technicians.** A field technician is somebody in a truck that does maintenance on the network and that fixes problems in the field. In some versions of the study we also assume that the technician(s) install new customers.
- **Network Technician.** This employee would be in charge of all electronics and the operation of the network. In a business this small it would be expected that the technicians are cross-trained for both inside and outside work tasks.
- **Customer Service.** These are the employees that take orders, receive and process bill payments and answer customer questions. The metric is similar to that for field technicians and a small ISP generally has one customer service representative for every 1,500 customers.
- **Benefits and Taxes.** We assume that the ISP's benefits and payroll taxes will add 35% to the cost of the base salary.

Internet Help Desk. These are the people in an ISP that handle technical support. This means that they take technical questions from customers, fix any problems that can be done remotely through the electronics, and maintain 24-hour monitoring of the network. While some small ISPs do this function in-house, the more common method is to hire an external company to handle this function. This function today costs roughly \$4.50 per customer per month.

Bandwidth. The ISP must buy wholesale bandwidth to the Internet. In the forecasts we used a price of \$1,800 per month for a gigabit of Internet bandwidth. That should be adequate for the number of homes in the market today. We obtained a quote at this price for getting access to bandwidth in Chelsea. The model assumes this cost grows with inflation, but it's possible for this cost to instead decrease over time.

Other ISP Operating Costs. There are a number of other incremental costs for the ISP to serve new customers, as follows:

- **Wholesale voice.** The model assumes offering telephone service. Today there are a number of quality wholesale voice providers. We've assumed the purchase of wholesale telephone lines at a cost of \$7 for a basic line and \$9 for a line that includes unlimited long distance.
- **General asset-based expenses.** This would include things like the gas and insurance for the vehicle used to serve the township. It would include computer expenses for the employees. It would include the electric bill for powering the fiber electronics.
- **Advertising.** There will be some advertising costs at the beginning of the business to sign up new customers.
- **Billing.** There are costs to create, mail, and collect payments for billing. Some customers are going to want paper bills. Others will want to pay by credit cards.
- **Software.** Most ISPs maintain software that they pay for by the number of customers they have. This might include mapping software and OSS/BSS software (the recordkeeping, customer service, and billing software).
- **Maintenance Agreements.** A maintenance agreement is a plan offered by electronics vendors that provides for assistance such as repair of defective units and access to technical assistance. Some small ISPs don't buy a maintenance agreement, but we've included one for the PON electronics.

Backoffice / Overheads. The study considered backoffice expenses such as accounting / audit, legal, and consulting.

Fiber Maintenance. The business is responsible for the cost of fixing the network when something breaks. This could be a cut fiber or a customer card that goes bad.

Rights-of-Way Expenses. In Michigan there is a proscribed fee that must be paid each year for access to public rights-of-way. This is covered in the METRO Act as follows:

*Section 8 (4) Except as otherwise provided under subsection (6), for each year after the initial period provided for under subsection (3), a provider shall pay the authority an annual maintenance fee of 5 cents per each linear foot of public right-of-way occupied by the provider's facilities within a metropolitan area.*

This would apply to all state, county, and township roads. It would not apply to private roads. There are approximately 98 miles of roads that might incur this fee, which results in an annual expense of about \$25,000. We think the township could waive this for township roads, cutting the expense to around \$15,000. If this couldn't be waived directly there are probably a number of other ways this could be funneled to the business.

Start-Up Costs. There are one-time costs for getting into this business. These include costs like this feasibility study and the project management needed to help create the business. Even should you hire the small recommended staff they would need a lot of temporary assistance from consultants and others to launch the business.

## Financing Costs

If this is funded as a private ISP or as a Cooperative, the financing would have to be some form of private bank financing. This will be discussed in more detail later in this report.

We've assumed that loans would be for 15 years with an interest rate of 5.5%. The biggest obstacle for bank financing is that banks require equity from the business owners before considering a loan. We've used a somewhat industry standard of 20% of all funding to be supplied by equity. This is perhaps the biggest hurdle to making this plan work and will be discussed in more detail along with the financial findings.

## C. Summary of Financial Findings

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. But it's even more common for an asset-intensive business like this one for a business to reach positive cash flow but still have a negative net income—due almost entirely to depreciation expense on the network, which is a non-cash expense.

**Debt Breakeven.** The year when the business has generated enough excess cash that would enable the retirement of the remaining debt. Many loan covenants don't allow excess 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 a for-profit business would generally use something like net income to measure profits.

As described earlier in this report, all of these scenarios assume that the business is operated by a for-profit ISP or Cooperative.

All of these results are reported in terms of millions of dollars (\$M).

Following are the results of the various scenarios. Also note that a table of all of the financial results is included in Exhibit B.

## **Build to Rural Township Only**

This scenario looks at building fiber to the rural parts of the township plus a handful of customers in the Village that happen to live near the fiber that passes through the Village on the way to Chelsea. These scenarios assume normal commercial financing that would require a 20% equity investment into the project. These scenarios assume a 70% customer penetration in the rural areas and a 60% penetration for the handful of customers in the Village.

These scenarios compare the results in looking at three different scenarios of fiber cost, described in Section IV.C above. These are described as all-buried, expected cost, and lowest cost.

	<u>All-Buried</u>	<u>Expected</u>	<u>Low-Cost</u>
Asset Costs	\$11.04 M	\$ 9.08 M	\$ 7.71 M
Debt	\$ 9.72 M	\$ 8.03 M	\$ 6.87 M
Equity (20%)	<u>\$ 2.43 M</u>	<u>\$ 2.01 M</u>	<u>\$ 1.72 M</u>
Total	\$12.15 M	\$10.04 M	\$ 8.58 M
<b>Passings</b>			
Rural Township	1,030	1,030	1,030
Village	142	142	142
<b>Penetration Rate</b>			
Rural Township	70%	70%	70%
Village	60%	60%	60%
Cash after 25 Years	(\$7.13 M)	(\$5.47 M)	(\$ 3.92 M)
Years until Positive Net Income	Year 17	Year 15	Year 13
Years until Cash Covers Debt	Never	Never	Never
Biggest Annual Cash Deficit	(\$9.44 M)	(\$7.55 M)	(\$5.97 M)

These results show clearly that there is no scenario for building only to the rural township area using traditional bank financing. There are several reasons for this.

- The cost of the fiber network is expensive compared to the number of households. This is due to the low housing density where there are fewer than 10 homes per mile of fiber.
- The second issue is with the small number of passings. The fiber business is an economy of scale business and the 1,172 passings in this scenario are not large enough to create a viable standalone fiber business. This scenario contemplates the creation of a cooperative or similar corporate structure to operate the business, and this is not enough potential customer revenue to cover the cost of operating the business.
- The primary result of these two issues is that this business cannot afford the needed debt to build the network – the revenues are not enough to cover the principle and interest payments on the debt. However, as shown below, the scenario is possible if most of the debt can be eliminated by funding instead with equity.

This first scenario is a good place to discuss equity. Bond financing is the only kind of financing that will cover 100% of the cost of building a project. If a business cannot be financed with bonds, then any other form of financing is going to require equity – meaning a cash infusion of some sort into the business. The most typical place for a cooperative to get equity would be from the members of the cooperative, but there are other ways. There is a detailed discussion of equity in Section V.E below.

**Even Lower Construction Costs**

There are a few ways that the cost of building the network could be even lower. The first way would be to install all customers using company technicians instead of outside contracts. Since you have to pay a technician anyway, this makes the incremental labor portion of the installations near to zero. The downside of building with your own technicians is that it would probably take three years from the start of the project to install all of the customers – compared to installing everybody in perhaps 18 months if the installations are done using contractors.

The second way to lower costs would be to eliminate the construction contingency. The contingency represents funds that are borrowed in case there are cost overruns when building the network. The contingency could be eliminated by doing more engineering up-front and by then soliciting bids for a fixed-price construction contract. With such a contract you’d not need a contingency since you would know the exact price for building the network. This example is illustrative only, since the detailed engineering might show a cost higher than first estimated.

These three results are for the lowest-cost fiber network scenario, and the first column below is identical to the third column above.

<u>Lowest-cost Fiber</u>	<u>Base</u>	<u>Self Installed</u>	<u>Self-Installed and No Contingency</u>
Asset Costs	\$ 7.71 M	\$ 6.86 M	\$ 6.37 M
Debt	\$ 6.87 M	\$ 6.48 M	\$ 6.07 M
Equity (20%)	<u>\$ 1.72 M</u>	<u>\$ 1.62 M</u>	<u>\$ 1.52 M</u>
Total	\$ 8.58 M	\$ 8.10 M	\$ 7.58 M
<b>Passings</b>			
Rural Township	1,030	1,030	1,030
Village	142	142	142
<b>Penetration Rate</b>			
Rural Township	70%	70%	70%
Village	60%	60%	60%
Cash after 25 Years	(\$3.92 M)	(\$3.00 M)	(\$ 2.40 M)
Years until Positive Net Income	Year 13	Year 14	Year 13
Years until Cash Covers Debt	Never	Never	Never
Biggest Annual Cash Deficit	(\$5.97 M)	(\$5.23 M)	(\$4.63 M)

These results show that even at the lowest possible cost of construction there is no feasible financial scenario using bank financing. As described above there are just enough potential customers in the rural part of the township to create a viable business.

These results show that there is a significant financial benefit from installing customers with township employees. That reduces needed debt and equity by \$480,000 and increases cash over twenty years by \$920,000. There is additional benefit to eliminating the contingency. In this theoretical example this lowers debt and equity by an additional \$520,000 and increase cash flow over twenty years by an additional \$600,000.

These results also highlight a theme that will recur through many of the following scenarios – the business plan has years with significant cash shortfalls. Later I look to see if there are ways to make this work while maintaining positive cash during the first 20 years of the project.

**Making the Township Scenario Work – Breakeven Equity**

I next looked to see if there was any scenario where it would be financially viable to build fiber just to the rural township area. The only way to do this would be to somehow raise more equity. This explores the same two scenarios as above, but calculating the equity needed to make each scenario viable. The first column is the base scenario as shown above – shown to make it easier to make a comparison.

<u>Lowest-cost Fiber</u>	<u>Base</u>	<u>Self Installed</u>	<u>Self-Installed and No Contingency</u>
Asset Costs	\$ 7.71 M	\$ 6.86 M	\$ 6.37 M
Debt	\$ 6.87 M	\$ 2.05 M	\$ 2.28 M
Equity	\$ 1.72 M	\$ 5.87 M	\$ 5.20 M
Total	\$ 8.58 M	\$ 7.91 M	\$ 7.48 M
<b>Passings</b>			
Rural Township	1,030	1,030	1,030
Village	142	142	142
<b>Penetration Rate</b>			
Rural Township	70%	70%	70%
Village	60%	60%	60%
Cash after 25 Years	(\$3.92 M)	\$3.06 M	\$ 3.23 M
Years until Positive Net Income	Year 13	Year 14	Year 13
Years until Cash Covers Debt	Never	Never	Never
Biggest Annual Cash Deficit	N/A	N/A	N/A

This shows that with enough equity financing the township-only scenario could be self-sustaining. For example, using the self-installed scenario, if most of the needed funding can be raised from equity, then this scenario could be successful. By the end of twenty years the project will have

covered the costs each year of operating the business and will have generated \$3.06 million in additional cash.

This is a huge amount of equity considering the size of the customer base. For example, if each residential customer in the rural township were to raise this money (776 customers) the contribution would be \$7,564 each. Even were this to be required of every home in the rural township the contribution would be \$5,800 for each household (1,012 passings).

There are ways to make this work that are discussed in the funding discussion in Section V.E.

**Build to the Whole Township**

These scenarios look at building fiber to the rural parts of the township plus all of the Village. These scenarios assume normal commercial financing that would require a 20% equity investment into the project. These scenarios assume a 70% customer penetration in the rural areas and a 60% penetration the Village.

These scenarios compare the results in looking at three different scenarios of fiber cost, described in Section IV.C above. These are described as all-buried, expected cost, and lowest cost.

	<u>All-Buried</u>	<u>Expected</u>	<u>Low-Cost</u>
Asset Costs	\$13.08 M	\$10.75 M	\$ 9.39 M
Debt	\$11.25 M	\$ 9.25 M	\$ 8.08 M
Equity (20%)	<u>\$ 2.82 M</u>	<u>\$ 2.31 M</u>	<u>\$ 2.02 M</u>
Total	\$14.08 M	\$11.56 M	\$10.10 M
<b>Passings</b>			
Rural Township	1,030	1,030	1,030
Village	989	989	989
<b>Penetration Rate</b>			
Rural Township	70%	70%	70%
Village	60%	60%	60%
Cash after 25 Years	(\$1.24 M)	\$0.76 M	\$ 2.47 M
Years until Positive Net Income	Year 11	Year 11	Year 10
Years until Cash Covers Debt	Never	Never	Never
Biggest Annual Cash Deficit	(\$6.19 M)	(\$3.93 M)	(\$2.19 M)

These results show a significant improvement over the scenario that only covers the rural township. However, these scenarios don't quite work. For example, even though the low-cost network option is cash positive at the end of twenty years, at some point it suffers from a \$2.19 million cash shortfall

As can be seen in a comparison with the Township Rural version, this scenario adds a significant number of customers, but nearly as much relative cost – because the network in the Village is high density, with 58 potential customers per mile of fiber.

**Lower Network Costs for the Whole Township**

Following looks at the impact of using the self-install scenario where customers are connected to the network by company technicians. It’s not as easy of a choice to use employees for installation since it looks like it would take 3 ½ years to connect everybody – but the savings are significant. This also looks at the impact of eliminating the contingency. This scenario compares costs to the expected-cost scenario – the center one above.

<u>Expected Fiber Cost</u>	<u>Base</u>	<u>Self Installed</u>	<u>Self-Installed and No Contingency</u>
Asset Costs	\$10.75 M	\$ 9.39 M	\$ 8.71 M
Debt	\$ 9.25 M	\$ 8.97 M	\$ 8.39 M
Equity (20%)	<u>\$ 2.31 M</u>	<u>\$ 2.24 M</u>	<u>\$ 2.10 M</u>
Total	\$11.56 M	\$11.21 M	\$10.49 M
<b>Passings</b>			
Rural Township	1,030	1,030	1,030
Village	989	989	989
<b>Penetration Rate</b>			
Rural Township	70%	70%	70%
Village	60%	60%	60%
Cash after 25 Years	\$0.76 M	\$1.34 M	\$ 2.16 M
Years until Positive Net Income	Year 11	Year 9	Year 7
Years until Cash Covers Debt	Never	Never	Never
Biggest Annual Cash Deficit	(\$3.93 M)	(\$3.58 M)	(\$2.76 M)

These results show a significant improvement over the expected cost scenario. Using employees to install customer saves \$1.16 in the cost of the network, reduces debt by \$350,000 and improves cash over twenty years by \$580,000. However, the scenario still does not cash-flow and in the worst year has a cash shortfall of \$3.58 million.

Layering on the elimination of the contingency makes the results even better. This lowers the cost of the network by an additional \$680,000, reduces the needed debt by an additional \$580,000, and improves cash over twenty years by an additional \$820,000.

While not yet feasible, these scenarios are closer to breakeven than the scenarios that only built to the rural areas.

## **Making the Total Township Version Work – Breakeven Equity**

As I did for the Township-only version, I looked to see how much equity is needed to make the business successful. Asked a different way – how much debt can the business carry? This scenario compares costs to the expected-cost scenario.

<u>Expected Fiber Cost</u>	<u>Base</u>	<u>Self Installed</u>	<u>Self-Installed and No Contingency</u>
Asset Costs	\$10.75 M	\$ 9.39 M	\$ 8.71 M
Debt	\$ 9.25 M	\$ 4.34 M	\$ 4.36 M
Equity	<u>\$ 2.31 M</u>	<u>\$ 6.80 M</u>	<u>\$ 6.10 M</u>
Total	\$11.56 M	\$11.14 M	\$10.46 M
<b>Passings</b>			
Rural Township	1,030	1,030	1,030
Village	989	989	989
<b>Penetration Rate</b>			
Rural Township	70%	70%	70%
Village	60%	60%	60%
Cash after 25 Years	\$0.76 M	\$8.20 M	\$ 8.17 M
Years until Positive Net Income	Year 11	Year 6	Year 6
Years until Cash Covers Debt	Never	Never	Never
Biggest Annual Cash Deficit	(\$3.93 M)	N/A	N/A

This shows that with enough equity – between \$6 million and \$7 million – the whole township version can be made to work. Interestingly, by the end of twenty years, these scenarios return over \$8 million in excess cash – which would allow repayment of all of the equity put into the business by customers or others.

However, this is a lot of equity. In the middle scenario above the \$6.8 million in equity would equate to \$8,763 per rural township customer (776 customers), or \$6,719 per rural township passing. That’s a huge amount of money to raise to build the fiber network – but there are ways this might be done, which will be discussed in Section V.E.

## **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. However, the study results would change more significantly if changing the interest rates on debt financing.

The following sensitivity analysis looks at the impact of changing those assumptions that can most affect the results. All aspects of the sensitivity analysis look at the scenario of building fiber to the rural CenturyLink footprint, but similar results would be expected for the other major scenarios.

The sensitivity analysis specifically tested the following variables:

- Increasing the customers by 10%;
- Increasing broadband prices by \$5;
- Increasing the interest rate on debt by 1%;
- Increasing equity to 30%;
- Offering only a \$75 gigabit product.

The following looks at the impact of these changes on the self-installed option just above (the center option in the table immediately prior to this). These comparisons allow a quantification of the bottom line impact from making each change.

**Increasing Customer Penetration Rates by 10%:** This scenario increases the customer penetration rate in the rural areas by 10%. That increases the rural areas from 70% to 80%.

<u>Expected Fiber Cost</u>	<u>Base</u>	<u>Revised</u>
Asset Costs	\$ 9.39 M	\$ 9.39 M
Debt	\$ 8.97 M	\$ 8.97 M
Equity (20%)	<u>\$ 2.24 M</u>	<u>\$ 2.24 M</u>
Total	\$11.21 M	\$11.21 M
 <b>Passings</b>		
Rural Township	1,030	1,030
Village	989	989
 <b>Penetration Rate</b>		
Rural Township	70%	60%
Village	60%	60%
Cash after 25 Years	\$1.34 M	\$ 2.88 M
Years until Positive Net Income	Year 9	Year 7
Years until Cash Covers Debt	Never	Never
Biggest Annual Cash Deficit	(\$3.58 M)	(\$2.64 M)

This shows that increasing the customer penetration rates by 10% increases cash flow over 20 years by \$1.54 million. This relationship is somewhat linear and the impact should be about the same for decreasing the customer penetration rate.

**Increasing Broadband Prices by \$5.** This scenario increases all broadband product prices by \$5 per month.

<u>Expected Fiber Cost</u>	<u>Base</u>	<u>Revised</u>
Asset Costs	\$ 9.39 M	\$ 9.39 M
Debt	\$ 8.97 M	\$ 8.95 M
Equity (20%)	<u>\$ 2.24 M</u>	<u>\$ 2.24 M</u>
Total	\$11.21 M	\$11.19 M
<b>Passings</b>		
Rural Township	1,030	1,030
Village	989	989
<b>Penetration Rate</b>		
Rural Township	70%	70%
Village	60%	60%
Cash after 25 Years	\$1.34 M	\$ 3.14 M
Years until Positive Net Income	Year 9	Year 7
Years until Cash Covers Debt	Never	Never
Biggest Annual Cash Deficit	(\$3.58 M)	(\$2.44 M)

This shows that increasing customer prices increases cash over 20 years by penetration rates by 10% increases cash flow over 20 years by \$1.8 million. A word of caution, though, is that raising rates could result in fewer customers.

**Increasing Interest Rate by 1%.** This scenario increases the interest rate on debt from 5.5% to 6.5%.

<u>Expected Fiber Cost</u>	<u>Base</u>	<u>Revised</u>
Asset Costs	\$ 9.39 M	\$ 9.39 M
Debt	\$ 8.97 M	\$ 9.07 M
Equity (20%)	<u>\$ 2.24 M</u>	<u>\$ 2.27 M</u>
Total	\$11.21 M	\$11.33 M
<b>Passings</b>		
Rural Township	1,030	1,030
Village	989	989
<b>Penetration Rate</b>		
Rural Township	70%	70%
Village	60%	60%
Cash after 25 Years	\$1.34 M	\$ 0.44 M
Years until Positive Net Income	Year 9	Year 7
Years until Cash Covers Debt	Never	Never
Biggest Annual Cash Deficit	(\$3.58 M)	(\$4.47 M)

This shows that increasing the interest rate by a full 100 basis points decreases cash over 20 years by \$900,000. This is worth noting since we are starting to see interest rates creep high for the first time in over a decade.

**Increasing Equity to 30%:** This scenario increases equity required from 20% to 30%.

<u>Expected Fiber Cost</u>	<u>Base</u>	<u>Revised</u>
Asset Costs	\$ 9.39 M	\$ 9.39 M
Debt	\$ 8.97 M	\$ 7.76 M
Equity	<u>\$ 2.24 M</u>	<u>\$ 3.33 M</u>
Total	\$11.21 M	\$11.09 M
<b>Passings</b>		
Rural Township	1,030	1,030
Village	989	989
<b>Penetration Rate</b>		
Rural Township	70%	70%
Village	60%	60%
Cash after 25 Years	\$1.34 M	\$ 4.80 M
Years until Positive Net Income	Year 9	Year 7
Years until Cash Covers Debt	Never	Never
Biggest Annual Cash Deficit	(\$3.58 M)	(\$1.45 M)

Increasing equity also means decreasing the debt. In this case the debt drops by \$1.21 million. Equity increased by \$1.09 million, yet the cash at the end of 20 years increased by \$3.46 million. The improvement in cash generated is due to the lowered interest expenses on smaller debt.

**Offering only a \$75 Gigabit Broadband Product.** This scenario sets \$75 for a gigabit as the only product offered. The penetration rate is still set at 70% in the rural areas, but it's likely that this pricing strategy would lower the number of customers.

<u>Expected Fiber Cost</u>	<u>Base</u>	<u>Revised</u>
Asset Costs	\$ 9.39 M	\$ 9.39 M
Debt	\$ 8.97 M	\$ 8.93 M
Equity (20%)	<u>\$ 2.24 M</u>	<u>\$ 2.23 M</u>
Total	\$11.21 M	\$11.16 M
<b>Passings</b>		
Rural Township	1,030	1,030
Village	989	989
<b>Penetration Rate</b>		
Rural Township	70%	70%

Village	60%	60%
Cash after 25 Years	\$1.34 M	\$ 5.47 M
Years until Positive Net Income	Year 9	Year 6
Years until Cash Covers Debt	Never	Never
Biggest Annual Cash Deficit	(\$3.58 M)	(\$1.51 M)

This shows that a significant increase in cash from having only one broadband product priced at \$75. However, it's likely that fewer customers would buy service at that price, so the likely outcome would be lower.

### **Most Optimistic Scenario**

This considers the most optimistic scenario and includes the following assumptions:

- 80% penetration in the rural areas and 60% in the Village
- Aerial construction is at the lowest possible cost
- Installations are done using employees rather than outside contractors
- There is no contingency on construction
- Interest rate at 5%
- Equity at 30%

The second option of this scenario considers the amount of equity needed to allow the business plan to always remain cash positive.

	Base	Most Optimistic	Breakeven
<u>Expected Fiber Cost</u>			
Asset Costs	\$ 9.39 M	\$ 7.46 M	\$ 7.46 M
Debt	\$ 8.97 M	\$ 6.99 M	\$ 6.00 M
Equity	<u>\$ 2.24 M</u>	<u>\$ 2.10 M</u>	<u>\$ 3.60 M</u>
Total	\$11.21 M	\$ 9.09 M	\$ 9.59 M

#### **Passings**

Rural Township	1,030	1,030	1,030
Village	989	989	989

#### **Penetration Rate**

Rural Township	70%	80%	80%
Village	60%	60%	60%

Cash after 25 Years	\$1.34 M	\$ 7.91 M	\$ 9.80 M
Years until Positive Net Income	Year 9	Year 5	Year 5
Years until Cash Covers Debt	Never	Year 15	Year 12
Biggest Annual Cash Deficit	(\$3.58 M)	(\$0.81 M)	\$ 0.09 M

These two scenarios show that even with the most optimistic scenarios, normal bank financing that includes increasing equity infusion to 30% doesn't have cash positive cash flow during all years of the loans. However, increasing the equity to 37.5% keeps cash positive for the life of the loan

and generates significant cash of \$9.85 million by the end of 20 years. This indicates that there are probably ways to make the business plan work if the homeowners can figure out a way to raise the needed equity. Over time the business can make significant profits, pay back the original equity infusions and return significant returns.

However, the caution of this particular scenario is that it assumes the lowest possible capital costs for the network – something that might not be attainable.

**Joining a Partnership.** There is some economy of scale benefits from joining some kind of operational partnership, such as multiple townships banding together to provide the employees and backoffice functions. The benefits of the partnership can vary in size. Unfortunately, the one area where a partnership doesn't provide much help is with the cost of the building the fiber network and most of the electronics.

Following is a look at a modest partnership where a few townships join together to provide service.

<u>Expected Fiber Cost</u>	<u>Base</u>	<u>Partnership</u>
Asset Costs	\$ 9.39 M	\$ 9.21 M
Debt	\$ 8.97 M	\$ 8.76 M
Equity (20%)	<u>\$ 2.24 M</u>	<u>\$ 2.19 M</u>
Total	\$11.21 M	\$10.95 M
<b>Passings</b>		
Rural Township	1,030	1,030
Village	989	989
<b>Penetration Rate</b>		
Rural Township	70%	70%
Village	60%	60%
Cash after 25 Years	\$1.34 M	\$ 2.47 M
Years until Positive Net Income	Year 9	Year 7
Years until Cash Covers Debt	Never	Never
Biggest Annual Cash Deficit	(\$3.58 M)	(\$2.70 M)

In this particular example the partnership provided a net benefit of \$880,000 over 20 years. The benefit could be significantly greater and this is a conservative look at a partnership. You need to know the specific facts of a potential partnership in to understand the value.

## **D. Findings from the Financial Analysis**

There are a number of things that become evident when examining the results of the various scenarios:

1. If you don't want to use tax financing, then the alternative is bank financing. From a business structure that is going to require creating a cooperative or a for-profit ISP, which

are discussed in more detail in Section VI. From a financial perspective, bank financing requires equity – a cash contribution to the business. Banks don't make 100% loans, particularly to a start-up business. Figuring out how to fund that equity is going to be a challenge for every scenario and is discussed more below.

2. It's evident that trying to create an ISP for only the rural part of the township is going to be a real challenge. That is not a large enough customer base to create a standalone business that is large enough to cover the debt needed to build the network. The ISP business is an economy of scale business, meaning that the business gets more efficient as the customer base grows. It's obvious that the 1,030 households in the rural part of the township is not enough people to reasonably support a standalone ISP.
3. The potential for the business looks better when building to the whole township, including the Village. Our experience elsewhere suggests that there won't be as many customers of a fiber network in the Village and that some households there will stay with the incumbent providers. However, the density of the Village is such that many customers can be added to the network for a far lower cost per customer for construction. Adding the Village primarily improves the economy of scale. we think the biggest challenge for getting customers in the township will be if you want them to somehow contribute equity in the same manner as the rural households. Since Village residents already have decent broadband alternatives it's probably going to be difficult to convince many of them to contribute to starting the new ISP.
4. The biggest problem with the majority of the scenarios studied is that they don't remain cash positive for the life of the borrowing. The base studies assume a 20% equity contribution, which is a normal starting point for bank financing. However, it looks like the business can't support the amount of debt that is left after the 20% equity contribution. we calculated the amount of equity needed for a few key scenarios to achieve long-term cash breakeven.
5. The most important cost factor for making this work is the cost of the fiber network. We considered both buried and aerial construction, and it looks to be unaffordable to bury the network. In a high-level feasibility we can't accurately estimate the cost of aerial construction due to what's called "make-ready" in the industry – this is the cost of making poles ready to accept fiber. That cost can vary from negligible to gigantic depending upon the condition of the poles. Our general observation is that the poles we looked at didn't seem to need a lot of make-ready – however, most of the poles run through the woods and are not directly observable from the roads and it will require an engineering review to get a more specific estimate of the make-ready costs. If there is interest in moving the project forward, then getting this more detailed estimate would be a necessary next step.
6. We did not consider scenarios where you bring in an operating ISP partner. An ISP partner would expect to make a profit from operating the business, and most scenarios are not profitable enough to pay an operating partner a profit on top of the cost of operating the business.

## **E. Financing Options**

The financial analysis shows that financing a fiber project is going to be challenging. Since it is unlikely that tax revenue can be used, then most normal public financing options are off the table.

## Private Financing Options

Since the likely structure of a fiber business would be a commercial ISP or a cooperative, then the most likely financing option is going to require some form of bank financing.

There are a few characteristics of bank financing that are different than bond financing:

- The interest rates on commercial loans are generally higher than on municipal bonds. For the first time in over a decade we are seeing increases on interest rates, meaning that you'll have to keep an eye on, and anticipate future interest rates when planning a project.
- Bank loans are generally for shorter time periods than bonds, with most banks leery of making loans for longer than 12 or 15 years. Some banks won't even go that long except in rare circumstances. The shorter the loan terms, the higher the debt payments – this business plan is highly sensitive to large debt payments, particularly in the early years.
- Banks won't finance 100% of a project in the same manner as can be done with municipal bonds. That means that equity will be needed to secure a bank loan. Getting the needed equity is going to be a biggest challenge for this project and will be discussed in more detail below.
- The ideal bank loan would take advantage of construction financing. This kind of financing is familiar to anybody who has built a new house. A first loan is structured as a line of credit and money drawn as construction proceeds. This saves interest expense by only charging interest on drawn funds. When construction is done a second long-term note is put in place (on a home this is the permanent mortgage). Ideally you want a package that bundles both loans.

Equity: Equity is value brought to the project by a borrower. Equity is usually in the form of cash, but it's possible for a bank to count other assets as equity if they benefit the project. For example, if somebody builds a new house on land they already own, the bank will generally consider the value of the land as equity. The amount of equity required for a given loan will vary according to the perceived risk of the venture by the lender. The higher the risk, the more equity required. A typical amount of required equity is 20% of the cost of a project, but this could vary and can be negotiated. In the financial analysis we assumed 20% equity. The trade-off for lowering the amount of equity required would likely mean higher interest rates, to account for the higher risk. We recently saw a fiber project that brought only a small amount of equity and was required to pay a 10% interest rate.

Equity for this project will almost certainly have to be cash since the community brings no other real assets to the table. The biggest issue facing this project will be how to raise the needed equity. There are a few different ways that businesses like this raise equity:

- Government. Some of the equity could come from the government. We've seen several examples of government equity. There are a number of rural counties that have made grants to a public/private partnership to build fiber. We also know of a case where cities and townships made a loan to the new cooperative that the banks considered to be equivalent to equity since there was no guarantee to repay the government loan. In your case, since the Village is not likely to support a grant or loan to a fiber project, this seems to be an unlikely source of equity – but one that still needs to be pursued.

- Businesses. We've seen fiber projects where local businesses have made equity contributions to help jump-start a fiber project. We know another case where a large nonprofit arm of a major corporation made a sizable equity investment in a fiber project. Such equity is generally recognized by giving some form of ownership of the company to the equity contributors. This is even possible within a cooperative by giving equity providers some sort of preferred status for future patronage dividends. In your case there are no obvious businesses in the area that are likely equity providers, but any amount of equity helps, so it's worth asking.
- Cooperatives. Cooperatives are generally restricted in how they can use accumulated cash. They can return it as dividends to members (with annual caps set by law), they can make charitable contribution for the communities they serve or they can loan excess money to other cooperatives. If you structure the new business as a cooperative it might be possible to get a grant or a 0% interest rate loan (which banks might count as equity) from another cooperative in the area.
- Wealthy Individuals. We've seen cases, particularly in farming areas, where wealthy farmers stepped up to collectively put in equity in order to get fiber.
- The General Public / Customers. Unfortunately, in your case the most likely source of equity is going to be the general public – your potential customers. There are fiber projects around the country that have gotten some of their financing in this way. One is Ammon, Idaho which charges households a cash fee to join the fiber network – when enough homes in a neighborhood have paid the fee, the neighborhood gets fiber. In Utah there is a project that has brought fiber to numerous small towns, called Utopia. In Utopia each homeowner makes a pledge in the form of a lien against their home. Those liens have collectively been used to secure loans – and if the loans default the homeowners would have to make monthly payments to cover the shortfalls.

We looked at several “breakeven” scenarios that provided the financing need for this project to break even and always maintain cash. A typical amount of needed equity for breakeven is around \$5 million. What is the impact of raising \$5 million from homeowners?

- If expected from each household in the rural part of the township, the equity would be \$4,854 per household.
- Of only assessed to customers from the rural township, at a 70% penetration rate the equity would be \$6,935 per customer and at 80% penetration would be \$6,068 per customer.

Those are huge numbers. However, asking for this kind of contribution from citizens is not a rare practice. We cited a few examples above of other fiber projects that have used customer financing in this manner. There are also numerous examples in towns that are getting a water/sewer system for homeowners to be assessed a similar fee. It's also somewhat normal for homeowners who put in private roads to pay for them in this manner. If you think of a fiber network as basic infrastructure, then this kind of financing doesn't seem out of line.

How might a given homeowner cover this level of required contribution? There are several ways we've seen used:

- A household is always allowed to pay their share of the project up-front in cash.
- Generally, this kind of financing needs the cooperation from a local bank that is willing to make loans to numerous homeowners to cover this. This can get complicated since the

bank is going to probably put a lien on most homes, depending upon a given customer's credit. That would mean that if somebody sells their home that has one of these liens they'd have to pay off the loan at closing (but it's also a cost that could be passed on in the home value to the next homeowner).

The public will need to really want fiber badly to consider this form of financing. If they finance their contribution with a loan they would have to make payments on the loan while also paying full rates for products at the ISP. This contrasts to the property-tax basis for the loans in Lyndon Township. There, the homeowner will pay higher property taxes (which would be the equivalent of paying for the equity loans), but they then get lower-priced broadband.

To put this kind of financing into perspective, if the equity required is \$5 million, then the monthly payment for a homeowner would be \$54 per month on a 10-year loan or \$41 per month on a 15-year loan. The impact of financing the project with property taxes is probably similar, and it is that impact that makes this a difficult path to funding.

There is no reasonable way to require homeowners to contribute to the project in this manner, which complicates the process of raising the money. For example, if only 40% of households wanted to finance in this way, then the amount needed from each household would double. However, realistically that wouldn't be enough customers to support the business. The business needs relatively high penetration rates – 70% or higher – along with an equity infusion.

Bank Loans. In addition to the equity the new ISP business also has to borrow money. The banking industry as a whole does not like to finance long-term infrastructure projects. This is the primary reason why the country has such an infrastructure deficit. Historically banks would fund things like power plants, electric and water networks, and other long-term revenue-generating assets. But various changes in banking laws which have required banks to maintain larger cash reserves along with a general desire to go after higher interest rate projects mean that banks have largely stopped doing this kind of lending. It's not impossible to finance an infrastructure project at a traditional bank, but the general parameters of bank loans make it a challenge.

There are exceptions. A few of the large banks like Key Bank and Bank of America have divisions that will make bank loans to municipal ventures that look a lot like bonds. These loans will have long payment terms of 20 years or more and reasonable interest rates. However, most of these loans go for things like power generation plants and other projects that have a really strong guaranteed revenue stream. These banks have done a tiny handful of telecom projects, but they view most of them to be too risky. Banks are also somewhat averse to start-ups and prefer to make these kinds of loans to existing telecom businesses that already have a proven revenue stream.

There is one unique banking resource available to companies who want to build fiber projects. This is CoBank, a boutique bank. This bank has financed hundreds of telecom projects, mostly for independent telephone companies and electric cooperatives. CoBank is a relatively small bank and has strict requirements for financing a project. They are leery of start-ups and we can't think of a start-up they have financed recently. They also expect significant equity to be infused into a new venture. They tend to have high interest rates and somewhat short loan terms of 10–12 years.

The most likely source of bank financing for this project would be local banks. Historically local banks were the source in many communities for car and home loans. But over the last few decades those loan portfolios have migrated to other lenders and local banks have been struggling for a decade to find worthwhile projects in their regions. We know of many commercial projects for small telcos that have been financed by local banks.

One of the issues of borrowing from a local bank is that they are going to have a relatively small lending limit. Most local banks won't make an individual loan for more than one or two million dollars. That obviously doesn't go far for a fiber project. However, local banks have become adept at working in consortiums of multiple banks to make larger loans. This spreads the risk of any one loan across many banks. Banks who do this usually take part in consortium loans for a number of projects. These smaller banks see this as a way to make loans to quality projects and quality customers that they could not loan to on their own.

To make this work you generally must start with a bank that is local to the project and let them help you put together the consortium. Your local bank would essentially become the sponsor of the deal. This approach takes some extra work to put together, but there are many examples of this working for financing good projects.

Loan Guarantees / Surety. One way to make banks more amenable to loaning money to fiber projects is through federal or state loan guarantee programs. A loan guarantee is just what it sounds like. Some state or federal agency will provide a loan guarantee, which is very much like getting a co-signer on a personal loan. These programs guarantee to make the payments in the case of a default and thus greatly lower the risk for a lending bank. In return for the lower risk, the banks offer lower interest rates.

These guarantees are not free. There is an application process to get a loan guarantee in much the same manner as applying for a bank loan or a grant, meaning lots of paperwork. And then the agency making the guarantee will generally want a fee equal to several interest "points" up front. To some extent, this process works like insurance and the agency keeps these fees to cover some of the cost of defaults. If they issue enough loan guarantees, then the up-front fees can cover eventual losses if the default rates are low. These points are a payment to the agency for issuing the guarantee and are not refundable.

There are several state and federal agencies that might be willing to make loan guarantees for telecom projects. The following agencies are worth considering:

HUD 108 Program. The Department of Housing and Urban Development has a loan and loan guarantee program that is allotted for economic development. There is both federal money under this program as well as money from this program given to the state to administer. While these loans and loan guarantees generally are housing related, the agency has made loan guarantees for other economic development projects that can be shown to benefit low- or moderate-income households. If enough of a fiber project can be said to benefit low-income residents, then these loans can theoretically be used for a fiber project. This is unlikely to be of benefit to the township.

Small Business Administration 504 Loan Program. This program by the SBA provides loans or loan guarantees to small start-up businesses. These loans or loan guarantees must be made in conjunction with a bank, with the bank providing some loan funds directly and with the SBA loaning or guaranteeing up to 50% of the total loan.

USDA Business and Industry Guaranteed Loans (B&I). The Department of Agriculture provides loan guarantees through the B&I program to assist rural communities with projects that spur economic development. Such a project must, among other things, provide employment and improve the economic or environmental climate in a rural area. These loan guarantees are available to start-up businesses. The program can guarantee up to 60% of a loan over \$10 million or greater percentages for smaller loans. The key to getting this loan is in proving the economic development benefits. This loan guarantee would be far easier to justify in an agricultural area than in a residential township.

Rural Utility Service (RUS). This is a part of the Department of Agriculture. We cover their loan program in detail just below in this report. They also can provide loan guarantees. These come with the same sorts of issues associated with the loans. These loans and loan guarantees can only be used in communities that do not include cities of 20,000 population or greater, which would not be an issue in Manchester Township.

Rural Utility Service (RUS) Loans. The Rural Broadband Access Loan and Loan Guarantee Program (Broadband Program) furnishes loans and loan guarantees to provide funds for the costs of construction, improvement, or acquisition of facilities and equipment needed to provide broadband in eligible rural areas. These loans can't be used for any town with a population over 20,000.

RUS makes broadband loans and loan guarantees to:

- Finance the construction, improvement, and acquisition of facilities required to provide broadband including facilities required for providing other services over the same facilities.
- Finance the cost of leasing facilities that are required to provide broadband if the lease qualifies as a capital lease under Generally Acceptable Accounting Procedures (GAAP). The financing of such a lease will be limited to the first three years of the loan amortization period.
- Finance the acquisition of facilities, portions of an existing system, and/or another company by an eligible entity, where acquisition is used in the applicant's business plan for furnishing or improving broadband. The acquisition costs cannot exceed 50 percent of the broadband loan amount, and the purchase must provide the applicant with a controlling majority interest in the equity acquired.
- Finance pre-loan expenses, i.e., any expenses associated with the preparation of a loan application, such as obtaining market surveys, accountant/consultant costs for preparing the application, and supporting information. The pre-loan expenses cannot exceed 5 percent of the broadband loan excluding any amount requested to refinance outstanding telecommunication loans. Pre-loan expenses may be reimbursed only if they are incurred prior to the date on which notification of a complete application is issued.

RUS is allowed to make loans to a wide range of entities. Borrowers can be either nonprofit or for-profit and can be one of the following: corporation; limited liability company (LLC); cooperative or mutual organization; Indian tribe or tribal organization as defined in 25 U.S.C. 450b; or state or local government, including any agency, subdivision, or instrumentality thereof. Individuals or partnerships are not eligible entities.

To be eligible to receive a loan under this program, the entity must:

- Submit a loan application. We note that the loan application requires a lot of work including such things as pre-engineering, surveys, mapping, financial business plan models, environmental impact studies, and other things which make the application expensive to get prepared externally;
- Agree to complete the build-out of the broadband system described in the loan application within three years from the date the borrower is notified that loan funds are available;
- Demonstrate an ability to furnish, improve, or extend broadband in rural areas;
- Demonstrate an equity position equal to at least 10 percent of the amount of the loan requested in the application; and
- Provide additional security if it is necessary to ensure financial feasibility as determined by the Administrator.

In practical terms here is how the RUS loans have been administered over the past few decades:

- The rules say that a project needs at least 10% equity, but in reality this is often expanded to be anywhere from 20% to 40% at the discretion of the RUS. In effect, the RUS acts as a bank and they will require enough equity that the project can adequately cover debt payments. In comparing the RUS to other banks, we would classify them as conservative.
- The loan terms are generally in the range of 12 years, sometimes up to 15 years for fiber projects. This is much shorter than the terms available on bond financing, meaning the annual payment would be higher under an RUS loan than with a bond.
- It is exceedingly hard to get a project funded for a start-up business. When one takes an RUS loan they essentially want the whole company as collateral. Thus, the bigger and the more successful the borrower, the easier it is to meet their loan requirements.
- Their collateral requirements are considered overreaching. If they are not the 100% lender to a project and there is other debt, the RUS still wants 100% of the business as collateral – something that won't work with an additional lender.

These rules mean that it is challenging to use RUS to fund a start-up venture. To the best of our knowledge, they have never successfully funded a municipal venture and they rarely approve a project for a start-up business unless it is extremely well funded or backed by a demonstrably successful company.

The other big drawback of these loans is that they take a long time to process. They often have a backlog of loan applications at the RUS of 12–18 months, meaning you have to wait

a long time after application to find out if they will fund your project. That's a long time to wait to find out you're not going to get funded. If you are coordinating these loans with other forms of financing (like homeowner equity loans), this wait is not practical.

The loans are granted by using a very detailed checklist and rating system. This system gives a big preference to making new loans to existing RUS borrowers. However, the loan fund is huge and is currently at nearly \$1 billion. Congress generally has been adding additional funds to the RUS pot each year. The RUS also has some discretion and they have it within their power to make a grant as part of the loan. This is something that can't be counted on, but we know of projects where the borrower only had to pay back 80% of what they borrowed. The interest rates can be lower than market in some cases, but for the last several years, with low interest rates everywhere, the RUS loan rates were not much cheaper than commercial loans.

These loans also require a significant paperwork process to drawdown funds along with significant annual reporting requirements.

There is a low likelihood that RUS would be a funding source for this project. We must caution that if you talk to the RUS they will be rosily optimistic and can give you a false sense of security.

New Markets Tax Credit. The New Markets Tax Credit (NMTC) Program was established in 2000 as part of the Community Tax Relief Act of 2000. The goal of the program is to spur revitalization efforts of low-income and impoverished communities across the United States and Territories. Eligibility of the township to use these funds would depend upon meeting the earnings test for the average household income in the township.

The NMTC Program works by giving big tax credits to investors that are willing to invest in infrastructure projects in qualifying communities. The tax credits are so lucrative that often the other terms for accepting the funding are modest. The tax credit equals 39% of the investment paid out—5% in each of the first three years, then 6% in the final four years, for a total of 39%.

The Community Development Financial Institutions (SDFI) Fund and the Department of the Treasury administer the program. The process of how the Treasury allots credits is a complicated one and we won't cover it, but in the end there are entities who end up each year with some amounts of New Markets Tax Credits that they must invest to gain the tax credits. The credits are often purchased by the large national banks or other firms that invest in infrastructure.

Generally in practice, these funds act like a mix of loans and credits to the recipient. For instance, a community that received these funds might have to pay some modest amount of interest during the seven years of the tax credit, and at the end would have a balloon for the principal. However, often some or even all of the principal will be excused, making this look like a grant with interest.

Because the entities that get the credits change each year, and because you apply with the entities that hold the credits, and not with the federal government, the processes for applying for this money are fluid. However, there are entities and consultants who help find New Market Tax Credits and who can help you through the maze of requirements.

These funds are not likely to fund a whole, or even a large percentage, of a fiber project, but they might be used to fund 5% to 10% of the needed funds of a project and can be a very affordable piece of a funding package. In some cases the terms for getting these credits are so good that other pieces of the financing might look at the tax credit money as equity.

## **VI. Business Structure**

This section will first look at the possible business structures that the township can consider.

We undertook this study with the understanding that it is likely to be impossible to fund the network with some form of tax revenue. That eliminates a township-owned ISP as a possible business structure and means that the business structure will have to be some form of commercial entity – a standalone ISP, a cooperative, or perhaps forming an ISP or cooperative with one or more other townships.

### **A. Standalone Commercial ISP / Cooperative**

Since the customer base would be small this would have to be a simple and stripped-down ISP. We would envision a business operated by three to four employees. This would mean “small-town service,” but it would also be local service and these employees should be able to provide reasonable customer service. Many of the functions required to be an ISP can be purchased from vendors—meaning that the local employees would take care of local maintenance issues, bill customers, and answer customer questions. Following is a discussion of the pros and cons of a for-profit ISP versus a cooperative.

#### **For-Profit Corporation**

The telecom world is full of for-profit companies and it is the most typical structure for telecom companies. For-profit businesses have a number of options on the type of corporation they choose, but today the vast majority of corporations are either C-Corporations or LLCs, which are a type of S-Corporations. A C-Corporation is a taxable entity that pays income tax on their earnings directly. An LLC distributes the profits to the owners who are then responsible for paying the taxes.

The primary reason that companies elect C-Corporation is if they want to accumulate cash for some reason. In an LLC it's less convenient to accumulate cash because the owners get taxed on it even if you don't distribute it to them. Why would a company hold cash? One reason might be due to the terms of any borrowing. For example, for a start-up company the holders of the debt might say that there can be no dividends paid to the owners until the debt has been repaid. Under that kind of scenario if the business was an LLC the owners might have a tax liability every year without any cash distribution to cover their taxes.

LLCs are highly flexible. It's possible to have a different distribution for various things. For example, there might be one structure for ownership shares, another structure for voting, another structure for distributing cash, and another structure for distributing tax liabilities.

#### Advantages

- The primary advantage is that it gives control (and profits) directly to whoever owns the business. Almost anybody other than a municipality can own a for-profit business.
- Corporations can issue different classes of stocks to differentiate between owners that can vote, owners that get profits, and so forth. It's likely to be a challenge to decide who "owns" the business if a new commercial ISP is formed to serve the township.

#### Disadvantages

- The primary disadvantage is being taxable. In a state where there is both a state and federal income tax, the tax burden can be substantial. It is important to note that in a fiber business even when the business is cash positive there is rarely a tax liability for the first decade due to depreciation expense. But once the original network is mostly depreciated the tax burden can be greater than the cash generated.

### **Cooperatives**

Cooperatives are governed and protected under both federal (Capper Volstead Act) and state law - Michigan Statutes Chapter 450.<sup>1</sup> A cooperative is a legal entity owned and controlled by its members and members often have a close association with the enterprise as producers or consumers of its products or services. Cooperatives are typically based on the cooperative values of self-help, self-responsibility, community concern, and caring for others. Cooperatives generally aim to provide their goods or services at close to cost while any excess earnings tend to be reinvested in the enterprise or returned to individual patrons based on patronage of the cooperative.

Cooperative governance is structured into patron members and non-patron members operating under a Board of Directors elected at an annual meeting according to statutory guidelines and founding bylaws. Generally, anybody that buys services from the business is eligible to become a patron member when they sign up for services.

#### Advantages

- A cooperative is owned by the customers. People generally like to be members of cooperatives. They like the fact that they can have some say in what the business does and they really like patron dividends once those start being paid. Cooperatives generally have very little churn, meaning that once somebody becomes a patron they are not likely to leave the cooperative in response to a competitive offer from some other telecom provider. It is interesting to note that for-profit telecommunications companies are at the

---

<sup>1</sup> <https://micondolaw.com/michigan-community-association-law-hoas-co-ops-summer-resorts/co-ops-the-michigan-general-corporation-statute/>

bottom of national customer satisfaction lists while cooperative and municipal entities are the most popular with customers.

- A cooperative is a community asset. This means that the revenues of the business are spent locally and the profits from the business are kept locally. A telecom cooperative would add value to the community just through being local. Local ownership is historically more responsive to community needs and offers the promise of better services to customers through local accountability.
- Becoming a cooperative avoids a lot of the problems associated with launching the business as some form of municipal entity. There are significant advantages in building a new fiber optics broadband network and providing services as a private company because it is less likely to be the target of legal challenge such as might arise with a public ownership option in regard to telephone service.

#### Disadvantages

- Because the business is owned by customers, there is no way for the founders of the business to dictate the direction of the business or to direct the use of excess funds eventually created by the business. Once the business is given to customers it can never be taken back.
- If the cooperative option is chosen it will be important to make a sound judgment about community members' readiness to engage to ensure the success of the cooperative. There would need to be a number of citizens willing to step forward and take on roles as the cooperative board to set direction and to launch and operate the business.
- A cooperative is a taxable entity and must pay income taxes on its profits (unlike a municipal entity that is generally non-taxable).

**How Hard Is it to Be an ISP?** These options would require the new organization to become an ISP, and that leads to the natural question of how hard that is to accomplish.

In our experience that is probably a lot easier than you might think and it is certainly a lot easier than it was a few years ago. There are numerous small ISPs around the country that would be of a similar size of yours. Here are the primary functions the ISP would have to handle:

- Providing the Data Product. This used to be quite technical, but today this entire function can be outsourced to high-quality vendors for a reasonable monthly cost per customer. The outside vendor will route Internet traffic, check for viruses, protect the network against malicious software attacks, and so forth. This vendor would also answer customers' technical questions and would also have the ability to effectuate simple repairs for you remotely.
- Maintain the Network. For a fiber network this small there is not going to be a lot of maintenance required. You can hire a part-time technician to make any needed repairs and to maintain the fiber and electronics. You can contract with other local carriers or contractors to handle major repairs (such as when somebody cuts a fiber).
- Backoffice Functions. This involves things like taking orders, preparing bills, and collecting payments. For a company this small this can easily be handled by one employee. There are software systems available that make it relatively easy to take orders, bill customers and handle trouble calls.

One of the recommendations in the report is that you consider partnering with other townships to create a larger ISP. The larger the ISP, the more complicated. In that case we would recommend that the ISP be staffed with a general manager who would oversee all of the above functions. But otherwise, even a larger ISP only has to cover the basic functions. One thing we've learned is that the one product that requires a lot of staff effort is cable television, and as long as you don't offer that, then an ISP can be a pretty simple business. Obviously you will want to have a technician who is competent, but this kind of talent seems to be reasonably available almost anywhere.

### **What about Open Access?**

A common goal for many municipal broadband networks is to be open access – meaning opening up the network to allow multiple ISPs to bring services. The appeal of open access is the hope that multiple ISPs will bring price and product competition, providing more choices for the residents.

Most open access networks operate in US utilize this business structure because of mandates by legislation or regulation. For example, this model is used in the PUDs (Public Utility Districts – rural electric companies) in Washington that are restricted to being wholesale providers due to legislation passed a number of years ago. Utah has a similar law that applies to municipalities. This led to the creation of an open access fiber business in Provo and another in a collective of small towns operating as Utopia. Open access is sparsely used and there are perhaps a dozen open access markets in the country.

The biggest drawback for operating an open access network is making the numbers work. In an open access network the various ISPs pay for 'access' to the network. The access fees they pay are the only revenues collected by the network owner. It's easy to understand the difference this means for the network owner. If Manchester was a retail ISP your average bill to residential customers would probably be in the range of \$75. In an open access network the ISPs would sell the products to customers. If ISPs were to collect that same \$75 from customers they would not want to pay Manchester more than \$20 - \$25 for use of the network. You would still have the costs of operating and maintaining the network – most importantly paying off any debt used to finance the network. The wholesale ISPs would take on the expenses of sales, customer service and billing.

The math for the network owner doesn't work and I'm not aware of any US open access network that has been able to repay for the cost of building the network. Many of them have enough revenue to cover operating expenses – but they've had to fund their network from some other source.

The only way that open access might work for the township would be if the network was financed with tax revenues. Then you could charge some nominal fee to use the network, and perhaps you and the ISPs could both be profitable.

There are a few other problems with open access. The City of Longmont, Colorado built an open access network a few years and zero ISPs showed up to provide services. The City had to quickly become the retail ISP.

The other big issue is cherry picking. That is the phenomenon where the ISPs only want to sell to the most lucrative customers in the market—those with the highest monthly bills. Open access leads naturally to cherry picking since having to pay an ‘access’ fee to use the networks tends to make ISPs ignore the lower end of the market. We’ve seen open access networks not get as high of a market penetration as retail networks due to this phenomenon.

## **B. Partnering with Other Townships**

Joining into a partnership with other townships to create a larger business can improve financial performance through taking advantage of economy of scale. The more townships that band together, the better the financial results for everybody.

The partnership could take numerous forms. Since it’s likely that each network would be financed separately, it would not make sense to create a partnership that owned the various networks. Rather, the most sensible partnership structure would be a business of some kind that provided the ISP services to operate on the networks separately owned in each township.

The larger the ISP, the more complex the business, but the economy of scale savings generally outweigh complexity issues.

### Advantages

- This is likely going to provide the best financial scenario.
- The biggest benefit from this scenario is the economy of scale. The bigger the joint effort, the bigger the benefit to every member township and their citizens. Such a partnership makes sense even for just two neighboring townships, but the benefits increase if the business could become larger.

### Disadvantages

- There is a lot of work required to establish this kind of coalition and to make it work. Buy-in is needed from township partners before any township can feel safe to launch. This is a bit of a chicken and egg phenomenon—townships might see the need to work together, but without enough of them joining it’s difficult to get started.
- It’s not necessarily a negative, but there is research needed to understand the best legal structure for such a joint business. The primary issue would be to find a structure for the partnership that would let the profits from the business flow back to the townships.

## **VII. Other Issues**

### **A. Connect America Fund**

In the fall of 2015, AT&T accepted funding from the FCC to improve rural broadband in Washtenaw County. This funding comes from the Connect America Fund (CAF) is a component of the High Cost Fund. The FCC set aside \$1.7 billion per year for the six years starting with 2016 to build or upgrade rural broadband. These funds were mostly made available to Census blocks

that have little or no broadband today. AT&T accepted \$435,687 per year to bring better broadband to 1,617 rural customers. There is a map attached as an addendum to the report that shows the areas covered by this funding and parts of Manchester Township are included in the upgrade areas.

AT&T is only required to use the money to increase rural broadband speeds to at least 10 Mbps download and 1 Mbps upload. The companies have six years to make the needed upgrades, with 2016 being the first year. Note that those speeds are far slower than the FCC's own definition of broadband—25 Mbps download and 3 Mbps upload.

We know that AT&T plans to use their funds to improve cellular broadband using the 4G LTE network. A lot of households in the township get broadband at their homes today through a fixed cellular product priced at around \$80 from AT&T. With that product, AT&T uses the same cellular frequencies used by cellphones to deliver broadband to homes. They are able to concentrate the signal and increase speeds by placing a small antenna on, or in the home. Supposedly the speeds on that product should be increased to at least 10/1 Mbps for customers that are seeing slower speeds. Customers that live close to a cell tower are going to see speeds a little faster than the minimum and today's 4G LTE speeds top at out at about 15 Mbps. These upgrades may have already been made, but the company has a few more years to complete them if they aren't finished.

The downside to this is that we also know that AT&T badly wants to get rid of their rural copper networks and they have started the process in many states of tearing down their copper. The company says that it's too expensive to maintain copper, and in areas like the township they'd like to see everybody using the cellular network. We expect them to eventually get rid of copper in the township and everywhere where they got the CAF II funding for upgrades.

The other bad news is that this speed upgrade is likely the last one the township is going to see for a long time. It's unlikely that the township will see another speed increase on cellular for a long time. It's possible that increases could come eventually from upgrades to 5G – we discuss this in more detail below – the cost of 5G upgrades will be prohibitive in rural areas.

It's also worth noting that the CAF II build-out allows ISPs to impose stingy data caps. The FCC suggests that data caps can be as small as 100 Gigabytes per month in total download. For a household that watches video over broadband that is a tiny data caps these days. As an example, my household doesn't have traditional TV and we watch all video over the Internet. With three family members (and a home-based business) we generally use about 700 Gigabytes per month.

The CAF II upgrades that will deliver speeds likely between 10 Mbps and 15 Mbps will be a welcome upgrade to homes that have had even slower speeds. You need to be prepared to hear households say that these speeds are fast enough. However, these speeds are far slower than the speeds that are delivered by Comcast in the Village and in other towns in Michigan. And these speeds are not going to get faster, although the average household demand for bandwidth and speeds has been doubling every three years.

## **B. Faster Broadband Coming?**

### **Satellite Broadband**

Elon Musk has created a new company, Starlink, which is promising to deliver low earth orbit (LEO) satellites to bring better satellite broadband to the world. His proposal to the FCC is to put 4,425 satellites around the globe at altitudes between 715 and 823 miles. This contrasts significantly with the current HughesNet satellite network that is 22,000 miles above the earth. The typical Space X satellite would be roughly the size of a refrigerator and would be powered by a solar array. There are some smaller satellites that would act to bridge communications between satellites and would not communicate with customers on earth.

Possibly the biggest hurdle to making this work (assuming the technology works as promised) is the ability to put that many satellites into orbit. The number of satellites being proposed is greater than all of the satellites ever put into space until now. However, since Elon Musk also owns SpaceX, the company that provides commercial rocket service, if anybody could make this work it's him.

Musk's proposal has major benefits over existing satellite broadband. By being significantly closer to the earth the data transmitted from satellites would have a latency of between 25 and 35 milliseconds. This is far better than the 600 microsecond delays achieved by current satellites and would match the latency achieved by many ISPs. Current satellite broadband has too much latency to support VoIP, video streaming, or any other live Internet connections like Skype or distance learning.

The satellites would use frequencies between 10GHz and 30GHz, in the Ku and Ka bands. Musk's request to the FCC is an attempt to reserve those frequencies for that purposes, which is no automatic thing. The FCC is only likely to allocate the spectrum for this purpose when it becomes clear that this is really going to be implemented – they allocated frequency in the past for a few satellite projects that never materialized. Now that 5G wants to use the same upper frequencies it will be harder for satellite broadband to grab big blocks of frequency.

The specifications at the FCC say that each satellite will have an aggregate capacity of between 17 and 23 Gbps, meaning each satellite could theoretically process that much data at the same time between it and customers on earth. The specifications say that the network could produce gigabit links to customers, although that will likely 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 such as 50 Mbps to 100 Mbps.

There is also speculation that the network would best be used in the US to provide broadband to cellular sites, including the possible small sites being proposed for 5G. So it's possible that even were such a network to be built that it might not be a panacea for rural broadband delivery.

However, if the satellite network is launched and used for rural broadband it could be revolutionary for rural America. The FCC spent over \$9 billion in the CAF II program to bring faster DSL or cellular service to rural America with speeds that must only achieve a speed of 10/1 Mbps.

The big question is if Musk can raise the needed money. Musk says this whole venture will cost about \$10 billion. There has been recent press suggesting that Musk is allocating all borrowing capacity to meet the demands of the SpaceX business, the electric car business, and the fast-train business and that there doesn't seem to be funding for the satellite initiative.

It's an intriguing idea, and if it was offered by anybody else other than Elon Musk it might sound more like a pipe dream than a serious idea. But Musk has shown the ability to launch cutting-edge ventures before. There is always a way to go between concept and reality and like any new technology there will be bugs in the first version of the technology. But assuming that Musk can raise the money, and assuming that the technology really works as promised, this could change broadband around the world.

## **5G Broadband**

The whole telecom industry is currently abuzz about the possibility for 5G to improve broadband. 5G is a new wireless standard that was finalized in late 2017. The standard defines various technological improvements that provide a roadmap for providing improved wireless products. The 5G standard can be applied to a wide range of spectrum – and the use case for these spectrums vary according to the physical characteristics of each spectrum. The consequence of this is that there are three different 5G applications being discussed in the market today that are all being labeled as 5G – yet the applications are widely disparate. This has led to a lot of market confusion because the first question that must be asked when somebody talks about 5G is which technology is being discussed. The press has widely confused the different technologies, which has led to articles talking about things like gigabit cellphones – something that is not remotely part of the 5G capabilities.

The three different current 5G applications are:

- 5G cellular service;
- 5G point-to-point links;
- 5G last-mile loop.

## **5G Cellular**

5G is the next generation of cellular service that will eventually replace the current 4G LTE. The new 5G standards propose an improved cellular experience for customers. There are 13 new technical improvements required to fully implement 5G. The most important of these are:

- The primary stated goal of the 5G standard is to be able to handle upwards of 100,000 simultaneous connections from a single cell site. We're all familiar with being unable to get a cell signal in a busy environment like an airport or stadium. This will fix that issue, but the real hope for the cellular companies is to be able to use cellular technology to be able to communicate with Internet of Things (IoT) devices. IoT is a term that refers to

the many devices that we communicate with wireless, such as the many devices in a home today that are connected to WiFi. Today the IoT works almost entirely with WiFi and the cellular companies envision capturing much of that market – but they have a huge uphill battle to wrest the market away from WiFi.

- The standards set a speed goal to eventually achieve widespread cellular speeds of 100 Mbps download and 20 Mbps upload. Contrary to the cellular company press releases, the standards goal of 5G is not to create blazingly fast gigabit cellular service.
- The last important improvement is to achieve latency at near-fiber levels. Latency measures a delay in a signal, and today cellular signals have higher latency than fiber connections. This is the primary reason why it often feels sluggish to download a web page on a cellphone.

These improvements won't all be introduced at once. The cellular equipment manufacturers typically introduce each new improvement as they are perfected, and it's likely to take another decade for all 5G improvements to be implemented. The same thing happened with the transition from 3G and 4G and the first true 4G cell site that fully meets the 4G specifications was just activated late last year – even though the cellular carriers have been selling what they call 4G service for a decade. This gradual introduction of the 5G improvements will mean a gradual improvement of 4G technology. In industry lingo, in five years we might see enough of the 5G standards implemented that from a technical perspective we'll be at 4.5G. Until then, from a technical perspective the industry will grow through 4.1G, 4.2 G etc. Even though this will take a decade to be fully implemented, the cellular marketing folks are already making claims about having 5G cellular in 2019.

There are numerous articles on the web that talk about gigabit cellphone speeds. This is mostly due to nontechnical writers confusing the three different 5G technologies. But this speculation has also been fueled by a few announcements of trials done by Verizon and Sprint. Sprint got great press by saying they had achieved a connection to a cellphone at 600 Mbps. This was a highly controlled test. It involved a cellphone that used an immense antenna array that could receive and combine signals from ten different millimeter wave transmitters at the same time. To achieve that same performance in real the real world would require ten small cell sites within proximity to a cellular customer - a world where there are cellular transmitters literally everywhere. A phone using this antenna array would have a likely battery life a half hour. The test shows that fast speeds are theoretically possible – in a controlled lab setting. Fast speeds will not be possible in the real world unless the parameters of this same test are met – multiple cell sites nearby, a cellphone with a massive antenna array, the use of ubiquitous millimeter wave spectrum (will be explained more later) and zero interference. It's worth knowing that the body of the cellphone user would block the signal to a phone in the “shadow” of the user. These signals are blocked by almost anything, and a person walking between a cell site and the receiving phone would block the signal. Because of numerous limitations of physics, we may never see that kind of performance in the real world.

The goal of achieving 100 Mbps cellular speeds is due to a major change in the way that the cellular network functions. Today's network is based upon the idea of roaming. For both voice and broadband purposes today's cellphone makes only one connection at a time to the cell tower that provides the strongest signal (and which has an open slot). 5G introduces a radical change

and would allow for a handset to connect to multiple cell sites and draw broadband from each of them. This is done using MIMO (multi-input multi-output) antennas that can make and sustain multiple connections. This is the most difficult 5G challenge to implement in the real world. First, in most places there are only one or two existing cell sites. Faster speeds will only be available in places where enough new small cell sites are added to increase the available transmitters. In practical terms this means that in most places cellular data speeds will remain at 4G levels, even after 5G implementation – any place where a customer can see only one cell site will not get faster broadband speeds.

### **Point-to-Point Millimeter Wave 5G**

The second 5G technology, which is defined by the same standard, is a technology to provide high-speed connection of up to a few gigabytes of speed over relatively short distances. This technology uses extremely high spectrum of 20 GHz or higher – referred to as millimeter wave spectrum. In what is being called the 5G Order, in Docket FCC 16-89 the FCC released a lot of new spectrum.

The US is the first country to authorize specific use of the spectrum in these upper bands. Moreover, the FCC isn't yet finished. Along with the Order, the FCC issued a Further Notice for Proposed Rulemaking to look at how it should deal with other blocks of spectrum, including existing space in the 24-25 GHz, 32 GHz, 42 GHz, 48 GHz, 51 GHz, 70 GHz, and 80 GHz. The FCC also asked for comments on how it might provide access to spectrum above 95 GHz.

The technology using this high spectrum can be deployed in two ways. First is as a hot spot. A goal of the 5G specification is to be able to deploy a hot spot within an office to bring gigabit speeds to users within the confined area. As a hot spot these frequencies don't travel very far, and so using them within one room is a reasonable goal. The higher up on the frequency scale the shorter the effective distance as a hot spot, and at the upper end of these spectrums at 60 GHz the signal dissipates at 50 feet from the hot spot. These frequencies won't go through walls, making this a room-by-room application as an alternative to WiFi.

The second use of the 5G technology is deploying 5G in the form of a highly focused beam. This kind of deployment has been done for years in the lower microwave frequencies, with the first big use in the industry being the microwave network that MCI deployed to do an end-run around AT&T in the 1970s. The transmitters for this application focus the radio transmission into a narrow beam that is sent between a pair of transmitter / receivers. The easiest way to think of this is as something the diameter of a pencil stretching between two antenna dishes.

These beam deployments can be done in two ways. First is the more traditional point-to-point transmission between two transmitter/receivers. There have been radios using the millimeter wave frequencies for several years that can deliver up to a 2 Gbps connection for 1 mile or a 1 Gbps connection for 2 miles. Current radios use native Ethernet rather than the 5G standard, but 5G speeds would be nearly identical. This configuration is mostly useful as a fiber replacement. It's a good way, for example, to beam a signal from a roof top to provide service to another building. It's a good way to connect buildings together in a campus environment without having

to build fiber. It's an interesting way to be able to provide temporary service to a large business customer until fiber can be built.

This technology is available to anybody since the required licenses are inexpensive and available to anybody. The largest company using this technology today is Webpass, a subsidiary of Google Fiber. Webpass deploys the technology in downtown high-rise districts to bring gigabit broadband to whole buildings. They start with a building where they have a fiber connection and bring that connection to the roof. From there they beam to other downtown buildings. This is far cheaper than constructing fiber in downtown areas. Radios today are affordable and a pair of transmitters / receivers costs around \$6,000. The technology is of limited use though, in that two radios are needed for every connection, and this can quickly clog up valuable rooftop space. Verizon, AT&T, and CenturyLink have been experimenting with the technology to bring fiber speeds to apartment buildings and other big broadband customers without having to build additional fiber.

This is mostly a downtown urban technology. The beams need pure line-of-sight and there can be no impediments in the signal path. As mentioned, the biggest limitation is deploying too many transmitters at the network hub building that has fiber since landlords are not likely to allow dozens or more antennas on the roof.

The other limitation is the amount of broadband. One or two gigabit speeds might sound large, but even in today's environment that's often not enough to serve a whole building. These radios are limited by physics to about 2 gigabits. Most companies deploying the technology view it as a temporary solution that will eventually be replaced by fiber.

## **5G Last-Mile Loop**

The other configuration of the technology is to deploy the network in a point-to-multipoint configuration. This is the same kind of network design that is used today by fixed wireless ISPs (WISPs) in some of the rural parts of the county. In this technology one transmitter can connect to multiple end-user customers. This technology exists today using low frequencies such as 2.4 GHz, 3.5 GHz and 5 GHz. There is a huge amount of news about this use of 5G since Verizon recently announced that they plan to build this out as many as 11 million homes in the next few years to provide home broadband.

This technology doesn't have the same bandwidth throughput as the point-to-point transmitters. The easiest analogy to understand the capability of this configuration is that each customer connection shares characteristics of both a hot spot and a point-to-point link. Verizon announced recently that they can deliver speeds of about 300 Mbps up to 1,500 feet. Those short distances are going to be the limiting factor of the technology.

The Verizon 5G technology relies on the placement of small transmitters on utility poles or street lights and the FCC just passed rules making it easier for a provider to get the needed connections. Each transmitter will be able to wirelessly transmit broadband to homes or businesses in the immediate area. Because of the distance limitation, any given pole-transmitter will be able to "see" anywhere from a handful up to a few dozen homes in a town or suburban

environment, depending upon what's called line-of-sight. The 5G spectrum requires a relatively clear path between the transmitter and a dish placed on the home – and that means that 5G is best deployed on straight streets without curves, hills, dense tree cover or anything that decreases the number of homes within range of a transmitter. It's already been reported in early deployments by Verizon that a home might not be able to get this if there is a neighboring home blocking the path to the pole-unit.

This technology, when perfected, will create what the industry has always called wireless local loops. The concept has been around for decades with the vision being that a transmitter would be placed on a power or light pole to deliver broadband to the nearby houses without having to build wires from the poles to the customers.

There are other hurdles to be overcome for this to become a viable business plan. Delivering gigabit broadband from a transmitter on a pole requires fiber at each transmitter. This implies needing a fiber network built on residential streets. This gets even more complicated in neighborhoods where the utilities are buried and there are no utility poles. This would require hanging the devices on light poles and somehow getting the fiber bandwidth from the ground to the top of a light pole.

The need for fiber is the big financial limitation of a 5G wireless loop network. The technology seems to roughly require the same investment as building fiber-to-the home. There are very few companies tackling residential fiber overbuilds today, and it seems unlikely that there will be many willing to spend the same huge dollars for a 5G network. For example, AT&T recently said that the technology is not of interest.

Verizon has one huge advantage over the rest of the market in that they already own an extensive fiber network that reaches to cellular towers, large businesses, schools, large apartment complexes, and high-rise buildings. Verizon plans on leveraging this existing network to bring wireless broadband to neighborhoods lucky enough to be near to their fiber. Verizon has a second benefit that few others share. As a huge cellular carrier, Verizon will benefit by relieving the pressure on their cellular networks in neighborhoods where they offer 5G. The bandwidth being demanded on cellular networks is the fastest growing sector of the industry with total bandwidth requirements doubling every 18 months. Verizon will save a lot of money by not having to bolster their cellular backbones in 5G neighborhoods.

To summarize, a 5G network needs transmitters on poles that are close to homes and also needs fiber at or nearby to each pole transmitter to backhaul these signals. The technology is only going to make financial sense in a few circumstances. In the case of Verizon, the technology is reasonably affordable since the company will rely on already-existing fiber. An ISP without existing fiber is only going to deploy 5G where the cost of building fiber is reasonably affordable. This means neighborhoods without a lot of impediments like hills, curvy roads, heavy foliage, or other impediments that would restrict the performance of the wireless network. This means not building in neighborhoods where the poles are short or don't have enough room to add a new fiber. It means avoiding neighborhoods where the utilities are already buried. An ideal 5G neighborhood is also going to need significant housing density, with houses relatively close together without a lot of empty lots.

This technology is also not suited to downtown areas with high-rises; there are better wireless technologies for delivering a large data connection to a single building, such as the high bandwidth millimeter wave radios used by Webpass. 5G technology also is not going to make a lot of sense where the housing density is too low, such as suburbs with large lots.

Most importantly, 5G broadband is definitely not a solution for rural areas like the Manchester Township where homes and farms are too far apart. In your area a small 5G site on a pole might only be able to see a tiny number of homes. It would be far less expensive to build fiber drops than to build and maintain expensive electronics on poles.

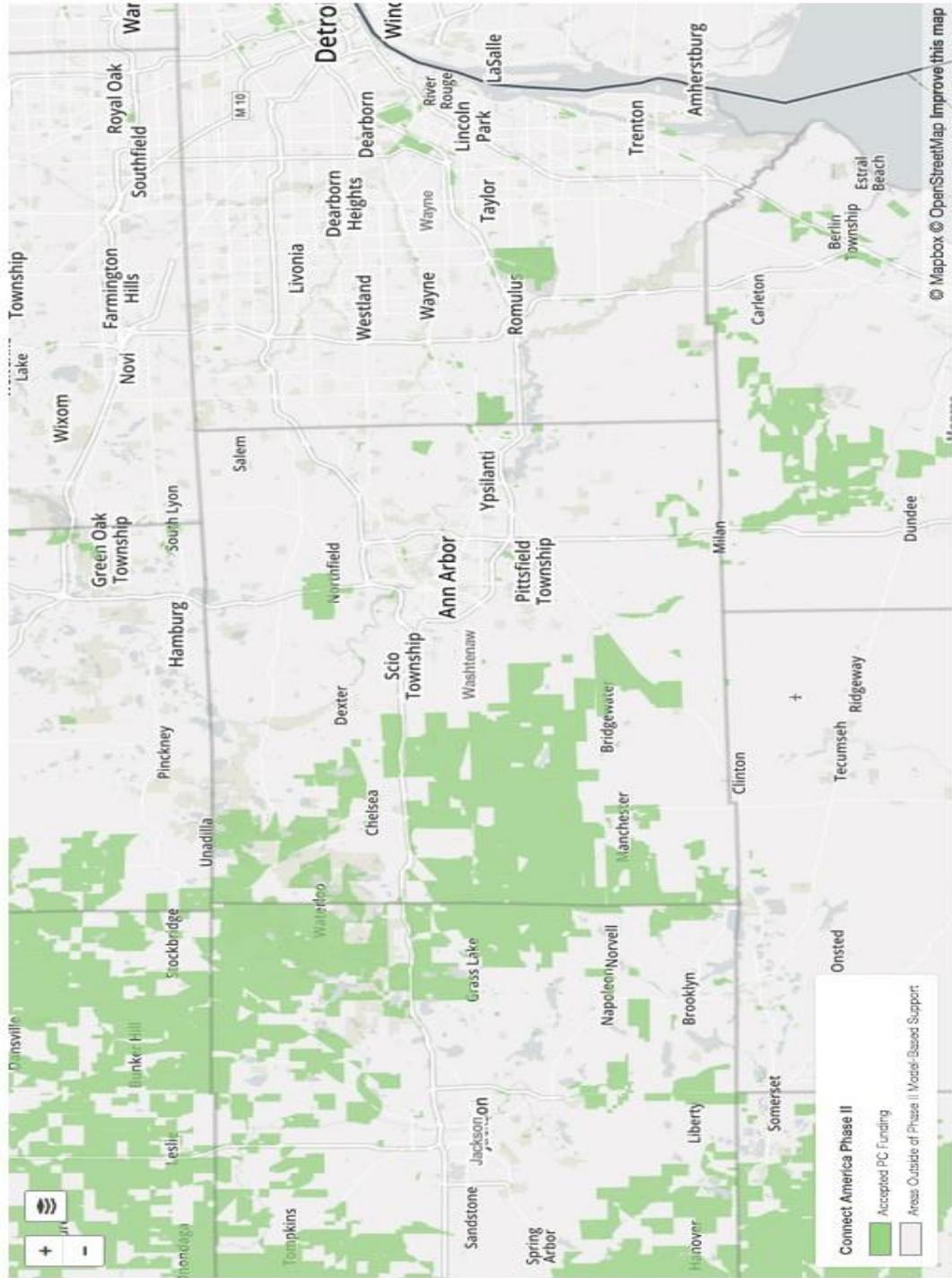
This also means that nobody is likely to bring 5G to rural America just like they're not bringing fiber. It's probable that the township might not even see 5G cellular for a decade or far longer, and it's inconceivable that an outside ISP would build the fiber needed to provide 5G broadband.

# VIII. Exhibits

## Exhibit I. Map of CAF II Coverage in Washtenaw County

### Connect America Fund Phase II

Accepted Areas Map



## A. Exhibit II. Summary of Financial Results

	Assets	Debt	Equity	Total Financing	Year 20 Cash	Worst Cash	Net Income Positive	Cover Debt
<b><u>Build Rural Township Only</u></b>								
All Buried Fiber	\$11.04 M	\$9.72 M	\$2.43 M	\$12.15 M	-\$7.13 M	-\$9.44 M	Year 17	Never
Expected Fiber Cost	\$ 9.08 M	\$8.03 M	\$2.01 M	\$10.04 M	-\$5.47 M	-\$7.55 M	Year 15	Never
Lowest Cost Fiber	\$ 7.71 M	\$6.87 M	\$1.72 M	\$ 8.58 M	-\$3.92 M	-\$5.97 M	Year 13	Never
Lowest Cost Self Install	\$ 6.86 M	\$6.48 M	\$1.62 M	\$ 8.10 M	-\$3.00 M	-\$5.23 M	Year 14	Never
Self-Install Breakeven	\$ 6.86 M	\$2.05 M	\$5.87 M	\$ 7.91 M	\$3.06 M	\$0.10 M	Year 11	Year 12
Lowest No Contingency	\$ 6.37 M	\$6.07 M	\$1.52 M	\$ 7.58 M	-\$2.40 M	-\$4.63 M	Year 13	Never
No Contingency Breakeven	\$ 6.37 M	\$2.28 M	\$5.20 M	\$ 7.48 M	\$3.23 M	\$0.10 M	Year 11	Year 13
<b><u>Build Whole Township</u></b>								
All Buried	\$13.08 M	\$11.25 M	\$ 2.82 M	\$14.08 M	-\$1.24 M	-\$6.19 M	Year 11	Never
Expected Fiber Cost	\$10.75 M	\$ 9.25 M	\$2.31 M	\$11.56 M	\$0.76 M	-\$3.93 M	Year 11	Never
Expected Fiber Cost Breakeven	\$10.75 M	\$ 4.57 M	\$6.60 M	\$11.17 M	\$7.45 M	\$0.10 M	Year 7	Year 12
Expected Cost Self Install	\$ 9.39 M	\$ 8.97 M	\$2.24 M	\$11.21 M	\$1.34 M	-\$3.58 M	Year 9	Never
Self Install Breakeven	\$ 9.39 M	\$ 4.34 M	\$6.80 M	\$11.14 M	\$8.20 M	\$0.10 M	Year 6	Year 11
Expected No Contingency	\$ 8.71 M	\$ 8.39 M	\$2.10 M	\$10.49 M	\$2.16 M	-\$2.76 M	Year 7	Never
No Contingency Breakeven	\$ 8.71 M	\$ 4.36 M	\$6.10 M	\$10.46 M	\$8.17 M	\$0.10 M	Year 6	Year 11
Lowest Fiber Cost	\$ 9.38 M	\$ 8.08 M	\$2.02 M	\$10.10 M	\$2.47 M	-\$2.19 M	Year 10	Never
Lowest Fiber Cost Breakeven	\$ 9.38 M	\$ 3.21 M	\$6.50 M	\$ 9.71 M	\$9.34 M	\$0.10 M	Year 4	Year 9
Lowest Self Install / Contingency	\$ 7.46 M	\$ 7.32 M	\$1.83 M	\$ 9.15 M	\$3.68 M	-\$1.59 M	Year 7	Never
Breakeven	\$ 7.46 M	\$ 4.36 M	\$4.85 M	\$ 9.21 M	\$8.19 M	\$0.26 M	Year 6	Year 11
<b><u>Sensitivity Analysis</u></b>								
Higher Interest Rate	\$9.39 M	\$9.07 M	\$2.27 M	\$11.33 M	\$0.44 M	-\$4.47 M	Year 10	Never
80% Rural Penetration	\$9.55 M	\$8.97 M	\$2.24 M	\$11.21 M	\$2.88 M	-\$2.64 M	Year 7	Never
\$5 Higher Prices	\$9.39 M	\$8.95 M	\$2.24 M	\$11.19 M	\$3.14 M	-\$2.44 M	Year 7	Never

<b>30% Equity</b>	\$9.39 M	\$7.76 M	\$3.33 M	\$11.09 M	\$4.80 M	-\$1.45 M	Year 7	Never
<b>\$75 Gigabit</b>	\$9.39 M	\$8.93 M	\$2.23 M	\$11.16 M	\$5.47 M	-\$1.51 M	Year 6	Never
<b>Most Optimistic Scenario</b>	\$7.46 M	\$7.30 M	\$1.83 M	\$ 9.13 M	\$7.15 M	-\$1.01 M	Year 6	Year 15
<b>Most Optimistic Breakeven</b>	\$7.46 M	\$6.00 M	\$3.60 M	\$ 9.59 M	\$9.80 M	\$0.09 M	Year 5	Year 12
<b>Partnership</b>	\$9.21 M	\$8.76 M	\$2.19 M	\$10.95 M	\$2.47 M	-\$2.70 M	Year 7	Never