Cortez, Colorado

Broadband Feasibility Study

May 4, 2018

Finley Engineering
CCG Consulting

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Executive Summary

CCG Consulting (CCG) and Finley Engineering submit this report of our findings and recommendations from the feasibility study conducted to understand the potential for bringing a fiber broadband network to Cortez. Our two firms looked at the feasibility from a number of different angles. Finley Engineering estimated the cost of building fiber everywhere in the city with several construction techniques including burying fiber and placing fiber on poles. CCG undertook research that told us more about the competitive landscape in the city that included research on existing competition and the incumbent broadband providers, an analysis of actual customer broadband bills, and the results of speed tests taken by Cortez citizens that measured their actual broadband speeds. CCG then created numerous financial projections that looked at different business plan scenarios for operating a broadband network in the city. Finally, the study answered various questions asked by the original RFP such as looking at how a fiber network might be funded.

The key finding from our analysis is that it doesn't look feasible to build and operate a fiber network if that network is funded 100% by a revenue bond issue. Instead, it looks feasible if the city can find a way to fund the network with some other source of tax revenues such as a sales tax increase.

The studies do show scenarios, funded by sales tax revenues, where the fiber business would generate significant excess cash which could be used to fund the city or to reduce broadband prices. There are also intriguing options for the city to bring fiber to every household in the city and give every home a free internet connection at a low speed, with higher speeds available to those willing to pay more for faster speeds. This would make Cortez one of the few places to solve the digital divide and bring broadband to every student in the city.

The report discusses the other benefits that fiber can bring to Cortez. The study, however, also discusses the risks of entering the fiber business and looks at some of the major pitfalls to avoid if the city moves forward. The report also looks at the major implementation and operational issues that must be addressed if you decide to launch a retail network.

Finally, the report makes a number of specific recommendations on the next steps for the city to consider if it wants to further explore fiber broadband options.

Report Summary

Project Description. Finley Engineering and CCG Consulting were hired to do a feasibility study for bringing fiber broadband past every home and business in the community. This network would add on to the existing fiber network already built by the city to serve its own needs as well as to sell wholesale connections to carriers and large businesses in the city today.

The project included a number of components including 1) a market analysis of the current products and prices offered in the market, 2) an engineering analysis and estimate of the cost of building and lighting a fiber network, 3) a discussion of the possible operating models to be considered to operate a government-sponsored fiber business, 4) the development of various financial business models to quantify the operating costs and potential profitability of the various operating models, 5) a sensitivity analysis to quantify the impact of varying the most important assumptions and variables supporting the financial models, 6) a discussion on possible funding mechanisms that can be used to fund fiber, 7) an analysis of the likely competitive response of the incumbent providers, 8) the benefits to the community from operating a citywide fiber network and the financial and execution risks that must be considered. After considering those issues the report then draws conclusion about the best path forward and makes specific recommendations on what the city might do next.

Fiber Network Design. Finley Engineering considered several designs before designing a reasonably efficient network for bringing fiber to the whole community. Finley explored options that include 1) burying the whole fiber network, 2) placing fiber on existing poles in the city and burying the rest, and 3) placing new poles where it looks to be too expensive to get onto existing poles.

Normally the cost estimates made by Finley Engineering are sufficient for estimating the cost of the network and are adequate for moving to the next steps of analysis. However, in Cortez's case Finley found that the cost to get onto existing poles in the city is much higher that what we see elsewhere. This led Finley to consider other options, such as the city placing new poles in the downtown alleys. However, the most cost effective network would be one where the city uses the existing poles where that makes financial sense and then either buries the fiber or places new poles where the cost of using existing poles is too high. The most affordable network design would involve a block-by-block analysis of existing poles to determine the lowest cost method to use for each portion of the network. It's likely that such a detailed analysis would result in a network cost that is lower than what we used in this analysis. But we were hesitant to forecast savings that might not be there.

The full cost of the assets needed to operate the network are as follows. The first estimate is to bury the fiber network everywhere. The second estimate would build new poles in the downtown alleys and bury fiber elsewhere. These estimates assume that 50% of homes and businesses in the city would subscribe to the network – the cost of electronics varies by the number of customers.

	100% Buried	Aerial & Buried
Land and Buildings	$ 383,396	$ 383,396
Operational Assets	$ 283,090	$ 283,090

Customer Electronics	$ 290,944	$ 290,944
Fiber Electronics	$ 1,729,455	$ 1,729,455
Fiber Drops	$ 3,072,114	$ 2,057,126
Fiber Network	$ 8,316,615	$ 5,830,600
Capitalized Software	$ 211,290	$ 211,290
Total	$14,286,904	$10,785,901

Business Models Considered. We considered two different operating models:

- City as Provider. This model looks at the cost of the city as the ISP.
- Open Access. This operating model would open the network to multiple service providers to use the network to provide products and services to customers.

We note that a third option is also possible, which would be for the city to partner with an ISP to operate the network. From a network cost perspective this would be identical to the option where the city is the ISP.

Our Approach to the Financial Analysis.

- As a starting point we arbitrarily chose a 50% market penetration (the percentage of customers using the network). We can't know how many customers might use a new fiber network and chose the 50% penetration as typical of other municipal and similar commercial fiber overbuilds.
- All projections were built to reflect a 25-year period in order to match the expected time frame for financing with bonds.
- All projections include projected financing costs for borrowing the money needed to build and launch the network. We looked at funding with traditional municipal bonds as well as financing with sales taxes.
- The engineering estimate is conservatively high. As an example, we added a 10% construction contingency to the cost of building the fiber network.
- All studies include an estimate of future asset costs that are needed to either connect future customers or to maintain and upgrade the network over time. We've assumed that electronics will become obsolete and will need to be replaced periodically during the study time frame.
- The base models include revenues for broadband and telephone service along with the existing wholesale revenues. We looked at a version that adds cable TV as a product. The models assume that most people will buy broadband and far fewer would buy the other products. We further project that the customers buying telephone and cable TV will drop over time. The projections also predict a modest amount of future margin from other unspecified future products that might include such things as security, smart home, managed WiFi and others.
- The estimates of operating expenses represent our best estimate of the actual cost of operating the fiber business and are not conservative. Again, we based these costs on local conditions including such things as typical salaries and benefit costs of the city. Most operating expenses are adjusted for inflation at 2.5% per year.

Key Financial Study Results

A summary of the financial results of the various scenarios studied is included in Appendix II. That appendix includes a table showing key results of the study including the cost of building the network under each scenario, the cost and method of financing each scenario and the amount of cash generated over 25 years. Following the table is a description of the various scenarios we studied.

> Funding with Revenue Bonds. The results of the financial projections for financing a fiber network with bonds are not as good as the city had hoped for. For example, financing an all-buried network with bonds would lose $19.6 million over 25 years at a 50% customer penetration. Even putting some of the network on poles would still result in a loss of $11.8 million over 25 years.
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> The losses reflect that the potential revenues from the project are not sufficient to cover the cost of bond debt.
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> Funding with Sales Tax Revenues. Funding the project with sales tax revenues shows a different story. The all-buried network with sales tax funding would generate $9.4 million in cash over 25 years, which could be returned to the city to reimburse much of the cost of building the network. Tax funding of the aerial/buried network would generate cash profits of $11.0 million over 25 years.
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> Digital Divide Scenarios. We also considered what we called a digital divide scenario. This would build fiber to everybody in the city and would provide every home with a minimum level of free broadband. This scenario looks attractive financially. If funded by sales tax it has results similar to the scenario above. The profits generated by this scenario could either be turned to the city coffers or could be used to directly benefit citizens by lowering the price of broadband.
>
> Open Access. It looks hard to justify operating an open-access network. This is a network that allows access to multiple ISPs and provides more options for customers. The operating losses for the scenario are much greater than if the city is the retail provider because it splits the potential revenue between the city and the ISPs while still requiring almost the same cost to build the network.

Sensitivity Analysis – Key Assumptions. Our analysis also looked at the impact of changing the key assumptions made in the study.

> Penetration Rates. The financial projections show that a fiber business in Cortez would be extremely sensitive to customer penetration rates. For example, a 60% customer penetration rate instead of a 50% rate generates $8.8 million in additional cash over 25 years. (But note the same is true in the other direction if the penetration rate is lower).

Customer Prices. The models are also sensitive to the prices charged for broadband. Raising prices across the board for broadband products by $5 per month increases cash generated over 25 years by $4.8 million. This is also a caution against lowering prices to capture market penetration or engaging in a price war, which would significantly lower cash flows.

Getting on Existing Poles is Expensive. The most expensive component of building a fiber network is the cost of the fiber that is built on each street of the city to reach homes and businesses. The cost of building aerial fiber on poles is higher in Cortez than what we see elsewhere:

- Our research shows that Empire Electric charges a lot for what is called “make-ready” in the industry. This is the cost of making existing poles ready to accept a new set of wires and can include paying to move existing wires if there is not sufficient space or even replacing some poles if they can’t be modified to accept the new fiber.
- The alternative is to bury fiber, which is more expensive than putting fiber on poles. Buried fiber is the most expensive kind of construction and burying the entire network drives up the cost of the network.
- We looked at another option for part of the city that would construct new poles in the downtown alleys rather than use the Empire Electric poles.

There are Significant Benefits from Building a Citywide Fiber Network. These include: expanding customer choice, providing a chance to address the digital divide issue, providing affordable broadband options, and enhancing economic development opportunities.

There Are Also Risks. The primary risk to the city is in not performing financially with a city-owned fiber network and creating a situation where the city would have to subsidize the broadband network. There is also a risk that other broadband technologies become available during the long time period required to pay for the network.

The Consequences of Not Building Fiber. There are several industry trends discussed throughout the report that define the likely consequence of not having a fiber network in a community:

- DSL is dying as a technology. CenturyLink is on a trajectory to de-emphasize residential broadband and it’s unlikely that the existing DSL technology will be improved, or even well-maintained going into the future.
- Dying DSL means that cable providers will grow to be near-monopoly broadband providers in any community where there is not another competing network. We know from experience that competition brings better customer service and lower prices.
- Broadband prices are expected to rise significantly over the next decade. Big ISPs need to increase broadband prices to make up for shrinking telephone and cable revenues and because broadband penetration rates are close to peaking in most markets. With the nationwide broadband penetration rate near 84%, most analysts believe we are near to the peak of the market.
- There are homes in Cortez and every market that can’t afford a home broadband connection due to the cost. These homes are being left out of the modern economy. We know students in homes without broadband underperform. As broadband prices increase it’s likely that more homes will be unable to afford broadband.

Recommended Next Steps

Residential Survey. Our analysis shows that the most important variable affecting the financial feasibility of building fiber is the potential number of customers. For example, getting 40% versus 60% of residents on the network has a huge impact on the amount of future cash generation.

We recommend that the city undertake a residential survey to understand interest in a fiber network. CCG Consulting has found that a well-designed random residential survey is a good predictor of the number of residential customers that might be interested in using city-provided fiber. We've been able to see a significant correlation when comparing the results of initial surveys to the actual customer penetration rates.

Our analysis shows that some amount of tax financing will be needed to create a business that generates enough cash to be self-sufficient and not require subsidies from the city. Therefore, it's vital to better understand the percentage of households that might be interested in using a new fiber network.

More Work Needed to Understand the Cost of the Fiber Network. Normally when we've completed a feasibility study we've provided a client with a decent, yet conservative, estimate of the cost of building a fiber network. But in Cortez we think that more work is needed to determine the cost of the network. The issue involves the high cost of placing aerial fiber on the existing poles owned by Empire Electric. We know from experience that the make-ready cost to get into these poles can be high, even to the point of making it more expensive to get onto the poles than to bury new fiber.

The city has a few alternatives to using the existing poles. One is to bury the network. That is also expensive. Another alternative is to place some new poles to avoid the existing poles. This makes the most sense in the downtown alleys. But there are likely to be some parts of these alleys where setting new poles might not be practical.

The most cost effective network will use some of each of these methods, with fiber placed on Empire poles where that makes sense, burying fiber instead of using the Empire poles in some cases, and building new poles as an alternative to the Empire poles. This means that understanding the best cost of the network will require a block-by-block analysis. We think there is a good likelihood that a network designed in this manner might be considerably less costly than the network costs we have estimated. But that can't be known without additional engineering.

Choose a Business Plan. The study considers two possible business plans. One is a more traditional business where the city is the retail ISP and competes against the incumbent providers. But there is an intriguing option where the city would build fiber to everybody and give every household at least a minimal level of broadband access for free.

Investigate the Possibility of Using Tax Revenues. The financial analysis shows that it is both beneficial and necessary to finance some or all of a new network using sales tax or other tax revenues. If the city wants to proceed after this study then it's going to be necessary to understand the possibility of using tax revenues.

It's possible to fund a fiber network with a mix of bond and sales tax revenues. We did not explore this alternative, but there are numerous combinations of the two sources of funding that would make financial sense.

There are a number of steps needed to understand the potential for this kind of funding. This might include:

- A detailed analysis of the funding mechanism you want to consider;
- An analysis to see if there are any legal issues with financing a network with tax revenues;
- Public outreach to understand the public's willingness to approve this kind of financing for fiber. This probably would entail a public education campaign if this is going to end up as a ballot measure – so it's a major undertaking.

Community Education/Buy-in. If the city decides to continue with investigating the fiber business, then a step that most cities take is to undertake a community education process to get feedback and gain buy-in of the concept.

Cities go about this in different ways. Making this report public is a good first step. Communities often hold workshops or other kinds of public presentations to answer the public's questions. It's common to build a web site that discusses the fiber initiative and which can be used to answer the typical questions citizens have about fiber. A lot of cities also create a citizen task force that can help move the project forward and which can act as a sounding board for ideas affecting the public.

I. Background Research

Following is a discussion of some of the general research undertaken in preparing this report.

A. Speed Test Results

As part of the analysis we asked broadband users in the city to take a speed test. We elected to use a speed test provided by Ookla at speedtest.net, which is the most commonly used speed test in the world. However, there are numerous other tests available such as dslreports.com, speed.io, the BandWidthPlace, and TestMySpeed. Many ISPs also make a speed test available to their customers.

A speed test is one of many ways to measure a broadband connection. Speeds tests in general measure the speed between a user and a remote test site router. Speed tests are generally routed regionally and we would expect that almost everybody participating in your speed test would have measured their speeds to the same regional hub.

Every speed test uses a different algorithm to measure speed. For example, the algorithm used by Ookla discards the fastest 10% and the slowest 30% of the results obtained. By discarding the slowest readings they might be masking exactly what drove someone to take the speed test, such as not being able to hold a connection for a VoIP call. Ookla also multithreads, meaning that they open multiple paths between a user and the test site and then average the results together. This could mask a congestion problem a user might be having with the local network.

Another issue to remember with any speed test is that it measures the connection between a customer's device and the speed test site. This means that the customer portion of the network, like the home WiFi network, are included in the results. A lot of ISPs claim that poor in-home WiFi accounts for the majority of the speed issue problems reported by customers. So a slow speed test doesn't always mean that the ISP has a slow connection.

We know that ISPs often give customers a burst of faster data for the first minute of two of a broadband connection. Since many web transactions are short in nature, this practice makes the customer experience feel faster. However, the practice also makes speed tests look faster than the sustained speeds a customer can achieve.

With all of this said, a speed test is a good way to compare the performance of customers using different ISPs. They are all trying to make a connection to the same distant place and seeing the variation in download speeds, upload speeds, and latency can tell us interesting things about the broadband in a given market.

It's important to note that the results from our test are not a random sample, and as such it makes no sense to tabulate the results or try to somehow quantify the results. For various reasons we can't make any definitive statements like "the average speed on TDS is X." Instead, the speed tests are most useful when comparing customers in order to spot interesting trends. The speed tests asked for three statistics from users: download speed, upload speed, and latency.

We generally expect to see slower upload speeds than download speeds. The technologies in use in the city offer a fixed amount of bandwidth to a customer connection and both CenturyLink and TDS have provided faster download speeds by limiting upload speeds. However, there are customers that now also care about upload speeds. There are some applications that need a reliable upload link including gaming, security cameras, and online video chatting. There are numerous companies working on applications that will require significantly faster upload speeds. For example, there is a lot of research being done to create telepresence, which is the ability to create a hologram of somebody in a remote location in order to facilitate business meetings or visits with family members. This technology will use some version of enhanced reality technology and will require a larger upload link than is available to a lot of households today.

The speed tests also measure latency, which is the measure of the time it takes for a data packet to travel from its point of origin to the point of destination. Latency is measured using milliseconds (ms) which are one thousandth of a second.

Speed tests measure latency because it tells a user about the quality of their connection. The lower the latency the better the connection. There are many real-time web applications that need relatively low latency in order to maintain the connection between a user and the online service. This includes applications like VoIP, gaming, live connections for online training, connections to corporate WANs when working at home, etc.

There are a lot of underlying causes for delays that increase latency—the following are primary kinds of delays. Total latency is the combination of all of these delays.

- Transmission Delay. This is the time required to push packets out the door at the originating end of a transmission. This is mostly a function of the kind of router and software used at the originating server. This can also be influenced by packet length, and it generally takes longer to create long packets than it does to create multiple short ones. These delays are caused by the originator of an Internet transmission.
- Processing Delay. This is the time required to process a packet header, check for bit-level errors, and figure out where the packet is to be sent. These delays are caused by the ISP of the originating party. There are additional processing delays along the way every time a transmission has to “hop” between ISPs or networks.
- Propagation Delay. This is the delay due to the distance a signal travels. It takes a lot longer for a signal to travel from Tokyo to Baltimore than it takes to travel from Washington DC to Baltimore. This is why speed tests try to find a nearby router to ping so that they can eliminate latency due to distance. These delays are mostly a function of physics and the speed at which signals can be carried through cables.
- Queueing Delay. This measures the amount of time that a packet waits at the terminating end to be processed. This is a function of both the terminating ISP and also of the customer’s computer and software.

The technology of the last mile is generally the largest factor influencing latency. A few years ago the FCC did a study of the various last mile technologies and measured the following ranges of performance of last-mile latency, measured in milliseconds: fiber (10 - 20 ms), coaxial cable (15 - 40 ms), and DSL (30 - 65 ms). These are measures of latency between a home and the first node in the ISP network. This is slightly different than what is measured in a speed test, which measures the latency the whole way to the speed test router.

It are these latency differences that cause people to prefer fiber. The experience using a 30 Mbps download fiber connection “feels” faster than the same speed on a DSL or cable network connection due to the reduced latency. Latency is part of the reason that cellular data connections feel slower. Cellular latencies vary widely depending upon the exact generation of equipment at any given cell site. However, even 4G latency can be as high as 100 ms. In the same FCC test that produced the latencies shown above, satellite was almost off the chart with latencies measured as high as 650 ms. I’ve seen speed tests that show satellite latencies as high as 1,000 ms.

A lot of complaints about Internet performance are actually due to latency issues. It’s something that’s hard to diagnose since latency issues can appear and reappear as Internet traffic between two points uses different routing. The one thing that is clear is that the lower the latency the better the connection.

In the speed test we got results from both CenturyLink and TDS broadband customers.

CenturyLink

We asked customers what download speed they thought they were purchasing—and we found that there is a lot of customer confusion about the speeds they are buying. For example, a customer might quote a speed that they purchased years ago, but for which the ISP has made faster over time.

For example, we see customers claiming to buy download speeds from CenturyLink between 3 Mbps up to 40 Mbps. It is possible to offer DSL speeds up to about 45 Mbps by joining two copper wire pairs to the customer location. But performance of DSL varies widely in different parts of the network.

We saw customers who were getting far slower speeds than what they thought they were buying, such as a customer who thought they were getting 40 Mbps but were getting 10 Mbps. There were also a few customers who were getting speeds faster than what they thought they were buying. It’s easy to understand customer confusion since the CenturyLink bills we saw don’t tell customers the speeds of their service.

A large majority of customers with CenturyLink DSL are getting less speed than what they are paying for. Except for some confusion about the speed being purchased as mentioned above, customers seem to generally get 70% - 80% of the speed they are subscribed to.

CenturyLink upload speeds are slow. Most customers are seeing upload speeds of less than 1 Mbps, with a few seeing speeds under 2 Mbps.

The latency on the CenturyLink connections varied between 29 and 51 milliseconds with the most common latency readings over 40 milliseconds. These are normal latencies for DSL.

TDS

TDS customers also reported a variety of products they thought they were buying that range from 5 Mbps to 60 Mbps. In our billing analysis the only speed we saw listed is the Ultra60 product that offers speeds up to 60 Mbps. But we think the customers reporting slower products might be grandfathered into older products because the slower speeds they are receiving match up what they think they are buying.

Customers who are buying the 60 Mbps product have the best results that varied between 38 Mbps with one customer reporting 62 Mbps. However, customers who believe they have some of the slower speed products are often getting speeds significantly less than what they think they are buying. For example, there were three customers who said they are paying for 50 Mbps but who are getting around 14 Mbps. There was one customer who obviously has a service problem who was getting only 1 Mbps.

The upload speeds also vary by product. Those with the older and slower download products saw upload speeds of less than 1 Mbps. But customers with the 60 Mbps product saw upload speeds between 4 Mbps and 6 Mbps.

The latency on the TDS network was consistent and was between 24 and 32 milliseconds.

There are a few takeaways that can be derived from the speed tests:

- The only customers who are getting broadband that meets the FCC definition of at least 25 Mbps down and 3 Mbps up are customers buying the 60 Mbps product from TDS. None of the CenturyLink products met those speeds and also the older TDS products fall short.
- CCG has given this same speed test in many different markets and these are among the slowest speeds we have seen for a city of this size. In most cities of your size the cable network offers much faster broadband than what TDS is offering, although the DSL speeds are largely consistent with what we've seen elsewhere.
- Since TDS is upgrading their network the city might want to ask citizens to take the speed test after the upgrade to see if the speeds increase on the older existing broadband products. Even when TDS upgrades the network, only customers who get a new DOCSIS 3.1 modem will be able to get faster speeds.

B. Customer Bill Analysis/Existing Rates

As part of the analysis we asked for customer bills for from existing telecom providers. We received nearly 100 telecommunications bills from Cortez customers.

We reviewed bills for several reasons. First, we wanted to understand the prices charged for broadband and other products in the city today. We were also interested in the transparency of the service providers in what they are reporting to customers and to see if there were fees that were charged separately that are also part of the basic products being sold in the city.

Results of Bill Analysis

CenturyLink. CenturyLink primarily sells DSL for Internet access plus telephone service. We also got a few bills that included bundled DirecTV for cable TV, but the TV portion of the bill was basically the DirecTV normal fees plus a small bundling discount.

Our observation of the bills is as follows:

DSL Broadband

- There is no evidence in the bills we saw that CenturyLink charges more for unbundled DSL. We see customers who are paying the same for DSL with and without a bundled telephone line. For many years there was a bundling discount to induce customers to keep telephone lines, but maybe they've given up on that concept.
- Charges for DSL broadband varied between $37 and $57 with the most typical rates being $39 and $50.
- DSL customers are all billed a "Cost Recovery Fee." There is no specific external regulatory fee for DSL, and broadband in general has been made exempt from taxes by Congress. We have to assume that CenturyLink keeps this fee as revenue and that it is not a tax. Customers paid either $1.99 or $3.99 for the fee.
- About half of the customers are paying $9.99 per month for a DSL modem. The remaining customers have no fee and we guess that they have purchased their modem rather than leasing it.
- There were a few DSL customers being charged for taxes, which is puzzling since broadband is generally exempt from taxes. Most DSL-only customers are not charged taxes.

Telephone Service

- The most common rate for a telephone line is $35, although a few customers paid a little bit more.
- The company bills a fee they call a "Federal Access Charge" of $6.50 per month per telephone line. In the industry this is called the Subscriber Line Charge. It's a fee from decades ago that transferred access charges from long distance companies to customers. CenturyLink keeps this fee as revenue and it is not a tax. This means that a $35 telephone line really costs $41.50.
- The company also bills a fee called "Access Recovery Fee" of $2.14 per month. We are not entirely sure what this is for and think that the company probably also keeps this as revenue.
- There are numerous taxes on the telephone bills, which is typical of the industry. The list is long but looks like the normally expected taxes for things like 911, hard-of-hearing service, contributions to the Universal Service Fund, etc. Telephone providers collect these taxes and submit them to the appropriate tax authorities.

Customer Discounts

- Over half of the customers get no discounts and pay full price for the services. Some of the discounts look to be due to bundling together DSL and telephone, although some customers with both services don't get a bundling discount. There are also customers who are clearly getting a discount for being either a new customer or for having signed up for a term agreement of 2 – 3 years. The discounts vary from $5 off the prices to one customer who is getting standalone DSL for half price. It’s obvious that the discounts are negotiated because there doesn’t seem to be any standard discount.

TDS. As the incumbent cable provider TDS sells the full triple play of cable TV, broadband and telephone service. We saw the following when looking at TDS bills:

Broadband

- TDS sells traditional cable broadband using the DOCSIS standard. This service requires a DOCSIS modem in the home.
- All of the bills we saw were for a product labeled as Ultra60, implying that the download speeds should be up to 60 Mbps. We don’t know if they offer faster or slower broadband speeds or if this is their only product.
- Prices seem to be consistent and are $50 per month for customers who have at least one other service and $60 per month for standalone broadband. We found some exceptions to this and found a few customers with bundled services paying $60 per month.
- Almost every customer is charged for a cable modem, although we found a few customers who are not billed for this. We don’t know if TDS will sell a modem to a customer, but DOCSIS modems are usually specific to a system and are not generally available on the market.
- The charges for a cable modem vary from a low of $4.95 to a high of $10. There were a few customers with modems priced at $9.25 or $10 where the bill noted that the modem includes WiFi. So we suspect that the basic modem has no WiFi and that a customer can get a WiFi-enabled modem from TDS for a higher monthly rate.

Cable TV

- Only about one-third of the bills we saw include cable TV. Our sample of bills does not constitute a random sample, and so we can’t know if this true across the whole TDS customer base. But at least for the bills we saw many customers are getting video from some other source or are cord cutters. A few customers sent us bills from DirecTV or Dish.
- We didn’t see any two customers paying the same rate for cable service. The bills we saw were either for the Freedom package or the Expanded package. But for each package customers are billed different amounts than what are shown on the company’s published rate sheet. We speculate that customers might get rates locked during a commitment period where they have signed up for a 2-year or 3-year promotion.
- We saw fees for settop boxes that vary and saw monthly fees of $5.95, $6.50, and $7.00. We saw a bill from one customer that pays a premium price for a TDS settop box that includes a DVR. That customer is paying $20 per month for the DVR box plus the associated DVR service.
- Most customers are billed $11.25 per month for a “Broadcast Fee.” This is a charge that is pretty common in the industry and represents fees that TDS pays for access to the local network channels like ABC, CBS, NBC, FOX, and PBS. The $11.25 fee is one of the highest such fees that we’ve seen anywhere. There are a few customers who are not being charged this fee. This fee is part of the cost of buying cable service, so

the real cost of cable is this fee plus whatever each customer is being billed for a cable product.

- Some customers are being billed $1.00 per month for a "Sports Fee." Even though the customers seem to have the same packages, only about half of the customers are charged this fee.

Telephone

- Every telephone customer bill we saw had telephone service at a flat rate of $20. The bills also included the typical telephone taxes. But TDS is not billing the Subscriber Line Charge and Access Recovery Fee like CenturyLink. The $20 price is inclusive with no hidden fees.

Discounts

- Just like with CenturyLink, the discounts are all over the board.
- The discounts are all referred to on bills as Promotional discounts, which seems to be associated with customers who have signed contracts for 2 years or 3 years of a pricing guarantee. The majority of these discounts are either at $20.05 or $26.05 per month.
- There are a few customers getting larger discounts. The highest such discount we saw was for a $59 discount on a bundled bill of about $140.
- About half of the bills have no discount even when customers buy multiple services. This tells us there is no "bundling" discount, but rather discounts based upon customers who will make term commitments for multiple-year periods. It's important for the city to take note of the TDS term contracts. If you decided to get into the business you would initially find a lot of customers unable to switch service until they finish their contract.

Summary. For both companies we see prices varying even for customers buying the identical services. Discounts also vary widely, with many customers getting no discounts and a few customers getting significant ones. Because of the varying prices and the varying discounts it's hard to say that there are "market prices" for the triple-play services in the market. It appears that customers can negotiate lower prices if they are willing to put in the effort.

Existing Rates - CenturyLink

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

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

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

Telephone Rates

Their basic rates were as follows when last tariffed. This does not mean that these are the rates any longer and with a de-tariffed rate CenturyLink is allowed to charge whatever they want, within reason. The following rates were the last listing of the flat rate option, meaning a telephone line using these rates can make unlimited local calls. There used to be options available for customers who wanted to be able to make and pay for fewer local calls.

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

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

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

CenturyLink DSL

CenturyLink sells high speed Internet using DSL technology. They sell both a bundled DSL product, meaning a telephone line and DSL service, and also "Pure DSL" meaning standalone DSL with no telephone product. As discussed above, CenturyLink offers a lot of specials, with special rates available on their web site for new customers. But as typical with most big ISPs, a subscriber's rates will increase back to "normal" rates at the end of a special promotion. Following are some of the rates charged for residential DSL. We say some of the rates because there are certainly going to be customers in the market on older specials that have different rates than these. Note that the quoted speeds offered by CenturyLink DSL are "best effort" speeds, meaning they are not guaranteed. In fact, rural customers typically get speeds significantly slower than the advertised speeds.

Residential DSL

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

Bundled Pricing (bundled with either telephone service or DirecTV)

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

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

DSL Only

Pure DSL is CenturyLink's name for a DSL line that is not bundled with telephone or DirecTV. The CenturyLink website shows the following current prices for Pure DSL. A customer must sign a 2-year contract to get the discounts. There is one price for the first year, a higher price for the second year, and after that the customer pays the list price:

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

Pure DSL also comes with the $6.99 CenturyLink DSL modem.

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

CenturyLink Business DSL

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

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

Existing Rates - TDS

As the incumbent cable company TDS has a full set of options for cable TV, as follows:

Limited Basic – 14 channels	$39.95
Starter – 42 channels	$35.00
Freedom – 52 channels	$63.00
Expanded TV – 85 Channels	$83.00
Family Tier – 31 extra channels	$12.95
Sports Tier – 4 extra channels	$ 8.90
HS Plus Tier – 3 Extra channels	$ 6.00
Regional Sports Fee	$ 1.00
FCC Fee	$ 0.08
DVR Fee	$ 4.99
Broadcast Fee	$11.25
HBO	$19.99
Cinemax	$13.00
Showtime	$15.40
Starz!	$11.40
Starz!Encore	$ 7.40
Settop Box	$ 3.50
HD Settop Box	$ 5.95
DVR Box	$10.95

Note that the broadcast fee is added to every package and is to recover the cost of providing the off-air channels like ABC, CBS, NBC, Fox, and PBS. The current line-ups for these packages is at the following web site: http://hellotds.com/templates/tds/channel-lineups/cortez.pdf. Note that this pricing list will change over time, and so it is not likely that it will match this report in the future.

TDS also offers special pricing to attract new customers. These specials change over time. When we called we were offered the following special prices for a 2-year contract (meaning the customer has to pay for two years of service).

Freedom	$45.00 price lock
Expanded	$55.00 price lock

Telephone

Cable TV can be bundled with telephone service. With cable service telephone rates are:

Phone	$15.00 plus $.05 per minute long distance $35 with unlimited long distance

Note that while we were quoted the above prices on the phone that all of the customer bills show a rate of $20.

We don’t know if TDS offers a standalone phone product – meaning a customer could buy telephone service and nothing else.

Broadband

The company does not publish broadband rates and has different rates with different customers.

All broadband products come with a WiFi modem at $9.25 per month. In the bills we see modems priced at less than this and our guess is that this price is for older modems that don’t include WiFi.

II. Engineering Design and Cost

A. Network Design

The first step in any network design is to collect data about the community to be served in terms of number of potential customers, miles of fiber that must be built, existing assets, etc.

We gathered GIS data from the county databases for the location of roads, address points, and parcels. We evaluated the existing city fiber network to determine the subscribers who are already connected to the existing fiber in the city. We utilized this data extensively to determine potential fiber routes, crossing locations for major roads, equipment locations, and other items that will be detailed later in this report.

Passings

The telecom industry uses the term passing to mean any home or business that is near enough to a network to be considered as a potential customer. The engineers looked at several different sources of data on passings including Census data, satellite imagery, and GIS statistics. Our engineers settled on the following as the count of potential passings in the city:

Residential	3,275
Multi-Dwelling Units	386
Business	540
Businesses Already on Wholesale Fiber	197
Total	4,361

The basis for each of these groups of passings is as follows:

- Residential: This includes single-family houses as identified by the city GIS system.
- Multi-Dwelling Units: This includes structures that contain more than one dwelling unit. For example, an apartment building with ten units would count as 10 passings.
- Businesses: It's always difficult counting businesses in a city. Our goal for conducting this study is to count businesses that would be able to independently subscribe to broadband. While there are likely many home businesses throughout the city, it would be difficult to determine the exact number and they would not be likely to independently purchase a business service. The city thinks the best count is to use electric meters counts for businesses. They got a count of business meters from Empire Electric and reduced them by 10% for meters for things like billboards. That resulted in a count of 740 businesses
- Since the city already operates a wholesale fiber network for itself and for other businesses we have to also recognize existing wholesale business fiber connections, which is 197.

Network Design

Cortez already has a fiber network in place and serves a number of businesses, schools, and other institutions in the city. This network was evaluated to determine how it could be utilized to reduce costs for a city-wide FTTH network deployment. It was determined that the existing fiber assets would best be utilized to provide transport to key locations throughout the network. While there is significant fiber counts in some of these cables, much of it would be insufficient to feed a high percentage of individual subscribers, with the exception of a few areas.

The first major assumption in the network design is that the existing fiber and some new fiber would be used to feed remote splitter and electronics nodes across the city. This fiber would form a redundant fiber ring throughout the city to connect multiple electronics nodes.

We then considered the use of one central location for electronics versus multiple nodes in neighborhoods. The primary node on the existing fiber network is located at the Networks Operation Center (NOC). This office is located on the far northwest corner of the city limits, and if this was to be the only node on the network there are not sufficient existing fibers to connect to all of the potential customers within the city. It would be costly to overbuild the existing fiber route to the NOC to accommodate the extra fiber pairs needed to use the NOC as the only fiber node.

While Cortez is a relatively compact city, the size of fiber bundles can grow fairly large if everything is brought back to a single node. Having a single NOC is also not ideal since fiber cuts near to that node could take out much of the network in the city. For these reasons we elected to design the network using four new electronics sites around the city in addition to the existing NOC. This design allows for the creation of a redundant fiber ring passing through the five node locations.

Fiber rings are self-healing, meaning that the electronics immediately react to a fiber cut since traffic on the ring travels continuously in both a clockwise and counterclockwise direction, thus bypassing a single fiber cut. The core fiber ring was designed to utilize redundant 10Gbps channels. This ring will also be able to add multiple 10Gbps or even 100Gbps channels in the future at a minimal cost to increase capacity. Our design will allow the city to grow affordably as bandwidth needs grow over time.

The last-mile fiber network then extends from each node into the surrounding neighborhoods. We have designed enough fiber pairs to support both a PON network as well as having the capability to deliver a dedicated 10 Gbps connection to high usage subscribers. There is a network diagram of the proposed new ring included as Appendix I of this report.

Each of the four nodes on the ring can be upgraded with electronics to be used as a point of presence (POP) for making direct connections to other ISPs or to allow ISPs to tie into the optical network. The existing Network Operations Center (NOC) would remain as the central point of control for the entire network.

The distribution fiber is designed in a remote splitter configuration, meaning that all fiber comes from each subscriber to neighborhood-level remote splitter cabinets. These cabinets would be located on poles or in public right-of-way. These PON cabinets do not contain any electronics, are not powered, and are impervious to weather. At most of these remote splitter sites, existing city fiber would then transport traffic to the nearest electronics site.

Electronics Nodes

Finley priced the FTTH (Fiber to the Home) electronics in this study based upon recent prices obtained from several different manufacturers. These are established vendors that we have confidence in and their equipment is similarly priced. Finley Engineering is vendor neutral and are not suggesting that you use any one vendor. Rather, our experience is that the cost of the FTTH 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.

The network electronics will be placed in the nodes throughout the city. Each node will contain a variety of different equipment including:

AC and DC Power Equipment. This is for the DC power plant that will power the network electronics. There are monitoring systems included in these rectifier systems that will notify the operator as well as overcurrent protection devices.

Battery Backups. These are banks of batteries that will connect to the rectifiers to allow the system to sustain short-term power losses. These are typically designed for 8 hours of loss of power.

Generator Connections or Generators. Generators are for long-term outages, and we have included a generator connection and transfer switch where a portable generator could be connected to temporarily power the facility and charge the battery banks.

FTTH Platform. This equipment would contain the individual lasers and receivers that are used to transport signal over the fiber to reach customers.

Fiber Frames and Terminations. These are junction points to connect between the ring fiber and that distributions fibers going to customers. Jumpers are installed between these fiber frames and equipment to make the connections from subscribers to the rest of the network.

These systems are largely modular, meaning that more subscribers can be connected by adding more chassis, cards, optics, and even software upgrades. Our pricing models for the electronics vary according to the number of customers served out of each node.

The study also anticipates allowing other providers to use the network to reach customers, such as would occur in an open access environment. The network is also designed to take feeds from external sources for the triple-play services.

Network Technologies

The network design assumes the use of a Passive Optical Network (PON) design that utilizes splitters which are nonelectrical devices (passive optical) that allow a feeder fiber to serve up to and beyond 32 homes. These splits are distributed in splitter cabinets in the field, which don't have to be powered. A PON network is generally about 10-20% less costly than an active network due to the requirement for fewer lasers in the network. The cost of the fiber network is also less with a PON network since with PON multiple customers can be connected to the same fiber.

The alternative technology is Active Ethernet. While an Active Ethernet Network is more expensive than a PON network, it provides the ability to have a dedicated 1 Gbps connection to each potential subscriber. The downside is that Active Networks require a homerun design or a direct fiber connection between the subscriber and the electronics. This adds significant cost to the network since the fibers bundles contain more fibers, requiring a lot more splicing during the construction process. These technology options are explained in more detail later in this report.

Multi-Dwelling Units (MDUs)

There are a number of issues that affect your ability to bring fiber to multi-dwelling units (MDUs), which are apartment and condominium complexes. Generally the drop and electronics costs are lower for an MDU since these components can be shared among multiple tenants. But the wiring costs to reach these tenants can easily offset these savings.

Cortez has a relatively low number of MDUs. In the study we have assumed that the cost of serving an MDU customer with less than 4 units is roughly the same as serving an equal amount of single-family homes (a triplex would cost the same as 3 homes, for example). The most cost-efficient way to serve these units is to bring fiber directly from the street to the individual units. There is typically no common space to terminate fiber or locate equipment and the scale is so low that no advantage is gained by treating them differently from a single family home.

Customer Electronics

The customer 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 today there is also an ONT that can be placed indoors and which is powered by plugging it 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.

Historically, many FTTH networks have been 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 FFC 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.

B. Network Cost Estimates

Following is a discussion of issues that affect the cost of the network as well as a description of how the cost of the network was estimated.

Issues with Buried Fiber

Rock/Soil. During field observations there appears to be a significant amount of rock in the soil that would raise costs. The rock is more common and shallower in the southern portions of the city. We had multiple versions of the study with varying rock costs. In the end we opted with a lower cost to install in rock. The downside is that this will likely require shallower depths in both the right-of-way and on customer drops to keep costs lower. This would mean that in many cases fiber may be less than the standard 36" deep in the right of way and that drops would only be 10-12" deep or shallower where rock is an issue.

Conduit. The design assumes that all underground fiber would be placed in conduit/duct. There are some existing empty conduit banks around the city. We utilized these where possible to keep costs down.

Issues with Aerial Fiber

There is an extensive aerial and pole network within the city for power and other communications, the poles are owned by Empire Electric. The use of poles is regulated by both the FCC and the state and rules are generally setup for new providers to be able to access these poles. However, in practice there are many other issues that may make it not feasible to construct an aerial network.

1. Pole Attachment Fees – Anyone that attaches to poles must rent space in the form of attachment fees.
2. Access – Although regulations guarantee access to a pole, timely access may be a large issue. There are regulations regarding time requirements for pole owners to respond to requests and a builder can even build without permission if enough time passes. The main problem is making sure that the pole is in a condition to be attached to which is discussed below.
3. Placement on Poles – There are regulations on where fiber can be placed on poles and how it can be attached. These issues involve ground clearance, separation from other services, separation from power, and attachment to the pole. Field observations noted that much of the aerial infrastructure currently in place does not currently comply with existing regulations.
4. Make Ready Costs – Many of the poles were not in condition to be able to attach fiber today. This is due to a number of issues such as pole condition, clearance, tree trimming, and so forth. This would require extensive work to establish suitable conditions to attach a new fiber network to these poles (also referred to as make ready costs). These costs must be born entirely by the new provider. There would also be substantial time added to the project as existing providers would need to form new agreements to move up or down the pole to make space for new fiber. These make ready costs would easily offset any savings.

We know from visual inspection of the poles as well as recent experience in working with Empire Electric in Cortez and other nearby markets that the cost of make ready in the city is likely to be extraordinarily high. We also know from experience that the make ready can take a long time to compete, particularly in the case of building fiber everywhere in the city.

We considered two alternatives to using existing poles. One idea is to bury the whole fiber network. This has a number of benefits like protecting the network from weather and from storm damage.

The other idea is to construct new poles in part of the market. In the older downtown parts of the city the poles are in alleyways behind homes. We explored the idea of building a new set of poles in these alleys rather than pay for the make ready on the Empire poles. This is less expensive and also removed the delays from working through the make-ready process. In this design the rest of the network would be buried.

There are some concerns of placing a second pole lines in alleys that we think need to be considered.

1. Placing New Poles – We assumed that we could only place new poles in areas with back alleys. Some alleys have impediments like fencing, trees, or other structures that might make it difficult to place new poles. There must be enough space to place a pole on the opposite side of an alley from the existing pole line and not interfere with private structures or impede alley access.

2. Height – The poles must be tall enough to allow sufficient clearance for vehicles to pass under, for this reason we elected to look at 35' poles. This would allow a consistent pole height along the block and possibly reduce the total number of poles needed with larger spans.

3. Implementation – Perhaps the biggest issue is the congestion in the airspace in these alleys. It can be challenging to get drops from the new pole lines across the alley and passed through the existing wires on the opposite side of the alley. It's possible that even with new poles that the city would need to get access to the existing poles to add brackets or other hardware to allow drops to safely pass through existing wires.

4. Installation – poles are buried deeper than conduit and so the presence of rock below the streets could add to the cost of constructing new poles.

One of our recommendations is to do more work to estimate the cost of placing aerial fiber. The analysis would be done block-by-block and would consider the cheapest option – using the Empire poles, placing new poles, or burying fiber. With all these concerns a new pole line would likely cut costs dramatically.

Construction Contingency

In our cost estimates we added a 10% contingency to the cost of constructing the fiber. This is routine when performing a feasibility study like this one where the overall goal is to make sure that we have estimated a high enough cost for the network. The contingency might cover various situation such as inflation in the cost of building the network, adding a few streets into the city between this study and the start of construction, or just meeting unexpected hurdles during the construction process. Before bonding for the project we would expect the city to undertake another round of engineering analysis to better pin down the cost of building the fiber network. But that extra effort is not justified at this early stage of the feasibility. Note that since the cost of the fiber network is the most expensive asset to be constructed that some fiber builders bid out networks on a do-not-exceed price so that the cost of the fiber can't exceed the borrowing used to pay for the network.

Construction Inflation

We have not included any inflation in the cost of building the fiber network. If the fiber construction is started within the next few years we think our estimates are reasonable. However, the longer it takes to begin construction, the greater the chance that the cost of building fiber will increase over our estimates. We have probably more than covered any inflation through the use of the construction contingency.

We would note that the overall cost of build new FTTH networks has not increased much on a per-passing basis for the last decade. While there have been some increased in the labor component for building fiber, we've seen the costs drop for the fiber cable and for the various FTTH electronics. This past experience might not continue, but we not seen any net inflation in the cost of building and lighting fiber networks.

C. The Options for Fiber Technology

As mentioned earlier, there are two basic technologies used to provide fiber broadband—Passive Optical Networks (PON) and Active Optical Networks (AON). 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. This is a key decision because it impacts the way the fiber network is constructed.

The Active Optical Network (AON) dedicates a fiber for each user between the customer location and the electronics equipment in a 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.

Since everything on an AON network is digital, the only possible video product is IPTV. IPTV delivers one channel at a time to each TV in the house as customers request it. This is a different model than normal broadcast TV and minimizes the number of channels that are being broadcast on the network. With traditional cable TV the system sends all the channels all the time to everybody. With IPTV, a customer must have a settop box for each TV that wants to receive its own channels.

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

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 128 customers (more typically 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 feeder fiber "feeds" a passive splitter that takes the information that is transmitted onto the feeder fiber and distributes it across 32 or 128 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 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 cable signals into the home.

A PON network has the ability to transmit video at the RF level and have it split into multiple fiber drops. This means that a PON that is delivering analog TV would not require a settop box. A PON also uses existing wiring more easily since the video signal is delivered in the same way as the existing cable TV video is delivered by the cable company. This gives easier access to existing telephone and cable wiring.

The current vendors for PON equipment include Alcatel-Lucent, Adtran, Zhone, Nokia, and Calix. 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, which is shared by the number of customers on a splitter. As an example, a 1x32 splitter would mean that 32 customers would share a single 2.4Gbps downstream and 1.2Gbps upstream connection.

Active Optical Network

Advantages:

- Can serve customers up to 36 miles from last active field device.
- Does not require as much complex pre-planning and engineering. With AON there is a separate fiber to each customer, making it easier to engineer as you go.
- A single point of failure will often affect fewer customers

- Offers truly non-blocking 1Gbps and beyond speeds.
- Easily upgradeable to 10Gbps by switching optics.

Disadvantages:

- Cannot support RF video broadcast TV (only IPTV). An AON system requires every customer to get a settop box (a settop box for every separate TV, in fact), thus increasing video capital costs.
- Shares data and CATV bandwidth in the same data stream. Today an AON system can cost-effectively deliver up to 10 gigabits of data to each home, but more typically these networks are designed to deliver 1 gigabit. This is not a shared pipe with neighbors and each customer can get a dedicated gigabit pipe. However, this one data stream must support CATV, data, and voice together. Thus, if a customer is watching multiple HDTV sets, the amount of bandwidth left for data will be something less than a gigabit.
- Usually requires additional home wiring. Since the AON provides only one bandwidth (the data stream), the video service (IPTV) always requires a high bandwidth data wire, such as category 5 or 6 wire to each TV location. The increased use of WiFi and advances in WiFi speeds have mitigated some of this.
- More physical space is required for electronics because there are more fiber terminations onto the electronics. If the electronics are located in the field, the cabinets housing the electronics and fiber terminations can become relatively large. This means most cabinets need to be on private land and not on public rights-of-way.
- Fewer customers served per electronic chassis. Since only one customer can be served per laser then there are fewer customers that can be served from a single card.

Passive Optical Network

Advantages:

- Lower Cost (typically 10-20% less than Active for the core fiber electronics)
- Can support both RF Broadcast TV and digital IPTV.
- Can deliver analog TV without a settop box.
- Has a separate bandwidth stream for CATV and data services.
- Much more efficient use of bandwidth at the customer premise. A GPON network delivers 2.4 Gbps of data to a small cluster of houses and an individual customer will normally have access to much of this bandwidth for data transmission, thus giving the customer a faster bandwidth experience at the home. By contrast, a typical cable TV system shares 150 Mbps with up to 500 homes and an AON shares bandwidth farther into the core network.
- For the most part you can use existing home wiring. The PON network is designed to tie into existing telephone and cable wiring as long as they are conveniently located and in good working order.
- Requires no field electronic devices. The key word about a PON network is that it is Passive. This means that no power is needed except in those locations, generally at major hubs or huts, where the provider places electronics.

- Can easily provide traditional T1s for larger business customers using business ONTs.

Disadvantages:

- Customer must be within 12 miles of hub when using 1 X 32 splitter. This means with very large installations that multiple hubs are required. For many cities, including Cortez, this is not a limitation since the higher density requires a design with neighborhood huts that are close to customers.
- More customers potentially are affected by a fiber failure in the field.

The Finley Engineering design of the network allows for the easy use of either technology. The network has primarily been designed to accommodate a PON network, but there sufficient extra fibers in the network to also serve any customer who wants a dedicated fiber connection.

The initial network design uses Passive Optical Network (PON) technology for several reasons. First, the city is already using this technology for the wholesale fiber network. Second, this technology reduces the size of the fibers in neighborhoods since customers share fibers. But the network is being designed with extra fiber pairs and will allow the delivery of bandwidth up to 10 Gbps for customers that need the extra bandwidth.

Why Not Next Generation PON Technology?

This is a new generation of PON technology just entering the market. There is a lot of debate within the industry about the direction of the next generation of last-mile fiber technology. There are three possible technologies that might be adopted as the preferred next generation of electronics—NG-PON2, XGS-PON, or active Ethernet. All three technologies are capable of delivering 10 Gbps streams to customers.

Everybody agrees that the current widely deployed GPON will eventually hit a technology wall. The technology delivers 2.4 Gbps downstream and 1 Gbps upstream for up to 32 customers, although many networks are configured to serve 16 customers at most. This is still an adequate amount of bandwidth today for residential customers. However, many ISPs already use something different for larger business customers that demand more bandwidth than a PON can deliver.

The GPON technology is over a decade old, which generally is a signal to the industry to look for the next generation replacement. This pressure usually starts with vendors who want to make money pushing the latest and greatest new technology—and this time it’s no different. After taking all of the vendor hype out of the equation it’s always been the case that any new technology is only going to be accepted once that new technology achieves an industry-wide economy of scale. That almost always means being accepted by at least one large ISP.

The most talked about technology is NG-PON2 (next generation passive optical network). This technology works by having tunable lasers that can function at several different light frequencies. This would allow more than one PON to be transmitted simultaneously over the same fiber, but at different wavelengths. That makes this a complex technology with multiple lasers and the key question is if this can ever be manufactured at price points that can match other alternatives.

The only major proponent of NG-PON2 today is Verizon, which recently did a field trial to test the interoperability of several different vendors including Adtran, Calix, Broadcom, Cortina Access, and Ericsson. Verizon seems to be touting the technology, but there is some doubt if they alone can drag the rest of the industry along. Verizon seems enamored with the idea of using the technology to provide bandwidth for the small cell sites needed for a 5G network. However, the company is not building much new residential fiber. They announced they would be building a broadband network in Boston, which would be their first new construction in years, but there is speculation that a lot of that deployment will use wireless 60 GHz radios instead of fiber for the last mile.

The market question is if Verizon can create enough economy of scale to get prices down for NG-PON2. The whole industry agrees that NG-PON2 is the best technical solution because it can deliver 40 Gbps to a PON while also allowing for great flexibility in assigning different customers to different wavelengths. Still, the best technological solution is not always the winning solution and cost is the greatest concern for most of the industry. Today the early NG-PON2 electronics are being priced at 3–4 times the cost of GPON, due in part to the complexity of the technology, but also due to the lack of economy of scale without any major purchaser of the technology.

Some of the other big fiber ISPs like AT&T and Vodafone have been evaluating XGS-PON. This technology can deliver 10 Gbps downstream and 2.5 Gbps upstream—a big step up in bandwidth over GPON. The major advantage of the technology is that is uses a fixed laser which is far less complex and costly. Unlike Verizon, these two companies are building a lot more FTTH networks than Verizon.

While all of this technology is being discussed, ISPs today are already delivering 10 Gbps data pipes to customers using active Ethernet (AON) technology. For example, US Internet in Minneapolis has been offering 10 Gbps residential service for several years. The active Ethernet technology uses lower cost electronics than most PON technologies, but still can have higher costs than GPON due to the fact that there is a dedicated pair of lasers—one at the core and one at the customer site—for each customer. A PON network instead uses one core laser to serve multiple customers.

It may be a number of years until this is resolved because most ISPs building FTTH networks are still happily buying and installing GPON. One ISP client told us that they are not worried about GPON becoming obsolete because they could double the capacity of their network at any time by simply cutting the number of customers on a neighborhood PON in half. That would mean installing more cards in the core without having to upgrade customer electronics.

The bottom line of this discussion in terms of the study is that we chose to not consider NG-PON2. The technology is too expensive, and if it’s never accepted widely in the industry it might not get long-term support by vendors.

III. Financial Business Plan Analysis

This section of the report examines the financial aspect of bringing a retail fiber business to Cortez.

A. Studies Considered

We considered the following business plan scenarios.

- City as the ISP. The first option studied considers the city as the retail ISP. We consider this scenario as the base study because if this scenario doesn't generate enough profits to be financially self-sustaining then other scenarios cannot succeed.

- Open Access. This scenario would open up the market to multiple ISPs, which would provide retail products to customers. Under this scenario the city's only source of revenue would be from providing wholesale connections to ISPs to use the network.

- Digital Divide. This scenario builds fiber to every residential living unit within the city and supplies a small amount of broadband to everybody for free.

We also looked at variations on the above studies in what we label a sensitivity analysis. We looked at how changing some of the major variables in the business plans would change the financial results. We considered the following variations:

- Different Cost for Drops. There are different ways to go about building fiber drops and we looked at a range of options.

- Different Financing Scenarios. We looked at the difference between funding the project with traditional bond financing as well as through the use of sales taxes.

- 100% Coverage. We examined a scenario where the fiber network would be extended to everybody in the city and not just those residents and businesses that elect to buy services from the network.

- Customer Penetration Rates. At this early stage there is no way to know how many customers in the city might elect to buy services from a fiber network. So we varied the predicted number of customers to understand how that affected the projected financial performance.

- Changing Customer Retail Rates. In the retail scenario we looked to see how the projected results changed by using different retail broadband rates.

- Adding Cable TV. Our base scenario does not include a cable TV product, so we looked to see the incremental impact of adding cable to the network.

B. Services Considered

We considered the following potential products in the network design and the financial business plans.

High-Speed Bandwidth (in excess of symmetrical 100 megabits)

The network was designed to be capable of providing a shared gigabit broadband product to every customer. Likely most customers would have connections at lower speeds. We think it's important to realize that faster speeds do not necessarily mean greater use of the Internet. We've found through our many clients that residential customers who are able to get all of the Internet access they want consume a similar amount of bandwidth during a month.

Telephone services (VoIP)

Voice over IP (VoIP) is a digital telephone service that transmits a telephone call to customers using their broadband connection rather than establishing a more traditional analog telephone connection.

VoIP has been around the industry now for a few decades. The first major seller of VoIP was Vonage which still today delivers VoIP over the open Internet.

The study assumes that the retail provider of telephone service will purchase wholesale VoIP. This product is available from numerous vendors. These vendors own a digital telephone switch and they deliver calls to and from customers from that switch to the ISP.

The alternative to using VoIP is to buy a telephone voice switch and then establish connection between that switch and the public switched telephone network. These connections are referred to in the industry as "interconnection." We've found through a number of studies that it's hard to justify buying a switch and paying for interconnection costs unless a service provider expects to serve at least 4,000 telephone customers.

However, landline telephone continues to drop in popularity as a product and nationwide only about 40% of households still have a landline.

Internet Based Live Television (IPTV)

Our base study does not include a TV product, but we've looked at this as an option.

IPTV is a specific TV delivery technology that transmits only those channels that a customer is watching. The closest analogy to this would be to compare it to the way that Netflix sends programming over the Internet—they only send you the show you are watching. IPTV is far more bandwidth efficient than traditional television transmitted over a cable TV network. A cable network sends all channels to a customer, using a large amount of bandwidth, and the settop box then selects the channels a customer wants to watch from the larger video stream.

While traditional television can use as much as a dedicated gigabit of data speed to each customer on the network, IPTV sends individual video streams that vary between 1 and 4 Mbps depending upon the level of compression for any given channel (for example, action movies and sports use more bandwidth than “talking head” news shows).

The feasibility study made the assumption that the new fiber network would buy cable TV programming from a headend located outside of the area. A fully functional IPTV headend (the electronics needed to receive signal from satellites and transmit to customers) including all the needed bells and whistles can cost as much as $4.5 million, and we no longer see clients installing new headends unless they expect to eventually get 20,000 or more video customers.

There are several ways to obtain wholesale cable TV. First, there are several vendors that sell this as a product. Another approach is to share a headend with some other cable headend owner in the vicinity.

Other Future Products

Today most broadband network providers offer some variation of the triple-play products of telephone, cable TV, and broadband. In addition to these, ISPs are now expanding their product lines to make up for the shrinking number of customers they are experiencing with both landline telephones and cable TV.

Perhaps the best example of this is Comcast. They now offer a wide range of new products. For example, they have sold home security monitoring to many millions of customers. They are now probably the largest single nationwide provider of smart home products and they have a line of products such as smart lighting, smart watering systems, smart door locks, smart thermostats, etc. Comcast has recently begun testing a cellular product and announced that they already have 200,000 customers. Comcast also recently announced that they will start bundling solar panels with their other products.

It’s impossible to build a business case for products that have yet to be developed, yet it’s also fairly easy to believe that any sizable ISP will offer new products over time. Our business plans incorporate a generic revenue for “new products” which is undefined. The assumptions used will be described under the revenue assumptions below.

Wholesale Broadband

The city is already engaged in selling wholesale connections to telecom companies, government organizations, and large businesses. Today broadband for large businesses and for businesses with a nationwide footprint is largely provided by a small number of telephone companies, cable companies, or CLECs (competitive telephone companies). For example, it’s likely that the one ISP provider will serve all of the nationwide branches of a hotel chain or a large bank. These service providers don’t own network everywhere and want to buy broadband access from a local network.

There are also other typical wholesale broadband customers in most markets. For example, there might be an opportunity to provide bandwidth to cellular towers in the city. There are also often opportunities to sell bandwidth to connect schools together or to connect government locations together.

Wholesale connections can be provided either with dark fiber (fiber that doesn't include electronics, which must be provided by the customer) or using lit fiber, which differs from the broadband being sold to other customers by providing dedicated bandwidth to each wholesale customer.

C. The City as the Retail ISP

The basic premise of this financial model is that the city would finance and build the fiber network and then act as the retail ISP. The following assumptions are for the retail scenario, with the assumptions for open access then following.

Revenue Assumptions

Setting retail rates in a financial forecast is always challenging for a few reasons.

- In looking at the prices charged in the city by TDS and CenturyLink it's easy to see that the two companies have a significantly different set of rates.
- Not all customers pay the same rate even with the same service provider. The analysis of the bills show that the rates of products vary within both TDS and CenturyLink. Some of the difference is due to promotional or bundling discounts. But there also looks to be cases where customers have negotiated for different base prices for the identical service. This means there is no market rate for products in your market like telephone service.
- We can't know the future. We know that TDS is in the process of upgrading their HFC cable network. This will result in faster broadband products. We can't know the speeds and prices they might offer after the upgrade.

Our goal in setting rates was to use rates for the studies that are at, or a little less expensive than, the average rates for current products in the city. Following are the specific rate assumptions for triple-play products included in the forecasts.

<u>Telephone Rates</u>: It's obvious that the base prices for telephone service from CenturyLink are a lot higher than the rates for TDS. In addition to higher base rates CenturyLink also has several fees like the Subscriber Line Charge and the Access Recovery Fee that they list separately on bills but which are part of the rate for telephone service.

The models assume simple pricing for residential phone service:

Basic Local Line	\$20
Line with Unlimited Long Distance	\$30

Both lines would include a full package of features like voice mail, caller ID, etc. The basic line would only be able to make free local calls plus have access to 911. In Cortez today any call outside of the immediate vicinity of the city is long distance. A customer with a basic line would need to use a calling card or some other method to pay for long distance calls if they wanted to make them. The $30 voice product includes unlimited long distance nationwide. Anybody who still uses the home phone to make many calls would likely choose this product.

The models assume that these prices are all-inclusive and there would not be any add-on fees other than required taxes. There would be no separate Subscriber Line Charge or any other hidden fees similar to the ones charged by CenturyLink.

Business telephone rates vary more than residential rates. To a large extent business telephone rates have been deregulated. That means a telco or competitive provider can charge any rates they can negotiate. There are also a number of different kinds of business telephone lines. Businesses can buy bare lines with no features to use for fax machines, lines with features in the same way that a residence can buy them, and lines where the telephone company provides business features like call transfer, call hold, and those functions associated with business telephone service.

It's relatively easy for a competitor today to support most of these types of telephone lines. They can easily sell the newest kinds of digital phones that businesses want. The business should also be able to support customers who have their own in-house phone systems, referred to in the industry as a keysystem or PBX service. The product for this service are the outgoing lines that connect the systems to the telephone world.

By looking at the experience of many other clients the assumption was made that the smaller businesses in town will spend an average of $50 per month for voice. Those prices represent a mix of businesses that buy more than one voice line as well as a mix of features and long distance.

<u>Cable TV Products</u>: Our base study does not include cable TV as a product.

We did consider an alternative model that includes cable TV. This alternative scenario considers the use of a wholesale cable TV arrangement where a cable provider would supply the signal to the network and would pay the city a small fee for using the network. This arrangement will be described more below when we look at the sensitivity scenarios.

<u>Broadband Products</u>: Pricing of broadband is always a challenge for a new ISP. Price it too high and you don't get enough customers. Price it too low and you leave a lot of margin on the table that is needed to pay for the new fiber network.

Looking at the existing prices in the market today is not particularly illuminating because the broadband products of both CenturyLink and TDS barely qualify today as real broadband. The CenturyLink DSL is slow, mostly at 7 Mbps and under. The results from the speed tests show that the speeds on the TDS network are also a lot slower than the name of their broadband product – Ultra60 – would imply.

But TDS is in the process of upgrading their cable network and the speeds are likely to increase significantly. There is no way of knowing if that also means they will change broadband pricing. It's likely, at a minimum that they might introduce additional tiers of broadband with a better network. Today they sell an up-to product at 60 Mbps, although it appears that nobody gets that kind of speed. But with a more robust network they could offer more than one broadband speed.

For residences the models assume a 3-tier pricing structure. The model isn't specific on the speeds that will be offered and that determination can be made closer to launching a network. On a fiber network the top tier could easily be a gigabit product, but various fiber providers have starting products that vary from 50 Mbps to 100 Mbps. The three tiers are priced in the models at $60, $75, and $90.

It's typical for most fiber network providers that a majority of customers buy the introductory level speed, assuming it is fast enough to be considered quality broadband. The models assume that 82% of residences will buy the first tier, 15% the second tier, and 3% the top tier.

In the section on sensitivity analysis we will also look at what we are calling a Digital Divide scenario that will provide some small level of broadband to every home for free.

We've also assumed three tiers for business services, although those don't have to be set at the same speeds as residential pricing. The models assume those prices are $20 higher than residential rates and are set at $80, $95, and $110.

It would be possible to offer a wider array of different speeds, but the only real way to do so would be to offer some slower speed at a lower price. The problem with doing that is that we know that most customers would still buy the lowest tier product. For example, there would still be a majority of customers buying the first tier if it was set at 25 Mbps.

The forecasts anticipate small future rate increases for broadband. This is a controversial topic in the industry today. To a large degree there have been very few broadband rate increases from the major ISPs over the last decade. While prices have held fairly steady, the ISPs with good networks, like the cable companies, have unilaterally increased speeds several times while maintaining the same rates.

However, there is a lot of current industry speculation that Comcast and the other big cable companies are contemplating significant increases in broadband prices. The big ISPs are starting to feel earnings pressures. They are continuing to lose cable TV and landline voice customers. They are seeing drops in advertising revenue. There is a big hope among the largest ISPs that they will be able to monetize their customers' data, which will to allow them to complete with Google and Facebook in the targeted advertising business.

The big companies have posted increased earnings each quarter for many years due to the ever-growing number of broadband customers in the market, but overall broadband penetration is now over 84% of all households and the rate of annual customer growth is finally starting to slow down. The growth in customers in 2017 was 30% less than in

2016—the market is probably approaching full saturation where every home that wants broadband will have it.

The big cable companies and telcos are publicly traded companies and are likely to do everything possible to maintain their stock prices. That means that broadband prices will have to increase—most of them don't have any other easy way to regularly increase bottom line. There are industry analysts who have suggested that the market could handle broadband rates as high as $90 per month. While it's unlikely that anybody will leap to such a rate, it seems likely that big ISPs will start increasing broadband rates. We already saw some small rate increases from Comcast and Charter in early 2018.

If the whole market increases it does not automatically mean that the city would also raise rates—this would be a policy decision. There is a chance that since your primary competitor TDS is not a major ISP that the two of you will not raise rates. In the sensitivity analysis I look at the impact of never raising rates. The models anticipate small rate increases in rates of $1 per month every third year. This means that the initial $60 rate grows to $68 dollars over 25 years – an assumption that we still think is conservative.

<u>Wholesale Bandwidth</u>: The city already sells wholesale bandwidth to other carriers and large businesses. Our model assumes that these wholesale revenues are maintained throughout the 25-year time frame of the models. This is a conservative assumption because revenues would be higher if some of the businesses using wholesale connections were to convert to a retail product on the network.

<u>Penetration Rates</u>: Penetration rate is the industry term for quantifying the percentage of customers in the total market that buy service on the new network. The models are based upon broadband as the core product. It's assumed that every customer on the network would buy broadband. It was assumed that telephone would have a significantly lower penetration rate.

Since at this early stage it is impossible to know how many broadband customers might buy from the network it was necessary to establish some starting point for the forecasts to make it easy to compare the results between different scenarios.

The base penetration rate for residences used in the models was arbitrarily set to grow to 50% by the end of the fourth year of the new business, and then stay at that level moving forward.

The assumption was also made that the broadband penetration rate for small businesses also grows to 50%, although it takes longer to get to that level.

This penetration rate is completely arbitrary and is based upon the performance we see from other new fiber overbuilders in other markets around the country. However, every market is different. Each market has different demographics and also a different dynamic between the competitors in the market. This means that we can't easily know what the ultimate penetration rate might be.

One of the recommendations made in this report is for the city to undertake a residential survey if you like the financial results of this study. We've found that a well-designed residential survey can be a good indicator of how a fiber business might perform in the market. While there are always operations risk and launching poorly can hurt the penetration rate, if a network is launched well without major outages or problems then the number of customers who say they will switch broadband providers in a survey is a good yardstick to use in setting penetration goals for a new network.

There is an existing survey done for all of Montezuma County that shows a lot of interest in a new broadband network. But those results are probably not indicative of the response in Cortez since the rest of the county has extremely slow, or even no, broadband today. That survey is promising in that there is a lot of dissatisfaction with existing broadband, but there is no way to make any predictions for just the city based up the results of that survey.

Telephone Penetration Rates: Telephone penetration rates are set far lower than broadband penetration. Nationwide about 40% of homes still have a telephone landline, but that number keeps dropping every year as more people come to rely totally upon their cellular phones. But there are still markets where a lot of homes have landlines and it is something else to explore in a survey of the city.

Our models assume that only 19% of homes and 27% of businesses would buy landline telephone from a new network provider. In the models those penetration rates drop over time.

Future Products: Nobody that builds a fiber network today believes that they will only ever sell the triple play of voice, data, and cable TV. It's obvious that both telephone service and cable TV service are declining products. A decade ago 98% of homes had a telephone and a recent FCC report shows this has dropped nationwide to 40% and is still dropping. People have made the transition to the cell phone and this trend will undoubtedly continue. Cable TV just recently started a similar decline. In 2017 the cable industry as a whole lost over 3 million customers, or a drop of 2.4% of all customers in a year. A year earlier the drop was 1%; the rate of decline of the industry is clearly accelerating.

There are going to be new revenue opportunities over time that arise from having a fiber connection in homes. This might include such things as security, energy management, home automation, the Internet of Things, or some form of wireless phone service. It also might involve things like health products that help seniors stay in their homes longer, or better data platforms for gamers. CCG already has some clients that are successfully selling IP-based security systems and home automation systems.

The business plans include a small amount of unspecified new products starting in the third year of the business plan and growing slowly over time. The model does not predict what these future revenues will be, there will be new products sold over time. Since we can't understand the margins of each business plan the assumption has been used to show just the margins from the new business. We think the assumption used is modest and by the 25th year in the model these revenues grow to a margin of $15.50 per month for 36% of the customers on the network.

Churn: Churn is the industry term that refers to customers that leave the network. Churn is of major concern with an FTTH network because there is significant investment at each customer location for the fiber drop and electronics. When a customer comes on the network and then leaves before that investment is recovered it means that other customers have to make up for that shortfall.

The models assume that there is churn at a rate of about 3% of broadband customers each year. That may not sound like a lot, but over a 25-year business plan it would mean building a significant amount of fiber to homes that didn't originally have a connection.

A lot of financial models don't account for churn which underestimates the annual capital needed in future years to add new customers, even when total customer counts are not growing. The assumed churn for telephone and cable TV is higher and assumed at 6% per year to reflect customers that leave those services and don't buy again. Customers can obviously drop these services while keeping a broadband connection.

Expense Assumptions

Following are the various major expense assumptions used in the models.

Employees. Labor is generally one of the largest expense of operating a broadband network. The models all assume that the business will employ a local staff to operate the network and to run the business. The model assumes that these would all be new employees of the city. Salaries are set at market rates that also match the city's existing pay scale. All salaries assume an annual wage increase at 2.5% inflation. Benefit loading is set at 35% of basic annual salary which covers payroll taxes, other taxes like worker's compensation, and employee benefits.

The city has one current full-time employee today that works with the fiber network. The model assumes that the following new employees would also be added:
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Inside Technician	1
Installers	2
Customer Service	2
Total	5

CCG chose this level of staffing based upon the number of expected customers and our experience with hundreds of clients in the triple-play business. This level of staffing ought to be sufficient to provide a good level of customer service.

There are also additional functions that would be outsourced or handled by contractors, as follows:

Sales/Marketing. The city is typical of other municipalities and would have a hard time paying sales commissions. We've assumed a contract sales person for the first few years of the business who would sell largely by knocking on doors. Over time the need for this position decreases and the models show this cost declining, but never disappearing.

Technical Support/After Hours Support. Most small ISPs today outsource what is referred to as the ISP functions. This includes owning the routers that handle things like routing traffic to and from the Internet. One major function offered by these outside vendors is first level technical support where customers can call to ask about technical issues or computer issues. These firms offer these services as well as after-hours general customer support. Staffing this locally would cost more than outsourcing.

City Overhead Costs. The city bills the various departments for using jointly provided city services like accounting, payroll, and benefits management. The city also charges for use of city-owned vehicles to those departments that use the vehicles. We estimated the cost of these city overheads based upon what is already charged today for the existing fiber employee.

Start-Up Costs. There are considerable start-up costs included in each scenario. It's our experience that there are a number of one-time expenses associated with launching a new business and rather than list them, they have been included generically as start-up costs.

Maintenance Contracts. It is typical for small ISPs to buy maintenance contracts. The city already incurs some of these costs with Calix. These contracts provide for annual updates of all software and other improvements to electronics plus some base level of technical assistance from the vendors. The study assumes maintenance contracts for the FTTH electronics.

Internet Backbone. ISPs need to buy a large data pipe to the Internet to provide connectivity to the open Web. This is referred to in the industry as an Internet backbone connection.

The city already has this connection in place today to support the wholesale business. The current fees include two components—transport and bandwidth. The transport costs are for the fiber connection from Cortez to the nearest Internet POP, and that cost would not increase by getting into the fiber business. But as the new retail business adds more broadband customers you'd have to buy more bandwidth.

It's been our experience that bandwidth costs have been dropping over time, something we've seen happen for over twenty years. The models assume future decrease in the cost for bandwidth, although the amount of bandwidth needed will continue to grow over time as people use more bandwidth.

The quality of bandwidth delivered to customers is measured in the industry by use of an oversubscription factor. Oversubscription is the sharing of bandwidth between customers. For example, if there was only one customer on the network, then the network would not be oversubscribed and the oversubscription ratio would be 1:1. However, since customers don't all use the Internet at the same time to download or upload, a network can easily share a data pipe among multiple customers. The large cable and telephone companies are believed to use an oversubscription ratio of as much as 200:1 or even higher, meaning that at least 200 customers share a data pipe to a neighborhood. These models assume an oversubscription rate of no more than 100:1. This is a reasonably high-quality oversubscription ratio and most customers would get the bandwidth they want almost all the time.

Sales and Marketing Expenses. In addition to a contract salesperson the forecasts include a marketing budget. The assumption is made that there would be relatively high advertising costs in the first few years, but a continuous advertising cost forever.

Billing. A company has two choices for billing services. The company can subscribe to an external billing service or the company can buy software and do the billing internally. Even with internal billing many companies print and mail bills using an external vendor. These models assume the purchase of a billing system as part of a larger suite of software known as OSS/BSS. This software is used to take customer orders, to coordinate installations, and to keep track of inventory as well as to bill customers.

The billing assumptions assume that customers will pay in multiple ways. Some will have the business auto-bill and debt their bank account. Others will leave a credit card on file for billing. Other customers are still going to want a paper bill. There is a different cost to the company for each of these different classes of customers.

General & Administrative (G&A) Expenses. The models include the number of overhead costs for operating the business. This includes such costs as:

- General liability insurance
- Legal expenses
- An annual accounting audit
- Travel expenses
- Office supplies
- Fees for the bond trustee
- Regulatory compliance
- External consultants
- And, finally, a catchall account called other G&A—there are always expenses that are hard to put into a category.

Taxes. The models assume that since the business is municipal that you would be exempt for most normal business taxes like income taxes, property taxes, etc.

> There are a number of taxes that would accrue to the business due to being in the retail business. This would include things like the taxes to fund 911, fees assessed by the federal Universal Service Fund, and so forth. The assumption in the model is that all of these taxes would be passed on to customers and that the amounts collected would be sent to the tax authorities. Because of this these taxes are not shown in the forecasts because the tax expenses flow directly from customers to the tax authorities without affecting the company books.

Capital Assumptions

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

Capital includes several broad categories of equipment including fiber cable, electronics for FTTH, and the electronics needed to provide the retail services. In addition to capital needed for the network, there are expenditures predicted for assets like furniture, buildings, computers, vehicles, tools, inventory, and capitalized software. The amount of investment required is going to vary as well by the number of customers covered by a given business plan.

One of the major capital costs of building a fiber network is the cost of installing each customer. This work consists of three components—the fiber drop to get from the street, the fiber electronics that translate the light on the fiber into usable bandwidth, and any installation or rewiring needed inside the home.

Our goal is to be conservative with capital estimates. The estimates include a construction contingency to cover potential cost overruns. It is important to remember that these estimates are high level. The goal of these estimates is to provide estimated costs that are detailed enough to see if it makes sense to move forward and consider a fiber project. However, before raising the money to build this project it would be prudent to do additional engineering to better pin down the cost of the network.

Estimating Fiber Costs

There was no one easy answer about the best way to design and build the fiber network. This is due to the various issues having to do with the cost of building fiber. The area of the most concern is the high cost of putting fiber onto the existing pole network owned by Empire Electric. That network looks like it will require extensive make-ready costs, which are partially driven by the philosophy of Empire Electric. They seem to want a new attacher to pay to clean up historic problems with the placement of other wires.

Because of this we considered three different alternative network designs:

- A traditional build where the city pays to get onto the Empire Electric poles.
- An alternative where the whole network is buried.

- An alternative where the city builds new poles in the alleys in the older downtown area and buries the rest of the network.

The cost of the fiber network under these three scenarios is as follows:

Using Empire Poles.	$ 8,082,345
All Buried.	$ 8,316,615
New Poles in Alleys	$ 5,830,600

For purposes of the financial projections we considered both the all-buried option and the option to put aerial in downtown alleys on new poles. We did not consider the option of using the Empire poles. More research is needed to be certain that the city can build all new poles in the needed alleys.

The perfect network implementation would choose the lowest cost option for each street in the city. There are some blocks where it might be inexpensive to get onto Empire poles, others where the lowest cost would be to place new poles and others where burying is the best option. We believe that the actual cost to build the network will include a mix of these three methods and we've recommended that more research should be done to pin down the cost of the best network.

Specific Assets. Following are the assets that are in service by the end of the fourth year. That date was chosen because it represents a fully constructed network with subscribers. These would be the assets that would be funded by any debt. Assets added after the fourth year would be funded by revenues.

Perhaps the primary question we are always asked is, "what is the cost to build the network?" As can be seen by these numbers, the cost of the network varies by the number of customers. This particular table uses a fiber network that is both aerial and buried, and the numbers would be higher for the all-buried scenario.

	40% Penetration	50% Penetration	60% Penetration
Vehicles	$ 81,000	$ 81,000	$ 81,000
Tools	$ 75,000	$ 75,000	$ 75,000
Land & Buildings	$ 383,396	$ 383,396	$ 383,396
Furniture	$ 9,000	$ 9,000	$ 9,000
Computers	$ 18,090	$ 18,090	$ 18,090
Voice Gateways	$ 46,260	$ 69,660	$ 83,520
WiFi Modems	$ 178,360	$ 221,284	$ 265,188
FTTH Electronics	$ 1,518,405	$ 1,729,455	$ 1,917,126
Fiber Drops	$ 1,657,644	$ 2,057,126	$ 2,464,538
Fiber Network	$ 5,830,600	$ 5,830,600	$ 5,830,600
Inventory	$ 100,000	$ 100,000	$ 100,000
Capitalized Software	$ 209,100	$ 211,290	$ 213,530
Total	$10,109,625	$10,785,901	$11,445,553

A description of the buildings (huts), the fiber network, and the core electronics is included in Section II of this report. Here is a brief description of the other assets included in the study.

Vehicles. Needed for the installers.

Tools. These are capitalized tools like test equipment used to monitor network performance and to diagnose network problems.

Furniture. Needed for employees.

Computers. For employees, including basic software.

Voice Gateways. These are devices needed to provide Voice over IP. These can range from tiny devices placed at each VoIP phone, like is done by Vonage, or one larger device that would provide VoIP service to all phones connected to the existing telephone wiring.

ONTs. These are the devices at each fiber customer that receives a light signal from the fiber network and converts it into Ethernet.

Inventory. This includes spare electronics as well as spare fiber needed to make quick repairs.

WiFi Routers. Our analysis assumes external WiFi routers—meaning separate from the ONT. Some ISPs automatically assume that a customer wants a WiFi router and build it into that cost.

At CCG we recommend that our client not include WiFi routers directly in their terminal equipment. The indoor ONTs that are included in these studies do not include a WiFi router, but ONTs can be purchased with integrated WiFi capabilities at a higher cost than we've assumed.

It has been our experience that automatically including the WiFi router in the ONT is a bad business decision. First, many tech-savvy customers won't use a WiFi router from the ISP because there are better (or perhaps cheaper) WiFi routers available on the market. To provide unused WiFi routers to such customers is an expenditure that never gets recovered. More importantly, we know that WiFi technology is evolving rapidly. We are only a few years way from the introduction of 802.11ax and there seems to be a new generation of WiFi every five to seven years. Building WiFi routers into the ONT electronics means that the device can become obsolete due to the WiFi router, long before it is functionally obsolete as an ONT. We instead recommend that ISPs offer separate WiFi routers for lease.

Capitalized Software. The models also assume capitalized software. GAAP accounting requires that any software that is above a certain dollar amount and which has benefit to the business for more than one year be capitalized. There are a few kinds of software assumed in these studies that meet these requirements and which are shown as assets and not immediately expensed. These would include:

- An OSS/BSS operating system. This is the software used to run the company and includes such services as taking customer orders, billing, taking customer trouble calls, dispatching repair technicians, keeping track of inventory, etc.
- Mapping software. You will want a software package that captures the details of the network and that can be integrated with the OSS/BSS to make it readily available to customer service reps and technicians.

City Purchasing Practices. One issue that always has to be considered when municipalities build a fiber network is the potential impact of city purchasing practices on the cost of a fiber network. We've seen instances when such purchasing practices add extra cost to a network.

For example, the municipal RFP process can add a lot of time to the purchasing timeline. When financing with bonds it's extremely important to get the construction underway as quickly as possible. Fiber networks lose money initially, by definition, and it's vital to get customer revenues generated as quickly as possible to help pay for the network. There is a significant cost for delaying revenues and it can be deadly to have a slow purchasing process.

We've also seen government purchasing processes that end up compromising the quality of the network. Purchasing rules may require that each major component of the network be bid separately, and that might mean that the overall set of vendors selected might not be the team that will produce the best combined technical solution.

The most important factor is an interesting one. Government RFPs generally assume that vendors will bid with their best prices and that the government will get a good price for the components of the network. However, in real life practice we've often seen the opposite. Most telecom vendors are not experienced in working with municipalities since the majority of their customers are commercial ISPs. We've seen this lead to telecom vendors responding to government RFPs with "list" prices. Telecom vendors also often offer list prices to ISPs, which is then followed by a negotiation for lower prices. Yet most RFP rules don't allow for negotiation after the acceptance of the RFP and we've seen municipal fiber providers paying significantly higher prices for electronics and components than similarly sized commercial ISPs.

There are ways around these issues in some states. For example, we've seen cities that bid the entire price of building the network to a contractor, thereby making the contractor responsible for buying the network components. However, many states don't allow this process.

We mention this issue because there is a risk that the assets could cost more than we've assumed if the fiber construction process is run through routine municipal purchasing practices that could cause delays or lead to cost overruns.

Debt Assumptions

One of the scenarios we considered was financing the network using municipal bonds. There are several key factors that affect financing costs:

- Interest Rate. The higher the interest rate, the higher the annual debt payments, just like with a home mortgage. For the last decade or so bonds have had much lower interest rates than commercial loans. That is not always the case throughout a longer history, but it's generally the case. We've enjoyed low municipal bond rates for the last decade, but nobody expects low rates to hold forever. In the studies we've assumed a bond interest rate of 4.0%.
- Loan Term. The loan term means how long the borrower has to repay the loan. The studies assumed a term for bonds of 25 years. There have been a few municipal fiber bond issues financed for 30 years, which would result in more interest expense during the life of the bond but lower annual debt payments.
- Financing Construction. With bonds it is typical to borrow all of the money up front in a lump sum, meaning that interest is accumulating immediately. Commercial loans more often use what is called construction financing, meaning that the project borrows money each month as needed during construction, which greatly reduces the interest cost for the first few years.
- Capitalized Interest. Because bonds require the money to be borrowed up front, it's typical for a fiber project to have to borrow the funds needed to make the first 3–4 years of interest payments on the bonds, until the project generates enough cash to cover those payments. Commercial loans more typically excuse interest payments for the first few years (which is made up by applying a higher interest rate in the future). The studies assume that the first three years of interest payments are borrowed in the bonds.
- Bond Surety. Bonds often include some sort of surety, meaning some amount of money to cushion the bondholders against losses. This might include borrowing something called a Debt Service Reserve Fund, which is an amount of money that is borrowed and held in escrow during the life of the bond. This money would be used to pay principle and interest payments in case the project doesn't make enough to cover the needed payments. Bonds might also require bond insurance, which is an insurance policy, funded up front with the bond to cover future defaults. The forecasts assume that revenue bonds would require a Debt Service Reserve Fund. This would not be needed for general obligation bonds.

Example of Financing Assumptions. The following example shows the financing assumptions for building the network with a mix of aerial and buried fiber and using revenue bonds.

	50% Penetration
Interest Rate	4.0%
Term	25 Years
Assets Financed	$10.8 M
Bond Fees	$ 0.3 M
Working Capital	$ 0.7 M
Capitalized Interest	$ 1.8 M
Debt Service Reserve Fund	$ 1.0 M
Total Bond	$14.6 M

This scenario is typical for bond funding and shows that the amount financed is significantly greater than the cost of the assets, in this case by 35%. Following is an explanation of the components of the bond cost:

> Assets Funded. These are the assets built during the first 4 years of the project.
>
> Bond Fees. These are fees paid to raise the bond fund. They include numerous legal fees. The primary cost are fees charged by bond sellers to market and sell the bonds.
>
> Working Capital. Federal bond law requires that bond proceeds must primarily be used to pay for the capitalized cost of a project. However, the rules allow for a bond to finance up to 5% of the cost of the bond issue to cover other costs. In this case the working capital would be used to cover operating expenses during the first few years before revenues are high enough to cover costs.
>
> Capitalized Interest. We've assumed that the interest payments for the first three years are borrowed up front.
>
> Debt Service Reserve Fund. This is the surety described above and this amount is held in escrow during the life of the bond issue to be used in the case that the project is unable to cover bond costs. These funds are held in escrow for the life of the bonds and would be released to the general funds of the city or to the fiber project when the bonds are fully retired.

Type of Bond. There are two primary types of bonds used to finance fiber projects—general obligation bonds and revenue bonds. Revenue bonds are basically secured by the revenues of the project (in this case the revenues from the fiber network). General obligation bonds are secured by tax revenues.

But there is a nuance that is important when looking at funding a fiber network. One of the most common kinds of financing is a revenue bond that is backed by the full faith and credit of the city. That means that the revenues from the fiber project are expected to cover the bond payments, but if there is ever a shortfall the city must use tax revenues to make up the shortfall.

The only real difference in cost between a pure revenue bond and one that is guaranteed by the city in case of failure is a lower interest rate for the safer bond. The difference in interest varies according to the credit rating of the city as well as the vagaries of the overall bond market. As we write this report there was only a tiny difference in the interest rate of a project backed by tax revenues versus a pure general obligation bond—because bondholders view those as nearly equivalent.

The financial models all assume a revenue bond that is backed by tax revenue. It has become difficult to secure a pure revenue bond for fiber networks since there have been a few failures nationwide of municipal fiber projects.

D. Open Access

This scenario would open up the market to multiple ISPs, which would provide retail products to customers. Under this scenario the city's only source of revenue is from providing wholesale connections to ISPs to use the network. In an open-access network the city would build and own the fiber network and would then sell access to the network to multiple ISPs or other service providers. There is no one single way to do an open-access arrangement and the city and the ISPs would need to negotiate the specific arrangements.

In most open-access networks in the US, the municipality owns the fiber network and some portion of the electronics and the ISPs are responsible for everything customer related. This is not the only possible model, but it reflects the fact that many ISPs are undercapitalized and unable to contribute to capital costs. When open-access networks have required the ISPS to fund more of the customer costs, such as the ONTs or fiber drops, the penetration rates on the network have been extremely low. These studies assume that the city builds the fiber network including the fiber drop to the customers and the FTTH electronics at the customer location.

The most important change of assumptions between a retail model and open access is the speed of customer sales and connection to the network. The base retail model in this study has the city as the ISP and directly in charge of the sales process to customers. Since it's vital to drive new revenues quickly in order to make bond payments in a retail operation, there is always a big push for early sales. In fact, we would expect there to be a big presales effort so that a lot of the customers are on-board before construction is complete.

Probably the biggest surprise to cities that offer open access is that sales go much slower than anticipated. There are many reasons why the ISPs in an open access environment don't feel the same sense of urgency to sell. Many of the smaller ISPs are undercapitalized and understaffed and don't have the resources to connect many customers in a short period of time. Many ISPs on an open access network specialize in a niche of customers, be that a given demographic or a certain part of the market. But regardless of the reasons, it seems to take far longer to get to a reasonable customer penetration rate on an open access network.

Open-Access Revenue. The primary revenue for the city in an open-access environment is the fees that are charged to the ISPs for the right to use the network. Most of the open-access networks in the US charge the ISPs per loop, meaning they bill a flat monthly rate that buys the ISP a lit fiber connection at a given customer location. There have been a few open-access networks that have instead charged by the services being delivered to the customer. However, in today's world when almost every product on the fiber network can be delivered as an IP data stream, it's hard to monitor and charge properly by the service.

There has been a lot of debate in how to set the rate for ISPs in an open-access model. If the rate is too high it pushes the ISPs to cherry-pick. For example, a number of open-access networks today charge flat fees of between $28 and $33 per month to the ISPs. When charged that rate the ISPs will not offer a standalone broadband product in the hoped-for retail range of $40 - $50. They instead will either charge more for standalone broadband or else only sell to customers that will purchase a bundle of products. This cherry picking is well documented on existing open-access networks and results in these open-access networks getting lower customer penetration rates than retail fiber networks. Having fewer customers is not the only negative consequence of the cherry picking since it means that low-income residents essentially get shut out from using the network.

For the MDU market, the open-access environment makes it harder to sell into MDUs on a per-customer basis. For example, in a retail environment the city might only elect to build to an MDU after getting enough customers committed there. That is harder to coordinate with the ISPs. However, the open-access environment may instead lead to some increase in sales of wholesale connections to whole buildings.

The study considers a “traditional” open access model that charges $30 per month to the ISPs for connection to each customer.

Following are the other specific assumptions used in this scenario.

Employees. It takes fewer employees if the city’s only role is to operate the network. We have assumed in these models that these functions would also be outsourced to some third party so that the city is not operating the network with city employees. The employees needed by year 4 are as follows:

	Employees
Inside Technician	1
Installers	2
ISP Coordinator	1
Total	4

The only employees needed are those that directly take care of the fiber network as well as those that interface with the ISPs. There is no need for employees to provide the triple-play products or to interface with end-user customers.

Expenses. There are far fewer city expenses required in an open-access network. All expenses associated with the triple-play services disappear. All expenses required to directly interface with retail customers disappear. The need for an Internet Backbone disappears. These expenses all accrue to the operating ISPs. The required expenses are:

Vehicles and other expenses to support employees
Rent for office and equipment space
Power and other utilities needed to operate the network
Maintenance contracts on the electronics
A reduced amount of advertising to create awareness of the fiber network
Backoffice expenses like accounting, legal, and so forth, but at a lower level than a retail model

Specific Assets. Following are the assets that are in service by the end of the fourth year for the open access network. In this scenario the assumption has been made the ISPs are responsible for assets inside the premise such as settop boxes, WIFI modems, and voice gateways. ISPs also would be responsible for any wiring at the premise inside of the ONT.

City Assets	50% Penetration
Vehicles	$ 81,000
Tools	$ 75,000
Land & Buildings	$ 383,396
Furniture	$ 6,000
Computers	$ 12,090
FTTH Electronics	$ 1,729,455
Fiber Drops	$ 2,057,126
Fiber Network	$ 5,830,600
Capitalized Software	$ 100,000
Inventory	$ 100,000
Total	$10,374,667

The most striking thing about these numbers is that it costs nearly as much to build an open-access network as a retail network.

E. Digital Divide Scenarios

We also considered a digital divide scenario. In this scenario fiber is built to every home and every home gets a minimal broadband connection for free. This would be compensation for the public agreeing to pay for the project through something like sales taxes. The free speed would likely be something low like 5 Mbps or 10 Mbps.

We considered two options. In the first, customers who wanted faster broadband speeds paid the same prices as in the other retail scenarios. In the second version the broadband prices were reduced by $10 per month across the board, rewarding customers further for helping to finance the network through taxes. The primary impact to the financial models was to increase capital to build to every customer:

	50% Penetration
Vehicles	$ 81,000
Tools	$ 75,000
Land & Buildings	$ 383,396
Furniture	$ 9,000
Computers	$ 18,090
Voice Gateways	$ 69,660
WiFi Modems	$ 221,284
FTTH Electronics	$ 2,682,967
Fiber Drops	$ 3,592,513
Fiber Network	$ 5,830,600
Inventory	$ 100,000
Capitalized Software	$ 211,290
Total	$13,304,152

F. Business Plan Results

Financial Reports in the Forecasts

The financial forecasts were created to follow basic GAAP accounting. This means that intangible expenses like depreciation and amortization is applied to assets like bond financing costs. Each projection includes three standard financial reports—an income statement, a balance sheet, and a statement of cash flows. Each projection also includes balance sheet items such as accounts receivable and accounts payable in order to more accurately predict cash balances.

The models assume interest income on accumulated cash, earned at an interest rate of 1.5% annually. Over a long time-horizon that interest rate could vary. There is a general model assumption that cash is never paid out as dividends but always retained for the 25-year period. It is typical to show models that retain cash to make it easier to compare different scenarios. However, in real life cash is generally not retained in a business. In the case of bond financing any excess cash is often used to retire the bonds early.

The summaries below introduce a few new terms:

- Positive Net Income. This is when the books of a business show a positive profit. This is the standard way that commercial companies define a profit. A positive net income shows that the business is covering operating expenses as well as interest, depreciation, amortization, and taxes. Net income does not consider repayment of debt principle and annual operating capital. Still, this is an important milestone for a new business, because it measures when a commercial business is profitable for accounting purposes. Just note that it is possible to have a positive net income and still not have enough cash to operate the business.
- Debt Breakeven. This is when the business has generated enough excess cash that the remaining debt could be fully paid-off and retired.

The best way to measure profitability differs according to the structure of the business. A municipal business, for example, typically defines financial success by generating enough cash to operate the business without any external subsidy. However, a for-profit business would generally use a measurement like net income to measure profits, which is similar to the IRS definition of profitability.

It is vital that any business always have cash in the bank to meet its obligations. The business plans were built with a goal of trying to always have some reasonable level of operating cash to provide a cushion against nonlinear expenditures. A cash cushion is needed since not all expenditures are spent evenly throughout the year and so a business needs to have a cash reserve to allow for those times of the year when the expenses are higher than normal or the revenues are lower than normal.

Funding with Bonds

We first looked at financing the business using revenue bonds. Following are the results for the two different network designs.

	All-Buried	Aerial & Buried
Asset Costs	$14.3 M	$10.8 M
Bond Debt	$19.3 M	$14.6 M
Penetration Rates	50%	50%
Years Until Positive Net Income	Year 25	Year 25
Years Until Cash Covers Debt	Never	Never
Cash After 25 Years	($19.6 M)	($11.8 M)

It's obvious from this summary that this scenario does not generate enough revenue to cover the costs of operating the business. In looking more deeply at the numbers there are a few reasons for this poor financial performance. The primary issue is the cost of bond financing. The revenues generated by the business are sufficient to cover operating expenses and ongoing maintenance capital. But the revenues cannot cover the cost of the bond debt, even though it's at a low interest rate and financed over 25 years.

Funding with Sales Taxes

We also looked a different way of financing. This would raise sales taxes by 1 cent for six years and use that revenue to finance the network. The city would still float a bond that is backed by the future sales tax revenues, but this kind of general obligation bond is far less expensive than revenue bonds, with both a lower interest rate and also no bond overheads like the need for extra surety.

This kind of financing benefits a fiber network because the revenues of the fiber business are not needed to repay the bonds. Those are paid by the increased sales taxes. This scenario generates a lot of excess cash due to not having to cover debt payments:

	All-Buried	Aerial & Buried
Asset Costs	$14.3 M	$10.8 M
Sales Tax Funding	$15.9 M	$12.3 M
Penetration Rates	50%	50%
Years Until Positive Net Income	Year 11	Year 11
Cash After 25 Years	$9.4 M	$11.0 M

The excess cash generated under this scenario could be used in a number of different ways. It could be returned to the city coffers to benefit all citizens. It could also be used to lower broadband prices. As we'll see in a scenario below the revenues could be used to fund providing fiber to everybody in the city.

Open Access

In this scenario the city would build fiber everywhere and would then invite multiple ISPs to provide services over the network. In the industry this is referred to as an open-access network.

In this scenario the city would provide the fiber network everywhere, the fiber drop, and the customer ONT. The ISPs would provide any electronics needed to provide the triple play or any other services. The city would have a staff who would operate and maintain the network. There would be no customer service representatives or any of the employees needed to interface with customers, since those functions would be provided by the ISPs.

Following are the results of an open access network using the aerial and buried network and financed by sales taxes:

	50% Penetration
Asset Costs	$10.4 M
Tax or Other Financing	$11.9 M
Penetration Rates	50%
Years Until Positive Net Income	Never
Cash After 25 Years	($4.4 M)

These simplified results don't tell the whole story. The losses would be significantly larger if financed with revenue bonds.

But the biggest issue with open access is the customer penetration rates. Above uses the overall 50% penetration rate to make this comparable to other scenarios above. We can't find any reasonable scenario where open access can break even, even when using tax financing.

But in actual practice the open access networks in the US get lower penetration rates than retail networks and also take a lot longer to build up to those penetration rates. First, in looking at the experience of all other existing open-access networks in the country it's obvious that the rate of customer acquisition is far slower and also lower than with a retail network. In a retail scenario the company building the network is highly motivated to market to customers early and to get them onto the network as quickly as possible. In fact, today most fiber overbuilders pre-sell to customers so that they can connect customers as the network is constructed. Those early revenues contribute significantly towards making the network a financial success.

Yet for a variety of reasons the ISPs that operate on an open-access network go much slower. Part of this is due to the fact that they are not under financial pressure to make debt payments like the network owner. However, the primary reason seems to be that most of the small ISPs operating on open-access networks are tiny companies. They generally don't have the money available for widespread advertising and so they grow more organically through word of mouth.

It's certainly possible that over a long enough time period that an open-access network will get as many customers as a retail network; that has not been the case on any of the larger open-access networks in places like Provo, Utah; Tacoma, Washington; Chelan County, Washington; and Grant

County, Washington. Those networks have seen not only slow customer growth over the years, but none of them has as many customers as similarly sized municipal retail networks.

There are other reasons the ISPs don't do as well in aggregate as a direct retail provider. Many of the ISPs only sell to niche markets. Perhaps they only want to sell to business customers, or they might be happy to cherry-pick and only offer a high-priced product with high margins and are happy with a small number of customers.

Nevertheless, there is a more fundamental reason why these results are not as good as the retail scenarios above. The city has to borrow almost as much money to build an open-access network as the retail network, but there are fewer revenues to pay for it. In an open-access environment the city would save some money by not being in the retail business. That means fewer needed employees and none of the expenses or assets required to support the triple-play products, but the savings on expenses and assets are not nearly large enough to offset the huge difference in revenues.

This is the dilemma faced by every open-access network. Instead of having customer revenues that might average $120 per month they have wholesale open-access revenues that average $30 per month. Even though expenses are lower, the margins are far smaller.

At CCG we have worked with or are knowledgeable about all of the major open-access networks in the country. They all share this same issue in that they are generally able to generate revenues to cover operating expenses, but they don't generate enough revenue to pay back the cost of building the network. That means that an open-access network would need to be heavily subsidized or funded from a source other than the fiber business.

Most of the open-access networks in the country are operated in cities that also have a municipal power utility. The ones that continue to operate have subsidized the network with electric rates, which is a subsidy that is not available to Cortez.

Digital Divide Scenarios

We also explored a digital divide scenario, meaning that every home would be connected to the fiber network. Every household would get a minimal fiber connection for free, with faster broadband products at higher prices. You'd want to make the free product relatively slow, at perhaps 5 Mbps download. This would be fast enough to provide each home with the ability for kids to do homework or for somebody to stream one video stream. But households that want to do more than that with bandwidth could still buy the faster broadband products.

We considered two scenarios. One charges the same prices for broadband as the retail model (except for those who are happy with the free product). The second scenario trims the prices for all broadband products by $10 per month.

	Normal Prices	Reduced Prices
Asset Costs	$13.3 M	$13.3 M
Tax Financing	$15.0 M	$15.0 M
Penetration Rates	50%	50%
Years Until Positive Net Income	Year 11	Never
Cash After 25 Years	$11.2 M	$3.6 M

These are interesting results. They show that with tax financing that the broadband network could be extended to everybody in the city and still be profitable. In the first scenario the extra cash might be returned to the city coffers. In the second example the extra cash was used to reduce the price of broadband in the city.

This scenario meets a lot of social goals. Every home, including every student in the city, would have broadband. Those that want faster broadband could buy it, but everybody would get something. This scenario also opens up the possibility of using the network for other purposes. For example, by being in every home the network could more reasonably be used eventually for smart city applications, for meter reading or other city purposes.

No city of your size has yet financed with revenues other than traditional bonds. But there are a number of cities considering this, including San Francisco. There are smaller cities like Leverett, Massachusetts who have funded fiber in this manner.

G. **Sensitivity Analysis**

Sensitivity analysis is the process of examining the impact on the financial performance of the business due to changes in the key variables that impact bottom line performance. In creating the business plans we made hundreds of assumptions, but only a small handful of these assumptions have a big impact on the bottom line. Every assumption is important, but a few are more important than the rest. Since CCG has created many hundreds of similar business plans over the years we have come to understand which variables have the most impact. We looked specifically at the impact of changing the following variables:

- We looked at varying the customer penetration rates.
- We looked at the impact of building fiber drops at a lower price.
- We looked at the impact of financing with general obligation bonds instead of revenue bonds.
- We looked at the impact of having to pay a higher interest rate on bonds.
- We looked at increasing customer broadband prices by $5 per customer per month.
- We looked at the assumption that the business adds a cable TV product.

Following are the results of each sensitivity analysis compared back to the appropriate base case.

Varying the Customer Penetration Rates

At this early stage in the process we don't have any feel for how many households in the city might buy broadband from a city network. The city was included as part of a survey that included the whole county, but it's likely that the results of that study were skewed higher due to looking at rural parts of the county where there are no real broadband options.

Following considers the scenario with the fiber network that is on new poles in the alleys and buried everywhere else. This scenario is financed with sales taxes.

Effect of this Change	50% Base Case	40% Case	60% Case
Asset Costs	$10.8 M	$10.1 M	$11.4 M
Sales Tax Funding	$12.3 M	$12.3 M	$12.8 M
Penetration Rates	50%	40%	60%
Years Until Positive Net Income	Year 11	Never	Year 5
Cash After 25 Years	$11.0 M	$4.1 M	$18.8 M

These results tell us several things. Most important, there is a huge impact from varying the customer penetration rates. This makes it essential before building a network to do the market research needed to understand the potential customer penetration rates.

This also demonstrates what CCG calls the cost of success. It costs more money to provide service to additional customers and the cost of the network to serve 60% of the households in the city is $600,000 more than to serve 50%. So it's important to have borrowed enough money to be able to serve the potential customers.

Lowering the Cost of Fiber Drops

As discussed elsewhere in the report, there is probably an opportunity to build fiber drops for a lower cost than what was used in the base study. The base studies include the assumption that drops would be built by the same contractor that builds the network. There are often opportunities to build drops for less using an independent contractor that specializes in drops. In order to get the lower prices would require pre-selling so that the contractor could build a lot of drops at the same time.

Effect of this Change

Aerial & Buried Network	Base Study	Cheaper Drops
Asset Costs	$10.8 M	$10.1 M
Bond Debt	$14.6 M	$13.6 M
Penetration Rates	50%	50%

Years Until Positive Net Income	Year 25	Year 25
Years Until Cash Covers Debt	Never	Never
Cash After 25 Years	($11.8 M)	($9.9 M)

This shows a significant improvement of almost $2 million over 25-years when financing with bonds. That impact is a little less than half when looking at the sales tax-financed scenarios. It is definitely worth exploring building drops for less cost than is assumed in our base studies.

Financing with General Obligation Bonds

This scenario looks at the bottom line impact of using general obligation bonds.

Effect of this Change

Aerial & Buried Network	Revenue Bonds	GO Bonds
Asset Costs	$10.8 M	$10.8 M
Bond Debt	$14.6 M	$13.2 M
Interest Rate	4.0%	3.5%
Penetration Rates	50%	50%
Years Until Positive Net Income	Year 25	Year 25
Years Until Cash Covers Debt	Never	Never
Cash After 25 Years	($11.8 M)	($10.3 M)

This shows there is a difference between funding with general obligation bonds instead of revenue bonds. In this scenario we've assumed that the interest rate on general obligation bonds would be a little lower since there is less risk to bondholders when the bond issue is guaranteed by the full faith and credit of the city's tax revenues. You can also notice that the size of the bond issue is smaller since a general obligation bond shouldn't need any surety such as a Debt Service Reserve Fund.

Overall the general obligation bond improves cash flow over the term of the project by $1.5 million. Since this particular project doesn't look to work with bond funding this might not be very important. However, should you elect to finance part of the project with bonds then this difference matters.

Paying a Higher Interest Rate

We looked at the impact of raising the interest rate on bonds by 100 basis points (one full percent).

Effect of this Change

Aerial & Buried Network	Base Study	Revised Study
Asset Costs	$10.8 M	$10.8 M
Bond Debt	$14.6 M	$15.3 M
Interest Rate	4.0%	5.0%
Penetration Rates	50%	50%
Years Until Positive Net Income	Year 25	Year 25
Years Until Cash Covers Debt	Never	Never
Cash After 25 Years	($11.8 M)	($14.9 M)

As would be expected, a higher interest rate means lower profits and less cash. This shows that this business plan is very sensitive to a change in interest rates. A full 1% increase in interest means borrowing an additional $700,000 and also means that by the end of 25 years the cash generated drops by $3.1 million in order to cover higher debt payments.

We have enjoyed a lengthy period of low interest rates, but there is turmoil in the bond markets today and it's worth keeping an eye on interest rates since higher interest rates could kill a fiber project.

Increasing Customer Prices

This scenario considers raising monthly broadband prices by $5 for all data products for both residents and businesses. The base case below is the one with the buried and aerial network and with sales tax financing.

Effect of this Change

	Base Case	Higher Prices
Asset Costs	$10.8 M	$10.8 M
Sales Tax Funding	$12.3 M	$12.3 M
Penetration Rates	50%	50%
Years Until Positive Net Income	Year 11	Year 5
Cash After 25 Years	$11.0 M	$14.8 M

This shows that the prices charged is one of the most important variables. Raising rates by $5 increases the cash over the 25 years by $3.8 million.

This provides a cautionary tale. One of the first things a new business will often do when getting started is to lower the prices compared to the business plan in an attempt to be more competitive and get more customers. The impact of lowering the prices temporarily for new customers, such as through an introductory special, would be minor. However, as this analysis shows, lowering the prices permanently can devastate the business plan. This also demonstrates the danger of getting into a price war with the competition.

Adding Cable TV

This scenario quantifies the impact of adding a cable TV product to the network. The base study does not include cable TV.

The assumptions used are that you would add a wholesale cable TV product where you buy the product from somebody else and send to your customers. I've roughly modeled this after Skitter TV, but you might be able to buy cable from some other provider in Colorado who operates a cable headend.

Effect of this Change	Base Case	With CATV
Asset Costs	$10.8 M	$11.2 M
Sales Tax Funding	$12.3 M	$12.7 M
Penetration Rates	50%	50%
Years Until Positive Net Income	Year 11	Year 5
Cash After 25 Years	$11.0 M	$10.0 M

This shows the margin impact of adding cable TV is an overall loss of about $1 million over 25-years. While there are some new revenues, mostly from renting settop boxes, the biggest offsetting new expense is to pay for the extra bandwidth needed to bring the signal to Cortez. This affirms the industry belief that there is now little or no profit in the cable business.

However, most of the industry still think a cable product is a needed product to maximize the number of customers. It is still something you want to consider and something you might want to explore in a survey.

Breakeven Analysis

Finally, we looked at what we call a breakeven analysis. This was to determine the minimum number of customers required for a scenario to reach breakeven. This is defined as a projection where the business always maintains enough cash to cover all operating expenses, debt and future capital costs.

Since it does not look feasible for the business to break even using traditional bond financing we instead looked the breakeven number of customers needed of the network is financed with sales taxes.

Our analysis shows that the breakeven penetration rate needed for the mixed aerial and buried network is only 34%. This means that scenario would break even as long as you get that many customers.

Knowing that the breakeven penetration is relatively low takes a lot of pressure off building a fiber business. You'd be a lot more concerned if the breakeven was higher at 50% or above.

But there is a word of caution to note that the breakeven will change with every change of major assumptions, so you shouldn't take the 34% breakeven as gospel, but look at it again as you refine future business plans.

H. Summary of Financial Findings

Financial models are important and can tell us some key things about a potential business. The results show the big picture and show the relative amount of money needed to build and operate a fiber network in the city. The various options explored also show which variables are the most important and how changes in those assumptions impact the amount that needs to be funded and the eventual cash generated.

A Few Words of Caution

Before discussion of the specific things learned from the various business plans, it's important to talk about a few things that always remain unknown until a business is formed. There is always a danger in quoting the numbers derived from the business plans, such as "it's going to take us X million dollars to get this done." As can be seen with the sensitivity analysis, changing a few major variables can greatly change the projected results. That means that a city would need to do a lot more research and pin down the assumptions before launching a fiber business. The better that the key variables can be defined, the lower the risk of the project. Consider the following issues that affect the accuracy of the forecasts and the risk of the business plans:

> <u>Customer Penetration Rates</u>. These models investigate a range of customer penetration rates from 40% to 60%. There is no way to know at this early time what the customer interest in the network is likely to be. But obviously before building a network it's mandatory to understand potential customer demand. Residential customer demand is usually measured using statistically valid market surveys.
>
> We are often asked if there is not a similar way to understand potential business penetration rates. Unfortunately, we have never found a tool like a survey that works for the business market. Many of CCG's clients have undertaken business surveys and none found them to be effective – the results of the survey did not match the number of business customers that eventually connected to the network. This is for several reasons. First, the decision for a business to change telecom providers is not an easy one. We have found that businesses usually care more about reliability than price, and so they won't commit to moving their telecom service to a new network until they have assurance that the new network is reliable.

Further, a survey is only valid if the person responding is a decision maker. It does no good to ask the wrong person in the company if they would be interested in moving service to a new network. Many businesses don't even know who the decision maker will be until the opportunity to change providers arises. It may be that decisions are made by one person or by a committee.

This leads to a natural question of how one might justify building fiber to a business district. The good news is that network providers who have a stable and reliable network will get business customers as long as they have the right sales model. You probably understand this better than most cities since your network already reaches many of the businesses in the city.

Almost universally, sales of broadband and telecom to businesses are done using the consultative sales model. This involves meeting with a business several times. It means getting to understand their business enough to recommend the best solution for them—which might be quite different than what they buy today. Companies that listen to business customers and that craft a solution that best fits them will be successful in the market. We've seen this work many times.

Actual Performance. The actual way that a business is launched can have a huge impact on the ultimate success. To give an example, when Lafayette, Louisiana launched their fiber network they launched with IPTV, which was a new technology at the time. There were significant problems with the performance of the IPTV electronics and software and they didn't get nearly as many customers in the first few years as they had anticipated. The poor performance of the cable product hurt their brand name. They eventually got the cable working right and consequently over the years have grown to be financially successful, but their early start was far slower than their financial projections.

Sometimes success isn't due to anything in particular that a company does. Consider that Google has launched gigabit fiber networks all over the country. They offer the same products and prices everywhere. Nevertheless, they do better in some markets than others and this must be accredited to local market conditions.

There Are Always Risks. There are always financial and operational risks when launching a major new venture. A lot of the risk can be mitigated by doing the needed homework and market research upfront to make sure that the market wants what the fiber network is selling. However, these fiber investments will provide service far into the future and circumstances can change over the long run. Businesses can fail over time for many reasons. It's just as important up front to look at the downside of each business plan as it is the potential upsides. A city needs to make sure they are willing to accept the identified risks.

Even with all of these caveats there is a lot that can be concluded by examining the multiple financial business plan results we've created. We make the following observations from the analysis as follows:

Straight Bond Funding Will Not Work

Probably the most surprising result of the studies is seeing that straight bond funding will not work. There doesn't seem to be any reasonable scenario where the fiber business can support the amount of bond debt needed to build the network. This seems to be a factor of the relatively small size of the market as well as the cost of building the network.

In the CCG proposal we proposed to calculate the breakeven for each scenario, in terms of how many customers a given business plan need to be cash self-sufficient. However, that turns out not to be possible with bond funding since there aren't any cash-positive scenarios.

Open Access Is Not Economically Viable

The analysis shows that an open-access network looks like a poor investment. Even with 50% of the households in the city on the network in an open access environment the city would lose money.

Further, one of the least understood aspects of open access is that there is a distinct trade-off between the prices charged to the ISPs to use the network and the number of customers gained by the ISPs. The fact that the ISPs have to pay anything to get onto the network leads to cherry picking where the ISPs tend to only chase after high-margin customers. That's a natural thing for them to do, but in any market there aren't that many customers that buy the most expensive suite of products. The chances of a network succeeding is reduced if the ISPs are only chasing the top 30% or 40% of customers.

There is also a high probability that with your remote location that you might attract few, if any, ISPs to operate on an open access network. The city of Longmont, CO had this experience recently when they launched as open access and got basically no ISP participation. They quickly decided to operate as a retail ISP in order to salvage their fiber investment.

There might be scenarios where you could layer on open access after first gaining enough retail customers of your own to be financially successful. We don't know any cities that have tried that, but most cities we talk to love the concept of open access, which brings more choices to residents.

Funding with Sales Tax Revenues Looks Promising

The only scenarios that look financially viable use sales tax revenues to finance the network. But we note that this could just as well be property tax revenues or some other form of taxation or fees. The concept with this kind of financing is that the network is paid for from tax revenues that are not reliant on the revenues of the fiber network to repay.

Interestingly, under many of the scenarios we explored, the amount of "profits" made by the fiber business would repay the city (and your citizens) for the upfront investment they made through higher sales taxes for a few years. The main benefit of this financing method is to avoid the high fees and interest rates associated with 25-year revenue bonds. Avoiding those costs makes the business turn from unprofitable to profitable.

There is also an interesting aspect of sales tax financing in Cortez that makes this opportunity even more attractive. Our understanding is that the majority of your sales taxes are paid by people who don't live in Cortez—meaning that you could finance a lot of the network from somebody other than your own citizens.

While we have not modeled it, these results show that it might be reasonable to finance the network with a combination of some traditional bonds and sales tax revenues. There are likely numerous possible scenarios that could be modeled if this is of interest.

A Digital Divide Solution is Possible

One of the most interesting findings is that there are reasonable scenarios where you could bring broadband to every home in the city. You could provide some minimal level on internet access for free to everybody, perhaps 5 Mbps or 10 Mbps download. This would be a way to thank taxpayers for funding the network, but from a social perspective this means that every home, and every student in the community, would have broadband. Practically every city that looks at fiber has universal broadband service as a goal, but almost nobody has achieved it. Our analysis shows that with sales tax financing this is a reasonably achievable goal for the city. It would make you unique and would solve one of the biggest social issues we face today, where students without home broadband significantly underperform those with it.

I. Funding Considerations

One of the most significant costs of building a broadband network is the cost of financing the network. This section of the report looks at ways that other communities have been able to fund a broadband network.

There are a number of different financing options to consider. Below we will look at the following:

- Public Financing (bonds)
- Public Financing (tax revenues)
- Private Financing (loans)
- Grants
- Federal Programs
- Public Private Partnerships

Public Financing

There are two ways that municipalities can finance a new fiber network—through bond financing of some sort or through some other source of tax revenue.

Bond Financing. The two most commonly used kinds of bonds are revenue bonds and general obligation bonds. There are some major benefits of using bond financing. First, the term of the bond can match the expected life of the assets and it is not unusual to find bonds for fiber projects that stretch out for 25 to 30 years. Second, bonds can be used to 100% finance a project, meaning that no cash or equity needs to be put into the business up front. One downside of bond financing is that many kinds of bonds require voter approval.

<u>Revenue Bonds</u>: The primary historic source of public money used to finance telecommunications networks is through the issuance of municipal tax-exempt bonds. Revenue bond are backed by the revenues of the businesses. With a pure revenue bond the city would not be directly responsible for repaying a revenue bond should the project go into default. With that said, having a default would be a financial black eye that might make it hard to finance future projects. Therefore, to some degree the city would still be on the hook for the success of revenue bonds, at least tangentially.

However, it is getting harder to finance a project with revenue bonds due to some failures on the part of other municipal networks. Among these are Monticello, MN; Crawfordsville, IN; and Alameda, CA. These kinds of failures have made investors leery about buying bonds that are only backed revenues of the fiber business. This reluctance has made financing with revenue bonds more expensive.

The cost of a bond issue cannot be judged only by the interest paid. In fact, the other financing costs of bonds usually outweigh the interest rate benefit in the effect on the bottom line cost of repaying a bond issue. Because of market reluctance to buy revenue bonds, they often have higher interest rates than general obligation bonds, but they also can incur the following costs:

> <u>Debt Service Reserve Fund (DSRF)</u>: Many revenue bonds require borrowing additional funds to be kept in escrow as a hedge against missing future payments. The DSRF is often set to equal a year's worth of principle and interest payments. This money is put into escrow and is not available to operate the business.
>
> <u>Capitalized Interest</u>: Bonds begin accruing interest from the day the money is borrowed. Since fiber businesses take a number of years to generate enough cash to make bond payments, the bondholders require capitalized interest that is used to make the interest payments for up to the first 5 years of the project. Basically, the project must borrow the amounts needed to make debt payments which can add a significant amount to the size of the bond issue.
>
> <u>Bond Insurance</u>: Bond insurance is an up-front fee paid to an insurance company that will then pay 1 year of bond payments to bond holders in case of a default. We've seen bonds issued that have required both a debt service reserve fund and bond insurance.

For at least the last decade the interest rates charged to bonds has been lower than the interest rate on commercial loans. However, that has not always historically been the case. The difference between bond interest rates and commercial interest rates both change over time; that difference is referred to in the industry as the "spread." Sometimes the spread favors bonds and at other times it favors commercial borrowing. Interest rates are not the same for all kinds of bonds. For instance, the interest rate for revenue bonds can be considerably higher than general obligation bonds due to the perceived higher risk.

General Obligation Bonds (GO Bonds): If revenue bonds aren't an option then the next typical alternative is general obligation bonds. General obligation bonds are backed by the tax revenues of the entity issuing the bonds. This backing can be in the form of various government revenues such as sales taxes, property taxes, or the general coffers of a government doing the borrowing.

Variable Rate Demand Obligations (VRDOs): The only other kind of bond we have seen used to finance a municipal communications network is a VRDO. These are bonds where the principal is paid in a lump sum at maturity. This is sometimes referred to as a balloon payment. However, the borrower might the right to repay the bonds in whole or in part at any time (upon an agreed upon notice). VRDOs are effective in circumstances when the borrower wants to match the repayment of the bonds to a revenue stream that varies year to year or a revenue stream that can vary from initial estimates and changes over time. In the case of the new telecommunications system, this type of financing provides the flexibility to make bond payments that match the actual revenues received. If revenues are slower than anticipated, principal payments do not need to be made. If revenues come in faster than anticipated, repayment of the bonds can be accelerated without penalty. The only time we know of this being used for municipal telecommunications was in the city of Alameda, California.

Tax Financing

Another idea being used by some cities is to use tax revenues of some sort to directly fund some or all of a broadband project. There are several examples of places where this has been done in the country:

- Leverett, Massachusetts. In Leverett the citizens all voted to raise property taxes to fund and build a municipal fiber project. This is a relatively small town of about 2,000 people, but there was enough demand for broadband that a ballot initiative passed easily to use property revenues to pay for the fiber.
- UTOPIA, Utah. UTOPIA is a consortium of a number of small towns in Utah that banded together to get fiber. They also have pledged property tax revenues to fund part of the cost of the network.
- Cook County, Minnesota. Cook County funded about half of their fiber network using a federal grant awarded from the Stimulus funding program in 2008. The county held a referendum and used a sales tax increase to fund most of the matching funds needed to build the grant.

Our studies look at numerous scenarios with a network funded with sales taxes. It looks like a sales tax increase of 1 cent for roughly six years or ½ cent sales tax increase for roughly 11 years are sufficient to finance the fiber network. The exact length of a sales tax increase will vary according to modifying the most important assumptions in the business plans.

Private Financing

The traditional way for commercial ventures to get financed is through bank loans. The interest rates on such loans are generally higher than bonds. Still, there are some ways to mitigate the financing costs so that a project doesn't have to rely on only bank loans.

Equity: Most forms of private financing require some equity. Equity means that the borrowing entity brings some sort of cash or cash equivalent to the business as part of the financing package. The amount of equity required will vary according to the perceived risk of the venture by the lender. The higher the risk, the more equity required.

Equity can take a number of different forms:

- Cash: Cash is the preferred kind of equity and lenders like to see cash infused into a new business that can't be taken back out or that doesn't earn an interest rate.
- Preferred Equity: For a stock organization (like an LLC or other type of corporation) the business can issue some form of preferred stock that then acts as equity. Preferred equity usually gets some sort of interest rate return, but the payments are not usually guaranteed like they are for bank loans. If the business gets into a cash crunch they must pay bank loans and other forms of debt before they pay preferred equity interest.
- Assets: It's possible to contribute assets as equity. For example, a new fiber venture might be seeded by having one of the partners contribute an existing fiber route or other valuable asset to the business. In such a case the contributed asset generally has to be assigned a market value by an independent appraiser.
- Nonrecourse Cash: Nonrecourse cash would be taking cash in an obligation that is not guaranteed to be paid back. To give an example, in Sibley and Renville counties in Minnesota, a fiber business was recently launched in the form of a cooperative. The local government provided an economic development bond to the business as a nonrecourse loan. This means that the new fiber business will make their best effort to make the bond payments, but if they are short of cash then the government entities who issued the bonds would have to make bond payments. The other sources of financing for that project looked upon these bonds as a form of equity.

Bank Loans: While there are around 150 municipal fiber ventures in the country that largely have been financed through bonds, most of the other fiber networks in the country have been financed with commercial lending sources. Most fiber projects have been built by for-profit communications companies or by cooperatives.

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. Prior to 50 years ago, banks would fund things like power plants, electric and water systems, and other long-term revenue-generating assets. However, 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.

Most banks prefer not to make loans with a term much longer than 12–15 years, and very few telecom projects can generate enough cash in that time period to pay for the original investment. Bank loan rates are generally a few percentage points higher than bond rates, which also makes it harder to prove feasible.

In addition, bankers generally expect a significant amount of equity from the borrower. The banking industry has gotten much more conservative over the last decade and they now might require 40% equity where a decade ago for a similar project they might have required 20% equity. Since fiber projects are relatively expensive, it’s difficult to raise the kind of equity needed to make a project work.

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 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 adverse to start-ups and prefer to make these kinds of loans to existing 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 and a cooperative. This bank has financed hundreds of telecom projects, mostly for independent telephone companies. 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 somewhat high interest rates and somewhat short loan terms of 10–12 years.

The final source of bank financing is local banks. Historically local banks were the source in many communities for car and home loans. However, 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 in 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. They 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.

Comparing Bond and Bank Financing

Benefits of Bond Financing: There are several major benefits for using bond financing:

- The term of the bond can match the expected life of the assets and it is not unusual to find bonds for fiber projects that stretch out for 25 to 30 years. It's difficult to finance a commercial loan longer than 15 years. The longer the length of the loan, the lower the annual debt payments.
- Bonds can be used to 100% finance a project, meaning there is no need for cash or equity to fund the new business. Lack of cash equity is generally the most challenging requirement for commercial fiber builders.
- Bonds often, but not always, have lower interest rates. The interest rate is dependent upon several factors including the credit-worthiness (bond rating) of the borrower as well as the perceived risk of the project.
- It's generally easier to sell bonds than to raise commercial money from banks. Sometimes bonds require a referendum, but once bonds are approved there is generally a ready market for buying the bonds and raising the needed funds.

Benefits of Commercial Financing: There are also a few benefits for commercial financing.

- Generally the amount that must be borrowed from commercial financing is lower, sometimes significantly lower. This is due to several issues associated with bond financing. Bond financing often contains the following extra costs that are not included with commercial loans:
    - Surety: Bonds often require a pledge of surety to protect against default of the bonds. The two most common kinds of surety are the use of a debt service reserve fund and bond insurance. A debt service reserve fund (DSRF) borrows some amount of money, perhaps the equivalent of 1 year of bond payments and puts it into escrow for the term of the bond. They money just sits there to be used to help make bond payments should the project have trouble making the payments. Bond insurance works the same way and a borrower will prepay an insurance policy at the beginning of the bond that will cover some defined amount of payments in case of a default.
    - Capitalized Interest: Bonds typically borrow the interest payments to cover bond payments for some period of time, up to 5 years.
- Construction Loans. Another reason that commercial financing usually results in smaller debt is through the use of construction loans. A commercial loan will forward the cash needed each month as construction is done, and interest is not paid on funds until those funds have been used. However, bonds borrow all of the money on day one and begin accruing interest expense on the full amount borrowed on day one. Construction loans also mean that a borrower will only draw loans they need while bond financing is often padded with a construction contingency in case the project costs more than expected.
- Deferred Payment: Commercial financing often will be structured so that there are no payments due for the first year or two. This contrasts with bonds that borrow the

money required to make these payments. Fiber projects, by definition, require several years to generate revenue and deferring payments significantly reduces the size of the borrowing.

- Retirement of Debt: It's generally easy to retire commercial debt, which might be done in order to pay a project off early or to refinance the debt. This contrasts to bonds that often require that the original borrowing be held for a fixed number of years before it can be retired or refinanced.

Grants

We don't know of any specific grant programs that might benefit building a fiber network in Cortez.

Federal Grants. There are a few federal grant programs that are aimed at bringing broadband to the poorest communities in the country. The most consistently available grant is the Department of Agriculture "Community Connect Grants." However, these grants generally go only to communities with extreme poverty such as on Native American reservations.

2018 Broadband Grants. Congress approved a $600 million grant program for broadband in the 2018 operating budget. But there are a few restrictions on these grants that make them largely unavailable in Cortez. First, the grants can only go to finance project where at least 90% of households don't have access to broadband with speeds of at least 10/1 Mbps. In Cortez everybody has broadband available that is faster than that. These grants are largely targeted at rural places where households have no broadband options.

Federal Infrastructure Funding. There is still a lot of buzz in Washington DC about creating a larger infrastructure program, in the billions, that would include substantial funding for broadband. However, the discussion coming out of Washington suggests that these funds, if ever approved, will be aimed at communities without broadband.

Colorado Broadband Grants**.** The Broadband Deployment Board was established through a House Bill (HB14-1328) to provide grants for broadband access to unserved communities through the Broadband Fund. The Broadband Deployment Board within the Department of Regulatory Agencies (DORA) has awarded $10.9 million in grants since 2016 in an effort to close the broadband internet service gap between rural and urban Colorado communities. Sixteen infrastructure projects received Broadband Fund grants. As a result, over 13,000 rural homes and businesses across Colorado will benefit from Broadband Internet access. The fund can provide up to 75% of infrastructure project cost of a proband project.

There are a number of restrictions that means that these grants are not available to the city:

- The grants are aimed at rural Colorado in places where there is no existing broadband network.
- The grants can only be awarded to for-profit entities, with a few exceptions. For example, there can be an exception made for a nonprofit telephone cooperative or a nonprofit rural electric association that existed on May 10, 2014. But this means grant funding is not available to municipal entities.

Federal Loan Guarantee Programs

Another way to help finance broadband projects is through federal loan guarantees. A loan guarantee is just what it sounds like. Some federal agencies 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 significantly 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. 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 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 part of a fiber project.
>
> **Small Business Administration 504 Loan Program**: This program by the SBA provides loans or loan guarantees to small start-up businesses. These loans or loan guarantees must be made in conjunction with a bank, with the bank providing some loan funds directly and with the SBA loaning or guaranteeing up to 50% of the total loan.
>
> **USDA Business and Industry Guaranteed Loans (B&I)**: The Department of Agriculture provides loan guarantees through the B&I program to assist rural communities with projects that spur economic development. Such a project must, among other things, provide employment and improve the economic or environmental climate in a rural area. These loan guarantees are available to start-up businesses. The program can guarantee up to 60% of a loan over $10 million or greater percentages of smaller loans.
>
> **Rural Utility Service (RUS)**: This is a part of the Department of Agriculture. They also can provide loan guarantees. These come with the same sorts of issues associated with the loans. However, these loans and loan guarantees can only be used in communities have populations of less than 20,000, which would exclude Davis. Nevertheless, it might be possible to consider this funding if the city wanted to build to the rural areas surrounding the city.

Direct Customer Contributions

It’s also possible to pay for some of a broadband project through direct contribution of possible customers. This has never been done on a large scale because it would be exceedingly difficult to get a lot of residents to agree to write a check to fund a network. However, there are some examples to consider:

- Contribution to Aid in Construction. Most utilities have a program where they will agree to extend their network to customers if those customers agree to pay the cost of the connection. We are aware in the broadband area of numerous cases where small pockets of rural homes raised the needed money to get connected to a nearby broadband network.
- Ammon, Idaho. This is the only municipal attempt at funding a network in this way. The City of Ammon will connect customers to a fiber network if they will contribute $3,500 up front to cover the cost of construction. This program is just getting started and it reportedly has a few hundred homes interested. However, it’s an unusual combination of a city prompting citizens to pay for the needed network themselves.
- San Francisco. The city has floated the idea of charging every home and business a “utility fee.” This fee would be used to generate bonds to pay for the construction of a fiber network. The city would then open up the new network to all ISPs in an open-access environment. The ISPs would get free (or very inexpensive) access to the network, allowing them to offer broadband at affordable low rates.

IV. Other Considerations

A. Competitive Responses from Incumbents

This section of the report looks at the expected competitive response from TDS and CenturyLink, the two incumbent providers in the market.

TDS Telecom (TDS) as a Competitor

TDS is the incumbent cable provider in Cortez. As such they operate a hybrid/fiber coaxial network that provides traditional cable services including the triple play of cable TV, broadband, and telephone service. TDS was founded in 1969, is the seventh largest telephone company in the country, and is headquartered in Madison, Wisconsin. Most of the company consists of operating numerous regional telephone companies that the company has purchased over the years, and almost all of their other networks use telephone copper or fiber. While the company operates in a few larger cities like Madison, Wisconsin, most of its properties are rural.

In additional to the typical array of residential services the company also offers business services, such as business Internet phone bundles, phone and VoIP solutions, Internet and security, managed services, data networking, and phone systems. In addition, it offers business resource centers. It connects rural and suburban communities in the United States. TDS Telecommunications Corporation operates as a subsidiary of Telephone and Data Systems, Inc.

TDS also owns US Cellular, a company that it founded in 1983. Between all of its subsidiaries the company now has over 6 million customers and had revenues of over $5 billion in 2017, with US Cellular providing $3.9 billion.

Since the company is largely rural there are not a lot of examples of other companies or municipalities overbuilding a TDS market with fiber. But there is one example in Monticello, Minnesota. In that market the city sold bonds to build a fiber network to compete with TDS, the incumbent telephone provider and Charter, the incumbent cable company.

Immediately after the city sold the revenue bonds to build the fiber network, TDS sued the city and challenged their authority to build and operate a fiber network. It was fairly obvious to experts that the city did have such authority since there were already a few other cities in the state that had built broadband networks. TDS eventually lost the lawsuit, but the city was delayed from using the proceeds of the bonds and building the network until the lawsuit was resolved. The loss of market momentum as well as the accumulated interest expenses on the bonds put the city at a major financial disadvantage and they have struggled since then to be cash positive. TDS also responded to the Monticello network by building an FTTH network of their own, making Monticello perhaps the only city in the US that has two competing FTTH networks.

This is not to say that TDS would sue Cortez, but it’s a risk since there have only been a few cases where an incumbent provider sued a city to try to stop construction of a fiber network.

TDS says that they are in the process of upgrading their cable network to the new DOCSIS 3.1 standard. This will allow them to offer broadband speeds as fast as 1 Gbps download, but still much slower on uploads. This will make them a formidable competitor in terms of being able to offer a comparable broadband service to compete with fiber.

TDS is also likely to compete with “special” pricing. This is a tactic used by most cable companies in competitive markets where they offer low contract rates for a year or two to new customers or existing customers that call to ask for lower prices. Many customers find the special prices attractive, even though customers often get tired of the specials over time since the prices typically revert to list prices at the end of the contract period.

CenturyLink as a Competitor

CenturyLink is the third largest telephone company in the country with headquarters in Monroe, Louisiana. Several years ago the company purchased Qwest, which was formerly Mountain Bell and US West, and was part of the Bell Telephone system. CenturyLink had annual revenues in 2016 of $17.5 billion.

As the incumbent provider, CenturyLink is considered the “provider of last resort” in its service areas. This means that CenturyLink is required to serve all residential and business customers for basic local services, and it must provide facilities to all customers. The rules that govern the way that CenturyLink serves customers in the state are embodied in their “General Customer Services Tariff,” which is approved by the Colorado Public Utilities Commission. This tariff contains all of the regulated products and prices, along with the terms and conditions under which CenturyLink will sell them to customers. The tariff sets forth rules for such customer service procedures as the manner and amount of customer deposits, the rules by which they will disconnect service for nonpayment, and the rules by which they will reconnect service. Over the last decade CenturyLink has asked states to deregulate many services as competitive and remove them from regulation.

As a telco, CenturyLink sells the full range of residential and business voice services. CenturyLink also sells data products. They sell traditional TDM voice services based upon multiples of T1s. They also sell high-speed DSL service. CenturyLink has been upping those speeds in some markets by installing new DSL equipment. For instance, in some major cities CenturyLink now supports DSL products with speeds up to 25 Mbps. But these faster DSL upgrades have not made it to smaller markets like Cortez. Even when DSL is fast, not all customers can get the fast speeds. Some of the factors contributing to slower speeds include the distance the customer is from the CenturyLink central office and the age and size of the copper wiring in a neighborhood.

CenturyLink also builds fiber to some business customers and can sell a gigabit speed broadband. In recent years CenturyLink has invested significant capital in improving data speeds in metropolitan areas. For example, in 2016 the company built fiber to pass 900,000 homes in major markets like Seattle, Phoenix, Denver, and the Twin Cities. But there is no expectation that they are ready to invest in fiber in smaller markets.

CenturyLink also offers cable TV where the broadband is fast enough. The company, however, announced as this report was being written that they were not going to expand their Prism footprint into new markets and might stop selling it to new customers. In most markets CenturyLink partners with DirecTV for a cable product. The CenturyLink technicians install the satellite service and CenturyLink bills for the DirecTV on the telco bill. They also give a bundling discount, making it cheaper to buy DirecTV through CenturyLink than buying it direct.

For the most part CenturyLink has not responded significantly to new competitors. They will step up marketing specials when somebody is building a new network, but they seem to recognize that they can't compete on broadband speeds. Even though the company is now investing in fiber, we've not seen them yet build fiber in response to a competitive threat.

As this report was being written CenturyLink has indicated a change in direction of corporate strategy. The long-time CEO of the company, Glen Post, has said for several years that improving residential broadband performance was the primary company goal. The company has been improving DSL and in 2017 fiber-to-the-home to pass 900,000 homes. The merger with Level 3 is setting a new trajectory for the company. Glen Post is being forced out and Jeff Storey, the former CEO of Level 3 is taking the helm. He's said that the focus of the company needs to concentrate on the high-margin enterprise markets and that anything with low returns, like building infrastructure for residential broadband will be de-emphasized. This probably means no new FTTH construction, but it also means that DSL is likely to be allowed to die a natural death like is happening with AT&T and Verizon. The long-term consequence of this is that the cable companies will grow to become de facto monopolies in markets where there is no fiber competitor.

Summary

The clear competitor to a city-owned fiber network in Cortez is TDS. They are likely to compete with significantly discounted broadband packages that include much faster broadband speeds than the current speeds in the market due to the upgrade to their upgrade to the DOCSIS standard that controls the network. There is at least some chance that TDS might even sue the city or in some way try to put up a roadblock to you getting into the retail broadband business.

While CenturyLink is likely to continue to sell DSL as a low-price alternative to cable broadband, the fact that the company is de-emphasizing DSL means that there are no likely improvements coming for DSL speeds and that the product will deteriorate over time due to lack of capital maintenance, as we've seen with other companies like Frontier, AT&T and Verizon.

There is also likely to be increased competition over the next decade as cellular speeds improve and attract customers who are happy with a cellular connection rather than a landline broadband connection. There is also the chance that some provider will bring 5G fixed wireless to the market and compete directly with the city and the incumbent providers – but 5G requires significant amounts of fiber and Cortez is probably not high on the list as a target market for a 5G overbuilder.

B. Benefits of Broadband

One of the questions we are always asked is why a city might consider building a broadband network. Following are some of the reasons why other communities have built or are thinking about building a fiber network.

Choice

Customer choice is going to become a significant issue over the coming decade. It's clear that the copper wires in incumbent telephone networks are aging, and at some point they won't support DSL. Even today, the DSL speeds available in Cortez are slow and can barely be considered as broadband. It's not hard to imagine a time when DSL quietly dies and the only choice for broadband in the city would be the TDS cable network. Without a second competing network it's possible that TDS in Cortez (and cable companies in most markets) will become virtual broadband monopolies. Communities everywhere are nervous about the behavior of any broadband provider that has monopoly power, which generally leads to higher prices and less concern with customer service.

A fiber network in the community would mean competition for TDS. We've seen vigorous competition in markets that have a high-speed alternative to the cable network. One only has to compare broadband products and prices in places where Google Fiber or a municipality has built a second network to see that it makes a difference. We see that broadband speeds are faster and broadband prices are lower in markets with competition.

Digital Divide/Affordability

In every city there are households that can't afford broadband. Since national broadband penetration rates are now approaching 85% this means that the percentage of residents that want broadband but can't afford it is probably between 10% and 15%.

The issues associated with not having home broadband are well known. It's hard to raise kids in a home where they can't do electronic homework. It's now harder to exist in a society where so many of the things we do have moved online. Someone without broadband can't easily work from home. They can't interface with online city services. They can't easily hunt for a job if unemployed. They can't take online job training. They can't even save money by shopping online.

A municipal network might afford the opportunity to bring broadband to those that can't afford it. This study looks at a few digital divide options for you to consider. Cities that build their own fiber networks usually have solving the digital divide as one of their primary goals. They understand that the community will be stronger if everybody is connected to the Internet. That will be more important in the future as cities start implementing smart city technology to provide better digital access to city services.

Education

The need for home internet access to every single K-12 student is vital. With 21st century schools and the rapid speed of digital learning, students without internet at home are at a significant disadvantage. We must warn, however, that none of the larger municipal networks that have already been built have fully solved the digital divide issue—but a number of them are now considering solutions. Cities with fiber networks have made some progress. For example, many cities have brought broadband to public housing. Many have provided public WiFi hotspots to provide better access to the Internet. Nevertheless, none other than some tiny communities have yet found a way to afford to connect everybody to fiber.

Healthcare

Fiber offers two advantages to a city like Cortez that is geographically remote. With a good broadband connection, citizens can take advantage of telemedicine to visit with doctors in larger cities rather than make the long drive. Broadband also holds the opportunity for the elderly to remain longer in their homes. There are numerous companies working on technologies to meet this demand and the expectation is that within a decade this will become a common service. These technologies are likely to require good upload speeds.

Economic Development

Cities can use a fiber network as a tool for economic development. Cities also often use a fiber network to offer low-cost connectivity as a lure to bring new businesses to the city. Possibly of even greater value is that a fiber network can help to keep the existing businesses within a city from leaving. One of the fastest growing segments of the economy is people working from their homes. A good broadband connection can allow people in the community to get jobs with companies located elsewhere and is becoming a key factor for economic development in rural and remote communities.

C. Financial and Execution Risks

It might be easy for somebody reading this study to believe that it is pro-fiber and that it recommends building fiber. But we also understand that there are risks from spending the large amount of money on a fiber network that should be considered as part of the deliberation to build a fiber network.

Competition from Other Technologies

While fiber is considered as the ultimate broadband technology, meaning there is no realistic cap on the amount of bandwidth that can be delivered over fiber, there are other technologies that will compete with fiber in the market place. While many of these technologies may not be as fast as the capabilities of fiber, to the extent that they satisfy the broadband needs of segments of the market they will make it harder for a fiber network provider to generate revenues.

DOCSIS 3.1—Gigabit Cable Network

TDS uses a technology called DOCSIS (Data Over Cable Service Interface Specification) to insert broadband onto its coaxial copper network. The technology was developed by CableLabs, which is a research and standards organization that the cable companies have created for research and development purposes. DOCSIS 1.0 was first issued in 1997 as a standard and created the basis for cable modems. Since then the technology has undergone several major upgrades that were named DOCSIS 2.1 and DOCSIS 3.0. TDS says they will be upgrading to DOCSIS 3.1 in the city which will allow for broadband speeds up to 1 Gbps download.

5G Millimeter Wave Microwave

There are two different technologies being referred to as 5G. The one that will be seen in the market first is the use of 5G standards and millimeter wave spectrum to deliver gigabit microwave to customers. For the past twenty years this same technology has been referred to as wireless local loop, but in the broadband world the term 5G has marketing cachet. The technology involves transmitting a microwave beam from a tower or similar location to the customer premises.

This technology has been around for a long time, and in fact it was the use of microwave radios in the 1970s that helped MCI break the Ma Bell monopoly. However, the new technology will carry significantly faster broadband than current technologies. This is due to the spectrum being used. In what is already being called the 5G Order, in Docket FCC 16-89 the FCC released a lot of new spectrum. Quoted directly from the FCC Order the new spectrum is as follows:

> *Specifically, the rules create a new Upper Microwave Flexible Use service in the 28 GHz (27.5-28.35 GHz), 37 GHz (37-38.6 GHz), and 39 GHz (38.6-40 GHz) bands, and an unlicensed band at 64-71 GHz.*
>
> - *Licensed use in the 28 GHz, 37 GHz and 39 GHz bands: Makes available 3.85 GHz of licensed, flexible use spectrum, which is more than four times the amount of flexible use spectrum the FCC has licensed to date.*
> - o *Provides consistent block sizes (200 MHz), license areas (Partial Economic Areas), technical rules, and operability across the exclusively licensed portion of the 37 GHz band and the 39 GHz band to make 2.4 GHz of spectrum available.*
> - o *Provides two 425 MHz blocks for the 28 GHz band on a county basis and operability across the band.*
> - *Unlicensed use in the 64-71 GHz band: Makes available 7 GHz of unlicensed spectrum which, when combined with the existing high-band unlicensed spectrum (57-64 GHz), doubles the amount of high-band unlicensed spectrum to 14 GHz of contiguous unlicensed spectrum (57-71 GHz). These 14 GHz will be 15 times as much as all unlicensed Wi-Fi spectrum in lower bands.*

The US is the first country to authorize specific use of the spectrum in these upper bands, which have commonly been referred to as millimeter wave spectrum. Moreover, the FCC isn't yet finished and is also now looking at 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.

By definition, the higher a radio frequency, the more data can be transmitted. This is due to the fact that radio technology uses the peaks and valleys of the radio waves to transmit the digital ones and zeroes needed to pass information.

However, there is a trade-off for using higher frequencies in that the higher the frequency, the shorter distance the frequency can be broadcast before it spreads and loses signal integrity. This means that 5G millimeter wave transmitters will need to be relatively close to customers. And that means that a 5G network is going to require a lot of fiber close-by to customers.

For now these radios are relatively expensive and it's unlikely that the technology will be used to serve residences and small business. Instead, this technology will be used to serve larger business, MDUs, and other users that spend a lot for big bandwidth pipes. Effectively, this new technology is a last-mile competitor for fiber. That would make millimeter wave radios a competitor to a city-owned network in that this could be used to provide service to MDUs and to the largest businesses in the city.

The first use of this technology is in urban downtowns where transmitters can be placed on the top of tall buildings to create gigabit paths to other buildings. However, there are a number of hurdles that must be overcome before this technology makes it suburbia or to smaller towns:

- One of the primary issues will be finding a place to place the transmitters. In smaller cities without big high rises this will mean somehow placing transmitters on poles—and it requires those poles to be fiber fed. There is a huge nationwide discussion of how to streamline the process of providing access to poles for the wireless transmitters. However, absent from much of that same discussion is to ask who is going to build the fiber to get to the poles.
- The technology needs nearly a pure line-of-sight and there can be zero impediments between transmitter and receiver (such as foliage). These frequencies are disrupted by almost everything and can't pass through walls or anything else.
- These radios are relatively expensive for now, and the prices will have to drop significantly before this technology can be considered for any but the largest broadband customers.

5G Cellular

The other use of 5G is as the next generation of cellular service. Unlike the transition from 3G to 4G cellular, the new 5G is not expected to replace 4G, but rather to work in conjunction and enhance cellular broadband.

The cellular companies are likely to start claiming to have 5G cellular as soon as this year. But that is more marketing than reality. The new 5G standards include a lot of network changes, and as soon as any of those changes are added to network the marketing folks will start touting their networks as 5G. The same thing happened with 4G, and while the technology has now been around for almost 10 years, we are just now seeing cellphones that use the whole set of capabilities in the 4G standards.

There are already field tests of the 5G millimeter technologies discussed above. However, the conversion to true 5G cellular will be on a much slower path. Following is the expected industry timeline.

- 2019/20: Formal final specifications
- 2021: Initial production service rollouts
- 2025: Critical mass
- 2030+ - Phase-out of 4G infrastructure begins

There is a lot of discussion of 5G cellular being capable of gigabit speeds. Theoretically this is possible, but there are a lot of reasons why this isn't going to happen for decades, if forever.

- To achieve that kind of speed requires combining a lot of different frequencies into one transmission. That requires complicated and sophisticated antennas. That is always going to present a challenge for cellphones because supporting multiple frequencies adds to the cost, the power consumption, and the size of a cellphone.
- The frequencies used only travel a few hundred feet on a broadcast basis (about the same distance as a WiFi hot spot). That means there would have to be multiple cellular transmitters everywhere to achieve the needed coverage. We are a long way from developing inexpensive cellular transmitters that could meet this requirement.
- The technology also needs pure line-of-sight. This is easier to achieve with a fixed microwave path, but hard to achieve in use of a cellphone. A person's body would effectively block the signal, and that means needing a lot of small transmitters so that one could see a cellphone at any given time.
- Finally, this means building fiber everywhere. While this kind of technology might make sense in dense urban business districts, it's hard to envision somebody spending the needed investment in fiber to bring this technology to residential streets or open areas in cities. Deloitte recently estimated that the cost to build the fiber to support a 5G cellular network is $160 billion.
- Finally, this takes economy of scale. Nobody is going to build the handsets if there aren't enough places where this would work. Nobody will build the networks if enough people don't have the handsets. There are some analysts saying this might never happen.

For these various reasons it's unlikely that we will have 5G gigabit cellular for a long time. However, there will be the use of some of the capabilities of 5G cellular coming within a few years. The specifications for the 5G standard establish the goal of providing large numbers of cellphones in a given area able to receive 50 Mbps speeds. The goal is to eliminate the blocking that happens today when people can't make a connection in a busy environment.

50 Mbps cellphones will probably become a significant competitor to landline broadband networks, particular for younger consumers. To put 5G into perspective, the average 4G connection today is between 10 Mbps and 15 Mbps (depends on who is measuring the speeds). Even those speeds are adequate today to watch a single video stream on a cellphone. The 5G standard also has the goal to significantly lower latency, and the latency on a cellphone is the primary reason that a cellphone connection feels slow today. With no latency, a 15 Mbps satellite connection would feel a lot faster.

Satellite Broadband

Late last year Elon Musk announced that his SpaceX company is moving forward with attempting to launch low earth orbit (LEO) satellites to bring better satellite broadband to the world. His proposed to the FCC to launch 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. Each satellite would be roughly the size of a refrigerator and would be powered by a solar array.

Musk's proposal has some 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—about the same experienced in a cable TV broadband network. This is much better than the 600 millisecond delays achieved by current satellites. This means that Musk's proposed network could 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. The FCC filing is technical, but an interesting read: https://cdn.arstechnica.net/wp-content/uploads/2016/11/spacex-Technical-Attachment.pdf

The specifications say that each satellite would have an aggregate capacity of between 17 and 23 Gbps, meaning each satellite could theoretically process that much data at the same time, although realistically they would probably max out at 80% of that capacity (as do all broadband transmission methods).

The specifications say that the network could produce gigabit links to customers, although achieving that much speed would require making simultaneous connections from numerous satellites to one single customer. Moreover, 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 to a lot of customers.

Depending upon how this is priced this would create another competitor to landline broadband networks. A customer would need a dish to receive the broadband, similar to the dishes used to receive satellite TV today.

It's an intriguing idea, and if it was offered by anybody else other than Elon Musk it might sound more like a pipedream than a serious idea. He's said the idea requires at least $10 billion to launch, but Musk has shown the ability to launch cutting-edge ventures before. There is always a ways to go between concept and reality and like any new technology there will be bugs in the first version of the technology. Nevertheless, assuming that Musk can raise the money, and assuming that the technology really works as promised, this could change broadband around the world. The real beneficiaries of this technology, if it happens, are places with no broadband—rural America and a lot of the third world.

Competitive Market Risks

TDS Gigabit Speeds. It's impossible to talk about broadband speeds without acknowledging that TDS is upgrading its networks to support gigabit broadband. In doing so it's likely that they will also increase the speeds on their base products.

There are those that argue that fiber broadband is superior. On fiber it's easy to offer symmetrical speeds. This would be a challenge for a cable network, even with DOCSIS 3.1, but it's theoretically possible. But most customers don't care about upload speeds and will find the faster DOCSIS speeds to be adequate. When cable networks are faster, then fiber broadband will not be a "must buy" for many households.

Erosion of the Traditional Triple Play. Both cable TV service and telephone service are declining as revenue-generating products for ISPs. Nationwide the number of households that have a telephone landline is down to a little over 40%.

In the cable market the much-talked-about phenomenon is cord cutting. In 2017 the industry as a whole lost over 2.4 million homes cable subscriptions—either from a landline cable company or one of the satellite TV providers. This phenomenon seems to be accelerating.

Cable TV service is not going to disappear for a long time. So far this has hardly been much more than a blip on the industry and nationwide the number of homes with traditional cable just dipped under 90 million.

The trends in both of these market segments has to be of concern to a fiber network builder. Today, since over 70% of homes buy traditional cable, a new network provider generally feels obligated to offer cable TV to be a success. Google Fiber learned in Kansas City that a lot of homes won't change without cable as part of the new bundle.

The financial concern is that these products generate margins that help to pay for a network. The costs of operating a fiber network increase over time due to inflation. Since it's likely that a fiber network build would be financed for a long period of time, perhaps 25 years, there has to be a concern that the loss in margin from these products doesn't put the company at risk over such a long time period.

Nobody has a crystal ball and can predict what might happen to cable TV. For example, it might become possible for cable companies to offer a la carte cable lineups (selling just those channels that customers want to buy). That's not allowed today because of federal cable rules established by Congress and regulated by the FCC. However, there could be a change that would result in some different version of cable TV service to be around and be successful for a network operator. Nevertheless, traditional cable TV could also go the way of landline telephones and continue to shed customers year after year until it is greatly diminished.

Shifting Demographics. It's becoming clear that the younger generations in the US don't watch as much video as their parents and grandparents. Nielsen, the company that tracks TV viewership, recently published a report that quantified the difference in generational viewing of video content.

What might surprise a lot of people is that Generation Z and the Millennials together now make up 48% of the US population—and that means their viewing habits are rapidly growing in importance to the cable TV industry. The biggest finding from the Nielsen research is that the daily time spent using various entertainment media that includes such things as TV, radio, game consoles, and surfing the Internet varies significantly by generation.

For example, the average monthly TV viewing for those over 65 is 231 hours of live TV and 34 hours of time-shifted TV. However, for people aged 12-17 that is only 60 hours live and 10 hours time-shifted. For ages 18-24 it's 72 hours live and 12 hours time-shifted. For ages 25-34 it's 101 hours live and 19 hours time-shifted. The amount of viewing by Generation Z is decreasing from quarter to quarter.

Other research done by Nielsen over the last few years suggests that the viewing habits that people pick up as kids stick with them for life. Therefore, we need to recognize that the youngest generations are not likely to value traditional programming, or ISPs that offer traditional cable, as much as current adults.

There hasn't been this kind of massive study of broadband usage by generation. Nevertheless, the surveys and research that has been done suggests that Generation Z is largely satisfied with the level of broadband they get in a cellphone. Over time this might mean downward pressure on home broadband connections. This trend might be further exacerbated by a few other trends. First, we see that cellular providers are starting to include video content as part of the cellular package—such as T-Mobile recently including Netflix. Moreover, as discussed earlier, we also ought to see cellular data speeds improve over time, making them a reasonable alternative to landline broadband for some segment of demographics.

Operational Market Risks

There are also a few potential operational issues that the city needs to think about as part of considering building a fiber network.

<u>City as the ISP</u>. Many cities are concerned about the ability to operate a retail ISP in a competitive environment. Cities are generally not as nimble as commercial companies and don't always have a competitive mindset.

<u>Launch Issues</u>. One lesson that has been learned a number of times in the telecom industry is that it's hard to overcome a poor network launch. If a new network owner makes big mistakes at the beginning it can take many years to recover the confidence of the public in the network and in the business. Early network issues can be of many kinds. For example, we've seen new networks launched that had numerous network outages for the first year until the operator became fully comfortable with all of the nuances of their specific network. While network electronic technology has made great strides since FTTH was introduced, it's still a complex network and little issues can cascade to outages if not controlled properly.

New network providers can get a poor reputation in other ways. One example is the FTTH network in Lafayette, Louisiana which suffered from huge problems with their video product. This was due to their vendor, Alcatel, not delivering the product that was promised in their response to the original RFP. The TV was so bad that many customers dropped the product and a lot more customers decided not to try the new network. The city fixed the video problems in a year or two but it took many more years to overcome the launch problems and the public perception of the fiber business.

Sales and Marketing. One of the biggest risks of launching a new broadband venture is a poorly executed sales and marketing program. A network can't succeed without getting the needed customers. A new network can generally count on getting some level of customers that either dislike the incumbent providers or who perceive huge value in the new fiber technology. However, after that first wave of customers, getting the rest of the customers needed to be successful is hard work.

Risks of Operating Losses. It's always of concern for any city-owned venture to lose money. The city is already aware of this issue in operating your wholesale fiber network. The city needs to have a plan up front for how it will handle a situation if the revenues generated from the business don't cover the cost of the debt used to build the network. Many new fiber ventures find themselves with operating losses. Cities with electric utilities sometimes cover these losses by using electric cash reserves or even in raising electric rates. Commercial ventures that are part of a larger company can be covered for a while by the parent company.

However, standalone fiber ventures, either municipal or commercial, run a much greater risk. A standalone commercial venture that runs out of cash generally folds. In a municipal venture the only recourse might be to somehow cover losses from tax revenues.

A city can try to shield against operating losses by using revenue bonds that can shield tax revenues from shortfalls. But if a revenue-supported fiber network fails, and if the city won't jump in and support it with tax revenues, then the new venture will have to go out of business just like commercial operator. A city needs to ask the question up front of how it might cover operating shortfalls.

The Cost of Success. In the telecom world there is a phenomenon we call the cost of success. It's costly to add a new customer to a fiber network and if a new venture does better than expected, then a new fiber owner could find themselves without the funds needed to add new customers.

One way to handle this situation would be by issuing a second bond to pay for adding more customers. However, that is not always practical or possible for a city. Moreover, in most places, even a small bond takes a long time to approve and issue.

On the flip side, you don't want to borrow too much money and have the extra funds create interest costs for 25 years.

Operating Life of Fiber. How long does the fiber in a new network last? The answer is—it depends. There are a few factors that influence the life of fiber.

One important issue is how the fiber is installed. While fiber is tough, it can be stressed during construction, which can significantly shorten its life. The number one cause of fiber damage during construction is damage caused when pulling fiber through ducts. There is almost no damage caused by either blowing or pushing fiber, making those the safest installation techniques. However, it's possible to overstress fiber when pulling, which will eventually result in it developing opacity. The opacity in fiber grows over time as very tiny cracks and stress points in the fiber grow larger and start deflecting light.

The second biggest problem affecting the life of fiber is the number and quality of splice points. Over time, as fiber expands and contracts from temperature changes, each splice point can shift tiny amounts and degrade the connection. Luckily, some of the damage from shifting splices can be fixed by resplicing the fibers as they go bad over the years.

The biggest problem does not come from the original splices, assuming they were done correctly, but the splices added later to the network to make repairs for fiber cuts or to add a new customer in a location not contemplated by the original design. Any given fiber run deteriorates a tiny amount every time a new splice is introduced. Over time, too many splices can ruin a given strand of fiber.

Fiber has gotten better over the years as manufacturers have improved techniques. Today's fibers are nearly perfect out of the manufacturing process and ought to last longer than fibers made thirty or forty years ago. The manufacturers have adopted techniques such as pre-stressing fiber during the manufacturing process (pulling it slightly) which pulls out any tiny flaws to keep them from getting bigger.

Material scientists have been studying fiber since the 1980s and they have built models to predict how long fiber will last if properly installed. They look at all of the factors that can cause failure—how it was made, the presence of tiny flaws, factors that can cause cloudiness, the protection provided by the sheath, etc. What they found is reassuring. Studies have shown that properly installed fiber will only have a chance of failure at a rate of 1 in 100,000 per kilometer per year over a 40-year operating time frame. Statistics like that are hard to grasp for a layman, but it means there should be few outright fiber failures for a normal fiber installation during that time frame. This means that fiber ought to easily last forty years and far beyond. Nobody will yet say how much further beyond, but I talked once to a few scientists from Corning and they told me their best guess is at least 75 years; we are going to all have to wait around to see if that is true.

The same scientists have studied real life applications of fiber and have calculated that the chances of buried fiber being cut is 1 in 1,000 per kilometer per year. This means it is 100 times more likely to cut a fiber than to have it fail from inherent flaws. Again, statistics like this aren't straight-line ratios, but it you operate a 500-mile fiber network, this tells you that you can expect a fiber cut every year or so. Of course, some networks do worse than that. Outages from fiber cuts and the consequent weaknesses created by the repair splices are a far greater threat to your fiber network than any degradation of the fiber. So bury it deep!

Electronics Obsolescence. Fiber electronics don't last nearly as long as the fiber and have to be replaced periodically. The questions that should be asked up front are how long the first set of electronics used will last, and how the business will afford to upgrade when the time comes. There are a few reasons in the industry for replacing electronics—functional obsolescence, technical obsolescence, and vender obsolescence.

Functional obsolescence comes from a time when the electronics stop working well and problems cause too many outages. When FTTH electronics were first introduced the industry the maxim was that most electronics would last 7–8 years. However, the state of electronics has changed significantly since 2000 when the industry began. Electronics today are largely solid state and much of the brains of most electronics are embedded in chips. Older electronics had a lot more circuit boards that contained multiple electronics components, and circuit boards would shrink or grow a little, even with small temperature changes and often had problems eventually. Solid state electronics in general last a lot longer.

Functional obsolescence comes from the electronics no longer meeting the demand of the network. We see this most commonly on the electronics that are used to provide bandwidth between the network core and the neighborhood huts and nodes. When FTTH networks were first built, most connections between the core and huts were designed to carry 10 Gbps capacity. Over the years, as customers use more data, these links often have grown too small to handle the needed traffic volume and networks have had to upgrade these links to something faster. The same thing happened on the customer end with the first generation of FTTH electronics that was called BPON. That technology delivered a little less than a gigabit to share with the customers on a PON node (up to 32 homes). In many cases that grew to be too small and networks upgraded to GPON which more than doubled bandwidth. Today there are some network owners contemplating upgrading the customer connections to have a 10 Gbps capacity, and eventually this is likely to become the new standard. But most networks more easily solved this issue by not putting too many customers on a given PON. Cutting the customers from 32 to 16, for example, has the same practical result of doubling the laser speeds.

Finally there is vendor obsolescence, which is always the most frustrating. Vendors sometime fail and go out of business, meaning that a network owner can only find replacement electronics on the open market (like on eBay). More commonly, vendors stop supporting older generations of electronics. The lifecycle of an electronics vendor is that they always have to be improving what they sell. They need to make electronics smaller, faster, or less costly, and over time they keep tweaking electronics to make them better.

At some point they've made enough changes that the newest equipment might not be backwards compatible with older systems (meaning you could no longer buy a newly-manufactured replacement for a given component.) At that point vendors often stop supporting older equipment. This means they no longer manufacturer it. It also means they stop making improvements to the discontinued electronics. They no longer make software updates. They often lose the experts who understood the older equipment.

Network owners always have a choice of what to do with vendor-obsolete electronics. Generally, it's still working well. The network owner just needs to decide if they feel comfortable that they would be able to keep the network running if they encounter a big problem. Therefore, availability of spares and replacement components generally are the major issues that drive a network to replace electronics that have become vendor obsolete.

Municipal Purchasing Rules. We've seen that municipal purchasing rules can add to the cost of building a network. While these rules have the goal of making sure that a city doesn't overpay for things they purchase, the rules can add costs when buying something as complex as a fiber network.

The majority of networks built in the country are constructed by commercial companies and this means that the vendors in the industry are not used to working with municipal purchasing rules. We've seen that this generally leads to them padding their prices in a response to a municipal RFP to make sure they can be profitable. They are generally concerned that working with a city will be more difficult and so they build safety against unexpected cost increases into their bids.

Commercial companies are free to negotiate prices with vendors. In addition, they often work with the construction contractor to find ways to reduce costs during the build. For example, a commercial builder will likely have a representative in the field to discuss the lowest cost way to build each street or to engineer around impediments discovered during the construction process. The municipal purchasing process often makes this kind of real-time adjustment to the build process difficult or impossible. We've seen purchasing processes that allow for change orders to the original specifications that have added significant cost to a project.

D. The Basic Business Models

This section of the report looks at the basic business models considered in the study: a retail model and an open-access model. The following looks at the pros and the cons of these business models.

Retail Business Model

The primary option studied was the city becoming the operating ISP. Having an owner/operator of a network is often the most efficient and cost-effective way to operate.

Advantages

> Achieving Community Goals. Communities that choose the public ownership option generally have specific goals and values. These generally include community betterment and community investment. Communities generally have a goal to solve the digital divide and to bring affordable broadband to every home that wants it. Most communities also hope to use a fiber network to spur economic development and to make it easier for existing businesses to operate in the community. Achieving these kinds of goals is harder if a city builds a network but somebody else operates it.

Local Ownership. Communities often choose this option to provide for local accountability and on reaping the benefits of operating a fiber network from within the community. There are numerous benefits to a community from operating a business using all local employees. Communities also like the idea of not sending profits from telecom spending to the giant ISPs that are located in far-away cities.

City Control. In this operating model the city would get to establish the general policies and goals of the business and change those goals over time as needed.

Disadvantages

Financial Risks. The biggest disadvantage of building and operating a fiber network is the potential financial risks. Before building a fiber network a city ought to be able to answer the question of what happens if a network does not perform well financially.

The city can finance with pure revenue bonds that are backed only by the revenues of the fiber business. Those bonds are getting more difficult to find since there have been a few defaults of municipal fiber projects around the country. Moreover, even revenue bonds are not risk-free for a city. First, the bonds eat into the credit limit for a city and tie up lending capacity for a long time. Basically, money borrowed to finance fiber restricts a city's ability to borrow money for other purposes. More importantly, a default of a revenue bond is stilled viewed as a default by the city in the financial markets. A city that defaults on a revenue bond is going to be viewed as not being credit-worthy when trying to finance other kinds of bonds. Because of these risks we've lately seen cities that use sources of tax revenues other than bonds to finance a fiber network.

Political Interference with the Business. While having city control of a fiber business can mean using the business to meet community goals, there is also the potential for politics to interfere with the profitability of the business. For example, there are a number of examples of municipally owned telecom utilities that require the city Council to approve rate increases. Since politicians don't want to vote for higher rates we've seen cities where the profitability of the business suffered due to an unwillingness to raise rates. In today's industry anybody that offers cable TV must raise rates every year to keep up with increasing program costs. Therefore, cities need to take steps to shield the business from direct political control.

Open-Access Model

Open access refers to a business model where a city builds a network and then sells access to multiple ISPs. The city's only revenues derive from selling this wholesale access and the various ISPs provide broadband and other services directly to customers.

The open-access model thrives in Europe but has had a more difficult time succeeding in the US. Europe has seen success with open-access networks because a significant number of the large ISPs there are willing to operate on a network operated by somebody else. This came about due to the formation of the European Union. Before the European Union each country on the continent had at least one monopoly telephone company and a monopoly cable TV company, much as has happened here. However, the formation of the European Union resulted in a change in law that opened up existing state-run monopolies to competition. All of the state-owned telecoms and ISPs found themselves in competition with each other and most of these businesses quickly adapted to the competitive environment. This contrasts drastically with the US market where there is no example of any large cable company competing with another and only limited competition between large telephone companies.

When a few cities in Europe considered the open-access operating model they found dozens of major ISPs willing to consider the model. There are now large open-access networks in places like Amsterdam and Paris as well as hundreds of open access networks in smaller towns and cities. The big networks have over a hundred ISPs competing for customers—many of the ISPs with niche businesses going after a very specific tiny slice of the market. Due to that level of competition, the European fiber networks get practically every customer in their market since even the incumbent providers generally jump to the new fiber network.

That hasn't happened in the US. There is not one example in this country of a large telco or cable company agreeing to operate on somebody else's network to serve residential customers. The large ISPs here will lease fiber outside of their footprint to serve large business customer, but they have never competed for smaller businesses or residents in each other's monopoly footprints.

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

Open access network operators have struggled in this country due to the nature of the small ISPs on their network. Consider the example in Chelan County, Washington that today has only one local ISP that is selling to residential customers on an open access network. The network originally had almost a dozen ISPs, but over the years the ISPs either folded or were purchased by the remaining ISP. It's hard to even call the Chelan County network open access any longer.

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

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

- The PUDs in Washington State. These are countywide municipal electric companies. The PUDs are restricted to being wholesale providers for broadband due to legislation passed a number of years ago. There are numerous different open-access models being tried at various PUDs, with the largest being Chelan PUD, Grant PUD, and Douglas PUD.
- Utah has a similar law that applies to municipalities. This led to the creation of an open-access fiber business in Provo and another network called Utopia that serves a number of

small towns. The Provo network was losing a lot of money and the city decided to sell the network to Google Fiber for $1. Utopia is still operating a wholesale business but has had significant financial problems since inception. Utopia doesn't charge ISPs to get onto the network. Instead, when a household joins Utopia, a customer accepts a lien on their home, and has the option to pay $300 down and $30 per month for 10 years, zero down and $25 per month for 20 years, or a flat payment of $2,750. The arrangement allows ISPs to offer services like 250 Mbps fiber for $35 per month.

- A similar law was passed in Virginia after Bristol Virginia Utilities (BVU) built a retail fiber network. The legislation grandfathers BVU as a retail provider but only allows other cities to operate open-access networks. So far the wholesale model has been adopted by a few cities, the largest being Roanoke, which offers open access on a limited basis to only parts of the city.
- Tacoma, Washington chose a wholesale model where the city is the retail provider of cable TV, but connections to the network for telephone and broadband are sold wholesale to ISPs.
- Ashland, Oregon operates an open-access network, but the city also operates as a retail ISP on the network and competes against a few local ISPs that sell on the network.
- There are a number of municipal networks that have built fiber rings and which are promoting "open access" to carriers. For the most part these networks only service business customers. An example of this is AXcess Ontario in Ontario County, NY.
- Other communities have tried to build open-access networks but then were unable to find any ISP partners. For example, Longmont, Colorado tried to launch an open-access network, but since they were unable to find ISP partners they now offer full retail services directly to residents.
- There are other cities that are considering open-access networks. The largest of these is San Francisco, which is considering funding the network entirely through a "utility fee" charged by the city to every home and business in the city. The plan envisions offering free or low-cost access to ISPs.

Advantages

Customer Choice. The most appealing aspect of an open-access network is that it offers a variety of choices to customers over the same fiber network. Many cities hope to offer open access for this reason.

Disadvantages

Retail/Wholesale Revenue Gap. As described above, there is a big difference in the revenue stream between collecting the retail revenue stream (all customer revenues) and a wholesale revenue stream (the fees charged to the ISPs for access to the network). Unfortunately the cost of the network for an open-access network is only a little smaller than the cost of a retail network, and so the lower revenue stream makes it exceedingly difficult to cover the financing costs of the network.

Many open-access networks have operating revenues that are sufficient to operate the network, but we don't think any of these networks are generating enough revenue to cover the cost of building the network. That means open access is only reasonably possible if the network is paid for by some revenue stream other than the open-access revenues.

Not Many Quality ISPs. Every open-access network that has been tried in the US has had trouble finding and retaining ISPs on the network. Some examples are discussed above. The ISPs willing to operating in this environment are generally small and undercapitalized. Open access then forces these ISPs to compete against other small competitors, which holds down end-user rates, but which then also puts pressure on ISP earnings. Two of the largest open-access networks in Chelan County, WA and Provo, UT essentially lost most of the ISPs over a decade of operations.

Leads to Cherry Picking. The open-access model, by definition, leads to cherry picking. If ISPs are charged to use the network, then these fees will generally lead them to not want to sell to low-margin customers. In real life practice we see the ISPs in an open-access network only pursue business customers and high-end residential customers.

No Control Over Sales Performance. The network owner in an open-access network has no control over the customer sales process. That means they only do as well as the ISPs on the network. Every open-access network we know of has gotten fewer customers than they predicted. This is due to both the cherry picking by ISPs, but also due the fact that many small ISPs don't have the money or experience to operate effective marketing campaigns. They tend to spread more by word of mouth.

Stranded Investments. One interesting phenomenon that especially affects open-access networks is stranded investments at customer premises. When a customer moves or stops service with a network operated by one entity there is usually a big push to reestablish service at that location. However, in an open-access network the many ISPs don't make this same effort. Therefore, over time there grows to be a lot of homes and businesses that have gotten a fiber drop and ONT housing that are no longer used and are not repaying the cost of installation. One of the larger open-access networks has 20,000 active customers but also 5,000 of these abandoned customer investments.

E. Operations and Maintenance Considerations

The RFP asks us to look at various operations and maintenance considerations that can affect your success when entering the fiber business. The following discussions are based upon our experience in working with hundreds of ISPs. We have seen what works and doesn't work in operating fiber businesses.

The following list could easily be titled: The Things that Can Go Wrong as an ISP. Failure to do any of the functions well described below can result in lower profitability or lower customer satisfaction.

Pre-Launch

Well-Designed Survey. Success begins in a fiber launch with an accurate and believable survey. We know from experience that a survey done properly is a good indicator of the number of eventual customers a new business might get in a market.

There are a number of factors that are involved in performing a survey for which you can believe the answer:

- For a survey to valid the questions asked must be unbiased and can't lead respondents into answering in a given way.
- It's also vital for the survey to be administered randomly, which is a lot harder than it sounds. A lot of companies mail surveys to potential customers and this fails the random test, and you then can't believe the results of the survey.
- If a survey is to be administered by phone, it's vital these days to include cellphones in the calling base. Calling only those with landlines tends to bias the survey towards an older and more conservative set of respondents.
- A survey has to be given to enough people to be statistically valid. If you don't get enough responses you can't believe the answer. Most business surveys shoot for an accuracy of 95% plus or minus 5%, meaning that if the survey was given to everybody in the community you would expect the same results, within 5%. It generally takes 350 or more surveys to get that level of accuracy.
- Another factor to worry about is a well-known phenomenon called survey fatigue. If you ask too many questions a lot of respondents will not complete the survey.
- It's also worth noting that while surveys are a good indicator of a potential residential market, surveys don't work well for the business market. There are a number of reasons for this. Primary might be businesses don't know ahead of time how they might react to a new offering on a fiber network. They are going to weigh all of the facts after the network is up and running. Businesses don't change broadband or telephone providers casually and they usually kick the tires hard before making a decision. This means their responses to a survey might not represent how they will actually act later.
- Finally, you can't over-interpret the results of a survey. If the survey is statistically valid then you can believe the responses to the big questions. For example, you can have faith to responses to a question such as, "Would you be interested in changing broadband providers if a new provider brought fiber to your home?" But if you look deeper into the responses to that question you can't have faith in subsets of the response. For example, you can't make any definitive statements about how men versus women felt about the response unless you asked a large enough sample of each of those groups the question.

The bottom line is that you ought to find a survey firm to help with a survey who understands the right methodology, understands statistics, and understands how to interpret the responses.

Project Management. Launching a new fiber business is a complicated undertaking. There literally might be a few thousand different tasks needed to launch the business. We have found through experience that the only way to handle such a complicated undertaking is to use a formal project management tool like a Gantt Chart. This is a tool that identifies each task, defines who is responsible, puts the task on a time line, and relates the task to what they call predecessors (tasks that must be finished before the task can start) and dependents (meaning tasks that can't start until this task is finished). A finished Gantt chart then can do two important things. It can identify the critical path, meaning any tasks that will delay the entire project if they aren't finished on time. The Gantt chart also automatically changes the schedule to account for any task that is finished late.

We've found that launches that use a Gantt Chart properly can finish on schedule, while we've never seen a launch that doesn't use the tool launch on time. The key to that statement is to use the tool properly and everybody associated with the launch needs to participate in the process.

Marketing and Sales Plan. The number one problem we've seen for fiber businesses that are unsuccessful is a poorly defined or executed marketing and sales plan. Most financial problems experienced by ISPs can be solved by selling to more customers.

We went to a sales training seminar a few decades ago and still remember one piece of advice we got there—sales success is not random. This means that a company will perform best when having a well-designed sales plan that can achieve the needed sales goals and stay within the budget of the business.

There are a lot of different components to a good sales and marketing campaign:

Pre-Selling. There might be no more important ingredient to success in launching a new fiber network than pre-selling to customers. For many years the industry operated under what we call a build-it-and-they-will-come philosophy, and this meant building networks with the hope that eventually there would be enough customers on the network to make it work. If you look around the industry at the handful of failed municipal fiber ventures almost every failure is due to not getting enough customers. If you are working with a limited amount of funding (which is almost always the case), then revenues from new customers must be built to a level to sustain the business before the funding runs out.

Most successful fiber launches stress selling and start the marketing the day after financing is done. There are huge advantages to having customers on-board before construction gets to their neighborhood. The cost of adding a customer is significantly less if the contractors doing the work can add multiple customers in the same neighborhood at the same time.

The Right Sales Techniques. While every market is different, we've seen some techniques that seem to work well in most places:

- Door-to-Door Sales. By far the most successful method of selling with a new network is to knock on doors and tell people about the new network and the new products. No other sales process produces results even close to a door-knocking campaign. This is not to say that there should not also be other marketing being done, but knocking on doors will get the most customers the fastest. Door-to-door campaigns are often done by placing door-hangers in a neighborhood shortly before a salesperson knocks on doors.
- Sales Software. There is one software program on the market that we've seen help in a pre-sales campaign. It's from COS Systems from Sweden and mimics the

"fiberhood" sales process used by Google Fiber. It allows people in the community to sign-up for service online. It encourages people to invite their neighbors to sign-up. It communicates well with the public and keeps them informed on the progress of fiber construction.

- Other Pre-launch Marketing Techniques. The key to a successful pre-sales campaign is to get the word out that fiber is coming. Many customers will seek out a new ISP once they hear about the network. There are a few common tools that seem to work well. This includes billboards that announce the coming network. I've seen ISPs that have been successful by holding neighborhood events like ice cream socials or barbeques in each new neighborhood as part of the pre-sales campaign. Obviously you want to the press on board, but we often seen print ads see little success. It's important to get the city government, the chamber of commerce, the schools, and other key institutions on board and on your side.
- Don't Use Mailers. The technique we've seen have the worst success rate is selling a new network through mailers. This isn't hard to understand when you realize that most companies that advertise through the mail are happy to get only a few percent response to each mailer cycle. While a new fiber business needs some literature to leave behind with interested customers, we advise not spending too much on this. A few well-designed pieces should be sufficient.
- Consultative Sales for Businesses. There is only one tried-and-true technique for selling to business customers. It's called consultative sales and requires a multi-visit approach to win over each potential business customer. It starts with gathering the current bills from a business and asking them enough questions to understand their telecom needs. It then means making a proposal on a solution that needs to generally be more than just a lower price, but which takes the specific needs of the business into consideration. This process is labor intensive and we advise ISPs to not expect getting too many business customers quickly on a new network.

Sales Commissions. Most telecom salespeople expect to earn sales commissions. A few things to keep in mind about sales commissions:

- Cities are often precluded from paying commissions to employees. The most common way around this is to hire contract salespeople rather than employees.
- A commission plan needs to have a good balance between base salary and commissions, with most of the income coming from commissions.
- A commission plan must change over time to reflect the growth of the business. You should have one commission plan at the start of the business when you have no customers and a different one later after you have many customers and it becomes harder to get new sales. A good commission plan also rewards salespeople for getting customers to renew contracts.
- A commission plan needs to have the right incentives. For example, if the sales plan pays the most for selling plain broadband without other products, then that's what the salespeople will sell.

Define Processes. We've found that an ISP is more successful and profitable if they take the time up front to define their processes. Being an ISP means engaging in numerous repetitive functions in dealing with customers or vendors and standardizing the processes involved makes a huge difference. This includes such things as: taking orders, provisioning (getting a customer ready to connect to the network), taking and responding to customer troubles, billing, disconnects, etc.

It's important that an ISP define these processes and makes sure that all of the employees follow the same procedures. For example, numerous problems will arise over time if technicians use different processes and techniques when installing a new fiber customer. It becomes difficult and time consuming later when troubleshooting if you can't be sure of a customer's configuration.

Processes don't have to be cast in concrete and ought to be changed when you discover better ways to do things. It's still essential, though, that changes in process are formal and that everybody knows about them—without a formal way for changing processes, over time there will be no processes.

There are numerous tools that can be used to define the most efficient processes and to keep them up to date.

Triple Play Products

ISP Functionality. Today most of my clients outsource their ISP functionality. These are the many processes that are part of offering a broadband product. ISP functions include such things as DNS routing (getting customers to the Internet), email servers, spam filtering, preventing and curing viruses and malware, etc.

Historically, ISPs did these tasks themselves, but there are now a few large vendors that most small ISPs use to perform these function for them. These processes can be done more affordably by a large vendor since there is an economy of scale with all of these functions. A large ISP vendor also will have far more technical expertise than a small ISP and can better deal with malware, denial of service attacks, and other problems that can cripple a broadband network.

WiFi. Not all fiber ISPs offer WiFi to customers. But in the last few years as customers want to connect multiple devices to their home network, ISPs are finding that a big percentage of the trouble calls they get from customers are really issues with the home WiFi network rather than with the signal from the ISP.

There are several options if an ISP wants to offer WiFi on a fiber network.

- WiFi Built-in ONT. Indoor ONTs can come with WiFi. This is the least expensive way to offer WiFi from the perspective of hardware cost. But at CCG we don't recommend this option. We've found that ONTs last a long time, and from a cost perspective it makes a lot of sense to not have to replace ONTs. If WiFi is built into the ONT then the entire unit will likely have to be replaced if the industry migrates to a newer and faster WiFi standard, as is scheduled to happen a few years from now with 802.11ax.
- Standalone External WiFi. Some of our clients instead provide a standalone external WiFi unit. They generally buy something that's better than what most customers would buy at an electronics store.
- Networked WiFi. One of the issues with installing a single WiFi router is that it often won't reach everywhere in a home. This is becoming more of an issue as people use devices all

over the home on WiFi, including their cellphones. The solution to this is to offer a WiFi network. This consists of multiple routers that are linked together to create one network. That means one password for the whole home, plus the ability to locate WiFi routers wherever a strong signal is needed. These units can make wireless links to connect or they can be connected through MOCA using existing coaxial cable or through the home wiring using broadband over powerline.

ISPs are all over the board on how to charge for WiFi. Some include one hotspot for no additional fee. Others rent the WiFi routers for a monthly fee. The newest idea is to offer a product called Managed WiFi. With this service the ISP offers support with WiFi. For example, the ISP can peer into the WiFi network to identify and fix problems. They can help customers who are having trouble connecting to a new device. ISPs charge for this and it's a good source of revenue, but it also provides an advantage to the ISP to be able to see deeper inside a customer's network to identify and fix problems without truck rolls.

<u>VoIP (Voice Over IP)</u>. Very few new networks today launch a telephone product using their own voice switch. Our analysis over the years has shown that it doesn't become economic to operate a voice switch until a business has 3,000 – 4,000 telephone customers.

There are several vendors that sell quality VoIP products wholesale and who make it easy to deliver voice to customers. Most VoIP offerings are simplistic. For example, there might only be two residential products—one with unlimited nationwide long distance and another without. Most VoIP providers also offer the most basic kinds of business telephone lines, including those that we think of in businesses that can be used to easily do functions like put calls on hold or transfer calls.

The wholesale VoIP is not going to be sufficient to handle a complex voice customer like a hospital, college or large business—but these kinds of businesses rarely would buy voice from a small provider.

This study assumed the use of outsourced VoIP. The process of providing voice directly is both costly up front as well as time consuming.

<u>Wholesale Cable TV</u>. The study also considered wholesale cable TV. Building a new cable TV headend from scratch can easily cost $3M – $4M, so only companies that expect to get a lot of cable customers would consider that option today. There are only a few nationwide wholesale cable TV options. Most new market entrants share a headend with another local ISP.

There are two regulatory options that impact the cost and the timing of implementing a TV product. Even if you share another headend, if you want to be the cable provider then you must obtain a local franchise agreement and you also must contract with all of the various programmers to buy content. Those processes, particularly the acquisition of content, can take 6–9 months.

The alternative is to let somebody else be the cable company of record on your network. This is the fastest approach, but there is probably little or no compensation from letting some other provider on your network.

The other big expense to be mindful with outsourced TV is the transport required to carry the signal from a distance headend to your network. Depending upon the exact method of delivery and the compression being used this can require as much as a dedicated 10 Gigabit data pipe.

Operational Issues

Level of Staffing. One of the most common mistakes that municipalities make over time is to overstaff the business. Labor is generally the most expensive ongoing cost of running a fiber business and it's important to not let labor costs climb above forecasted budgets. Cities in general are not experienced in operating competitive businesses. There is probably no commercial fiber provider who wouldn't tell you that they are understaffed. But they always find ways to get things done while in that condition.

Controlling Truck Rolls. ISPs report that one of the things that can erode profits is extra or unneeded trouble rolls to customer locations. I've had reports from numerous clients that as many as 20% of visits to customers fail due to the customer not being at home when scheduled.

ISPs use various tools to mitigate the problem. One solution is to use texting as a way for the technician to communicate with customers in real time. I'm told this significantly reduces missed appointments.

Other tools used are diagnostic tools that can often pinpoint the source of customer problems without a truck roll. As described above, ISP access to an indoor WiFi network can give an ISP a deeper look into customer networks.

Management Span. Unless your new ISP is going to end up with tens of thousands of customers, your organizational span of management ought to be wide, meaning that most employees report to the general manager. As mentioned in the report, labor costs are generally the biggest single expense in operating a fiber network and smaller networks cannot easily support intermediate management personnel who supervise rather than perform needed functions.

Efficient Installations. Another place we see cost overruns is during installations. It's vital that you define exactly what is included in a "typical" installation. We've seen companies that try to accommodate every customer wish for free and who end up spending twice as much money on installations as budgeted. One of our clients calls this "letting customers drive the ship." It is important to define what is and is not included in an installation and have a ready price list for customer to choose additional options to keep installations within budget.

Help Desk. An associated function to ISP functionality is the help desk function. This is the function of providing first-line technical support to customers to answer their technical questions or to help them with computer-related issues. Many new ISPs are surprised to find that most customer calls for technical support are for customer questions about computers or viruses or issues other than your specific delivery of services to them. But small ISPs have also discovered that helping customers with these kinds of issues is the easiest way to foster customer loyalty. So most small ISPs encourage such calls from customers, within reason.

This is a difficult position to staff for in that customers expect somebody to be available to talk to them during business hours. Small ISPs try to handle these calls using their technicians and quickly realize that it can eat up all of their time. Therefore, the choices are to build a dedicated group to take these calls or to outsource the function. The companies that offer outsourced ISP functionality also offer this service and I have many clients who are satisfied with the level of service this provides for customers.

OSS/BSS Systems. The most important component for operations is a software product called OSS/BSS (operational and billing support). There are more than a dozen different vendors of the software.

The typical OSS/BSS software does the following functions:

- Provides the platform for taking customer orders.
- Provides the platform for provisioning a new customer, that is it notifies the correct employees of the tasks needed to provide service to a new customer on a timely basis.
- The platform provides a way to receive and track customer problems. It will log in customer complaints and notify and coordinate the staff needed to make repairs.
- The systems provide all of the components needed to bill customers. Many of the platforms will create customer bills.
- The system captures the history of customer payments and contain notification and disconnect processes for customers who don't pay their bills.
- These platforms sometime contain records that make it easier to diagnose customer problems. For instance it might tie into mapping or other software that can associate specific fiber routes, fiber pairs, and electronics with each customer. But not all systems do this.
- ISPs often tie these systems to other software. For example, the OSS/BSS might communicate directly with accounting software to track billing and customer payments. The software might tie in texting or other platforms that communicate with customers. The platform might tie into software like fleet management that coordinates field visits by technicians.

The prices for these platforms vary widely. We have clients who have spent over $1 million to purchase a system—and purchase is a loose word since there are usually annual maintenance costs for the software. At the other end of the spectrum are systems with small upfront costs but more expensive fees to use and maintain the software.

One thing that We've always found to be good advice is based on the fact that we don't think that CCG has one client who is happy with their OSS/BSS. There are always things that any good system does well and others that are done poorly. A common complaint is that it's often expensive to make any specific changes to a platform to customize it for your business. We highly recommend talking to other similar entities to see what they are using for this function. The systems are complex and the salespeople for the software will claim that the software will do everything under the sun, and none of the systems are that good.

Billing. Telecom billing can be simple or complicated depending upon the product mix being sold. Billing can get complex when it includes capturing and billing for specific customer usage such as long distance or pay-per-view programming. Billing can be simpler if an ISP has a set of standard products and charges the same to everybody.

One of the primary goals ought to be to reduce the number of bills that are mailed to customers. ISPs use techniques like charging credit cards or debiting bank accounts to avoid mailing bills.

ISPs wrestle with outsourcing the billing function. There are numerous vendors who will print and mail bills, but the function is not cheap. There are others who will maintain a lock box to receive payments, at a cost.

Operating a Storefront. Most smaller ISPs try to maintain a storefront presence in each market. The larger telcos and cable companies have largely eliminated storefronts but there are still a considerable percentage of customers who want to occasionally visit their ISP or make local payments.

After-Hours Support. ISPs need to offer business hours that meet their customer needs. For example, an ISP operating in a bedroom community needs to offer evening business hours to be able to communicate with commuters. In such communities there also ought to be evening installations and repairs.

These after-hours policies also extend to weekends; ISPs need to find a way within their budget to meet customer expectations. Most small ISPs keep technicians on call and will dispense somebody to correct major outages at night and on weekends.

It’s possible to outsource customer service 24/7, but most small ISPs don’t do this since after-hours vendors can generally only provide rudimentary assistance to customers.

Differentiating Between Residential and Business Customers. Most ISPs with any significant number of business customers generally maintain different processes and standards for business customers. For example, many ISPs won’t go home for the evening if a business customer is out of service. Small ISPs often assign a specific customer service rep to business customers so that they can get to understand the customer’s needs.

Regulatory Compliance. Depending upon the state you are operating in and upon the mix of services being offered, an ISP is likely to have some regulatory compliance rules to follow. They might have to make periodic reports to the FCC or to the state regulatory agency. There are also often regulatory hurdles to overcome before getting into business and ISPs often have to register with or be certified by regulatory bodies.

This report was not intended to be an advertisement for CCG services, but many of our clients outsource all of their regulatory compliance issues to us.

Dispatch. Dispatch is the function of scheduling interactions with customers, generally by field technicians. The perfect dispatching tool would minimize truck miles driven, eliminate missed appointments when customers aren’t home, makes sure that the technician has the right tools and components to satisfy a given customer visit, and would send a technician who is best able to fix a given issue. The bigger the company and the more technicians in the work force, the more complicated of a puzzle this can be.

The benefit of good dispatch software is that technicians might be able to visit more customers in a day rather than driving unneeded miles or sitting idly between appointments. There is a full range of this software available. It often comes embedded in the OSS/BSS system, although many clients report better results using more specialized software.

Network Issues

Indoor versus Outdoor ONTs. Today all of the makers of PON technology offer both indoor and outdoor ONTs. ISPs generally choose one of the two options in order to standardize on customer installations and troubleshooting.

There are a number of reasons why some ISPs still prefer outdoor ONTs. An outdoor ONT allows technicians to install and service the ONT without having to schedule and coordinate with customers. In today's world of working families this is often a huge plus in getting access to the ONTs during working hours. Outdoor ONTs are generally undisturbed once installed and customers rarely touch them. An outdoor ONT creates a clear demarcation point between the ISP and the customer—making whatever is inside the responsibility of the customer.

There are also advantages of indoor ONTs. They can be plugged into wall power outlets while outdoor ONTs sometimes require running a new power line. This means it's easier to move them to the best location in the home. Being inside often makes it easier to connect the fiber network to the existing phone lines to provide phone service. As mentioned elsewhere, an indoor ONT provides the ISP with a way to peer deeper into the customer network to aid in troubleshooting.

Network Monitoring and Escalation. Modern networks come with a host of built-in alarms that will notify the network operator of problems. Additionally, customers will notify the ISP about specific outages or service problems.

The ISP needs to have an organized way to sort through the reported problems, prioritize them, and fix them. For example, an alarm might report some issues that need eventual, but not immediate, attention while some network issues require the full immediate attention of the whole company.

This requires two tools. First is software that captures all of the alarms and reported problems and prioritizes them. These can generally be customized since every ISP will have their own ideas about how and when to respond to specific types of problems. Many of my clients outsource this function to a NOC (network operating center), which is a group of technicians that watch networks and decide the priority of repairs. Most NOCs offer the service of their technicians fixing problems when this can be done remotely. Often repairs can be made before customers even realize there was an issue.

There also needs to be a well-defined escalation process. ISPs need to define ahead of time how they want to deal with each kind of expected problems. Some issues are just routed to technicians for dealing with routinely. Others escalate to other specialists inside or outside the company when more help is needed. This external escalation might include contacting management, a NOC center, electronics vendors, or external fiber network providers. It's vital to know exactly who and how to contact the needed parties before there is an emergency.

Spares. A fiber network owner needs to maintain the spares needed to effectuate quick repair on the network. Companies generally keep an inventory of key electronics spares as well as spare fiber needed to make field repairs.

It's only necessary to keep spares for electronics components where failure will shut down the network. Key electronics today often come with hot back-up spares in the system, meaning that there are two units for key components arranged so that the switchover is immediate in case of failure.

Regardless of planning, networks still sometimes fail due to smaller network components. We recall a client that had a multi-day network outage that was due to a failed fan that caused an entire chassis to overheat and fail.

Upgrade Policy. We've seen numerous networks have major problems when something goes wrong during an electronics upgrade. During an upgrade the goal is to bring up the new system alongside the old one and then make a quick transition when everything is ready.

Sometimes upgrades go poorly. There might be a problem in the new hardware of software that makes it impossible to complete the upgrade. The problems we've seen usually occur when control is handed to the new electronics that then fail for some reason. If this possibility has not been planned for it can be difficult to cut back to the original network configuration.

We recommend that any network upgrades be well planned and that they always include a quick way to restore the original network in case the network fails.

Redundancy. Redundancy is planning a network that either is self-healing when it has a problem, or at least is quick to fix. The most common example of redundancy is through the use of fiber rings that are designed to survive a fiber cut. In these rings every signal travels in both directions around the ring, meaning that there is no interruption from a single fiber cut. Fiber rings are generally only used for major parts of a network and there are usually not a lot of redundant rings in the last mile network.

As mentioned earlier, many key electronics can also be made redundant, and this should be considered for any component for which failure would cause a large network outage. Where it's not possible for this to be done automatically there should be a plan in place to do it manually as quickly as possible.

Mapping. We think it's important for a fiber network owner to capture the details of the network to make it easier in the future to diagnose and fix network problems. There are numerous "mapping" software options on the market that can capture the needed information. However, these programs might better be called mapping databases because they capture a lot of details that are not really mapped. Relevant information includes things like the fiber strands throughout the network that are used to serve each customer, as well as the serial number of all electronics at the customer premise.

Good systems can capture a lot more and can include things like capturing the history of trouble calls and repairs made at each customer or site on the network. Some systems even include the ability to attach pictures, documents, and anything else that might be relevant in the future for a technician responding to a call at a given address.

We have known carriers that have put together their own database at a low-cost up, as well as ones that have bought software costing hundreds of thousands of dollars.

Understanding Equipment Lives. Every component in the network will eventually wear out and need to be replaced. This is referred to as the useful life and can be a long time for fiber and a relatively short time for components like settop boxes. Sometimes network components need to be replaced for other reasons, such as when a vendor stops supporting a given version or kind of electronics, which we call vendor obsolescence.

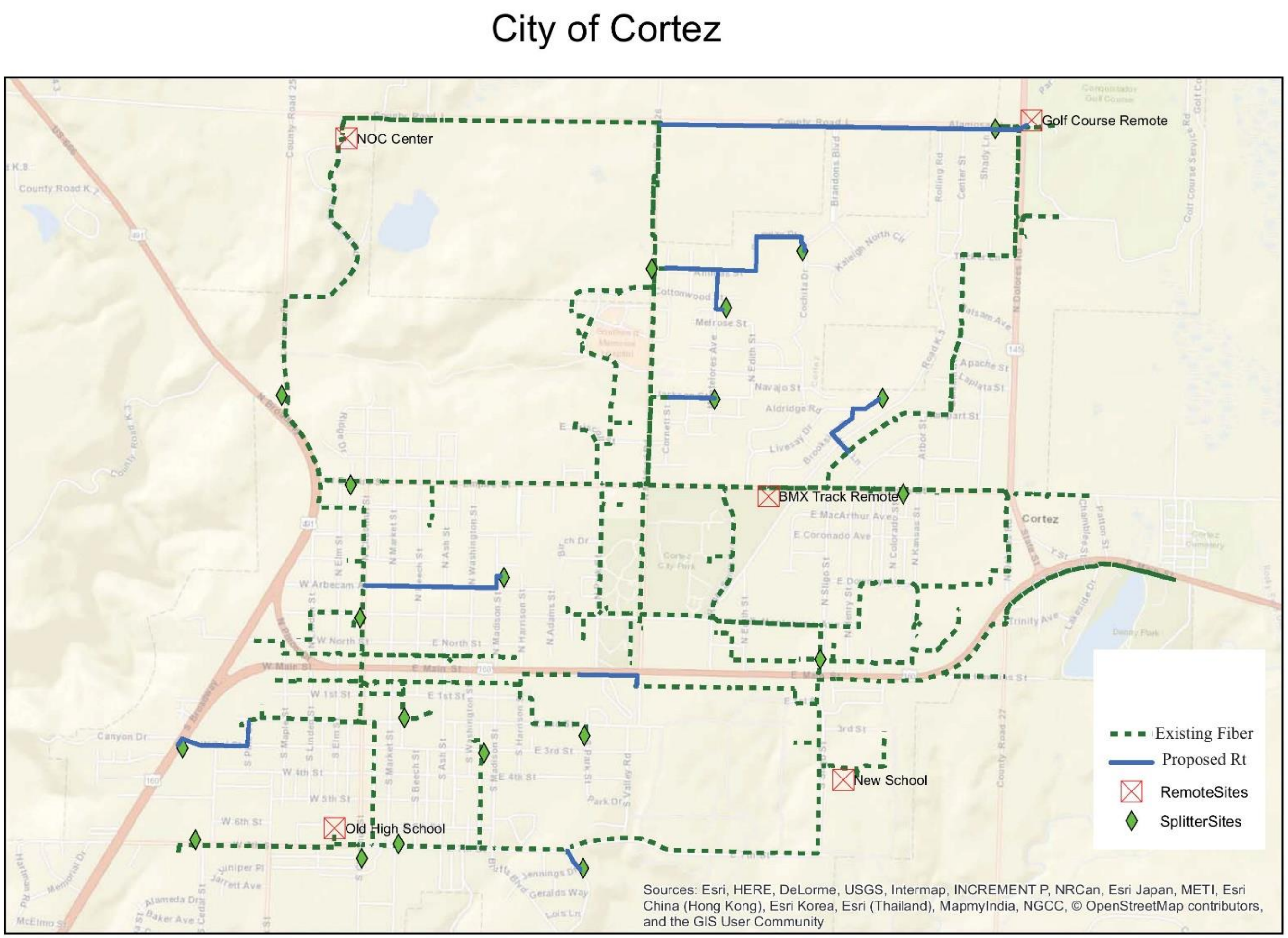
Any long-term business plan needs to anticipate the needed replacements and plan to have enough cash to make upgrades.

Maintenance Agreements? Carriers in the industry are of mixed opinions about maintenance agreements on electronics. Most vendors these days sell network maintenance plans that include upgraded software as needed as well as priority maintenance for components that fail.

CCG has clients who refuse the buy the maintenance agreements. They believe (rightfully) that over time the maintenance agreements can cost more than the original cost of the equipment and they believe they are better off by instead dealing with failures as they occur.

Trying New Technologies. It's always tempting to try new technologies or a new vendor who is competing with existing technologies. But we have learned over the years to be cautious. We can't think of a client who bought first generation technology who didn't experience significant problems. Sadly the vendors in the industry use their first few customers as their testing lab for a new product rather than vigorously testing in lab conditions. We even had a few clients who failed when a new technology failed badly—so be careful. We generally recommend not taking the chance unless there is no alternative.

Appendix I: Map of the Proposed Network Design



Appendix II: Summary of Financial Results[1]

	Assets	Take Rate	Tax Funding	Bond	Year 25 Cash	Net Inc Positive	Cover Debt
City as ISP – Bond Funding							
1. All Buried	$14.3 M	50%		$19.3 M	-$19.6 M	Year 25	Never
2. All Buried with Cheaper Drops	$13.0 M	50%		$17.6 M	-$16.4 M	Year 25	Never
3. Aerial/Buried	$10.8 M	50%		$14.6 M	-$11.8 M	Year 25	Never
4. Aerial/Buried with Cheaper Drops	$10.1 M	50%		$13.6 M	-$ 9.9 M	Year 25	Never
5. Line 3 with GO Bonds	$10.8 M	50%		$13.2 M	-$10.3 M	Year 25	Never
6. Line 3 with Higher Interest Rates	$10.8 M	50%		$15.3 M	-$14.9 M	Year 25	Never
City as ISP – Sales Tax Funding							
7. All Buried	$14.3 M	50%	$15.9 M		$ 9.4 M	Year 11	
8. All Buried with Cheaper Drops	$13.0 M	50%	$14.5 M		$10.3 M	Year 11	
9. Aerial/Buried	$10.8 M	50%	$12.3 M		$11.0 M	Year 11	
10. Aerial/Buried with Cheaper Drops	$10.1 M	50%	$11.6M		$11.7 M	Year 7	
11. Line 9 at 40% Penetration	$10.1 M	40%	$12.3 M		$ 4.1 M	Never	
12. Line 9 at 60% Penetration	$11.4 M	60%	$12.8 M		$18.8 M	Year 5	
13. Line 9 Adding CATV	$11.2 M	50%	$12.7 M		$10.0 M	Year 11	
14. Line 9 with Higher Prices	$10.8 M	50%	$12.3 M		$14.8 M	Year 5	
15. Line 9 Breakeven	$ 9.8 M	34%	$12.3 M		$ 0.1 M	Never	
Open Access							
16. With Tax Financing	$10.4 M	50%	$11.9 M		-$ 4.4 M	Never	
Digital Divide Scenario							
17. With Normal Prices	$13.3 M	50%	$15.0 M		$11.2 M	Year 11	
18. Prices Reduced by $10	$13.3 M	50%	$15.0 M		$ 3.6 M	Never	

[1] Basic description of each scenario below.

Summary of the Assumptions used for the Above Scenarios

The scenario numbers below match the numbers of the scenarios in the above table.

City as ISP – Bond Funding

These scenarios assume that the city operates as the retail ISP. Results would be similar if the city instead found an ISP to operate the network as a vendor, meaning the city would still own the network and own the customers of the business.

1. All Buried Network

This scenario assumes that the whole fiber network is buried.

2. All Buried with Cheaper Drops

This scenario is based on Scenario 1, but looks at building less expensive drops than what would be obtained from normal fiber contractors.

3. Aerial/Buried

The scenario assumes building new poles in the alleys downtown and burying the rest of the network.

4. Aerial/Buried with Cheaper Drops

This scenario is based on Scenario 3 but looks at building less expensive drops than what would be obtained from normal fiber contractors.

5. Impact of General Obligation Bonds

This is based on Scenario 3 and assumes general obligation bonds instead of revenue bonds.

6. Impact of Higher Bond Interest Rate

This is based on Scenario 3 that increases the bind interest rate by 1 full percent.

Sales Tax Funded

7. All Buried Network

This is based on Scenario 1 with sales tax funding instead of bond funding.

8. All Buried with Cheaper Drops

This is based on Scenario 2 with sales tax funding instead of bond financing.

9. Aerial/Buried

This is based on Scenario 3 with sales tax funding instead of bond funding.

10. Aerial/Buried with Cheaper Drops

This is based on Scenario 4 with sales tax funding instead of bond funding.

11. Aerial/Buried with 40% Penetration

This is Scenario 9 with a 40% customer penetration.

12. Aerial/Buried with a 60% Penetration

This is Scenario 9 with a 60% customer penetration.

13. Adding Cable TV

This is scenario 9 with the additional of wholesale cable TV as a product.

14. Higher Broadband Prices

This starts with Scenario 9 and then raises prices across the board by $5 per month.

15. Aerial/Buried Breakeven

This shows the lowest customer penetration need for Scenario 9, with breakeven defined as a business that always maintains a positive cash balance.

Open Access

16. With Tax Financing

This scenario allows multiple ISPs into the market and charges a $30 monthly fee for a connection to each customer.

Digital Divide Scenarios

17. Same Retail Broadband Prices

This scenario builds fiber to every home and provides for a basic broadband connection to everyone for free. It offers faster speeds at the same prices as the retail scenarios.

18. Reduce Broadband Prices by 10%

This is the same as Scenario 17, but lowers broadband prices across the board by $10 per month.